# The influence of culture, urbanisation, education and gender on local-global perceptual bias

By
Helen Jane Spray
Goldsmiths, University of London

A thesis submitted for the degree of
Doctor of Philosophy

# Declaration

Declaration of Authorship

I Helen Jane Spray hereby declare that this thesis and the work presented in it is entirely my own. Where I have consulted the work of others, this is always clearly stated.

Signed: _______________________ Date:

# Acknowledgments

With huge thanks first of all to my main supervisor Dr. Karina Linnell for her kindness, guidance, and support; I could not have done it without her and her knowledge and advice have been invaluable. A sincere thank you also to my second supervisor Prof. Jules Davidoff whose extensive experience in cross-cultural psychology has provided me with some very useful practical and theoretical advice and much inspiration.

Thank you to Prof. Ilona Kovács for her wonderful hospitality and training during my Erasmus visit at Pázmány Péter Catholic University and to her colleagues and students for all their help and support, in particular to Dr. Eszter Hámori and Zsófia Márki. Thank you to Mike Griffiths for his expert advice and considerable support with the statistical analyses, to Dr. Serge Caparos for his help in the field and general advice and assistance, Zeeshan Syed for his technical assistance and to Robert William Martin for his help during the third visit to Namibia. Thank you also to my internal and external examiners, Dr. Rebecca Chamberlain and Prof. Katsumi Watanabe, whose excellent feedback helped strengthen the final content of this thesis.

Special thanks to all my guides and translators in Namibia, Hungary and Romania for both their professional contributions as well as for their valuable friendships. John and Kemuu Jakurama gave me the best introduction to Namibia I could have hoped for, and Kemuu will be sorely missed. Aparicio 'Chinho' Lopes made me smile every day during my third visit and his hard work was greatly appreciated and Western Muharukua was a great professional and a pleasure to work with. Kinga and Norbert Vicsai in Romania were two of the most kind-hearted people I have met and the data collection in Cluj could not have been organised without them. Thank you also to Zsuzsanna Sági in Hungary who helped greatly with organising testing, translation and providing advice on collecting demographic material and to Tímea Ginter, Katalin Miklósy and Gergely Jezerniczky for their kind assistance with translation and Katalin Juhász for her help with arranging testing. Thank you also to Corrine Mortimer, Natalia Trendler, Michelle Foxwood and Ugo Lo Presti for their help arranging testing in London.

Thank you of course to all the participants, parents, schools, nurseries and youth groups who made the work possible. Thank you to the British Academy and the Economic and Social Research Council for funding the research projects which provided the infrastructure to make the data collection in Namibia possible. Thank you also to the Erasmus programme which facilitated my stay in Hungary and the data collection in Eastern-Europe.

Thank you to all my friends who kept me motivated, especially Michelle Foxwood, who was always there for me, and Dr Ionie Lyon and her son James Lyon who became like an extended family. Finally, thank you to all my family without whose support I could not have made it this far. In particular, thank you to my aunt and uncle Petra and Frank Herzig for taking me in and providing support when I needed it and to my sister Rowan Spray who always managed to make me feel better and who remains an endless source of inspiration. Above all, thank you to my parents Jane and Martin Spray for both their emotional and financial support and for all the love and encouragement they have given me.

# Abstract

We examined the roles of urbanisation and education in shaping the development of local-global bias across culture, age (early childhood to adulthood) and gender. We compared local-global bias, measured by a similarity-matching Navon task, across traditional and urban Namibian, Eastern-European Roma and British populations.

We found considerable within-group and between-group variability in local-global bias and evidence that urbanisation, education, gender and age all contributed to this variance. Effects of urbanisation, education, gender and age were highly interrelated. Higher levels of both urbanisation and education were associated with increased global bias; however, the effects of these variables were not equal for all groups.

Within-group analyses showed that whilst the association between urbanisation and global bias was somewhat stronger for females than males, the association between education and global bias was considerably stronger for males. Between-group analyses showed effects of urbanisation and education that were dependent on both age and gender.

We discuss the physical and sociocultural aspects of the environment associated with urbanisation and education which might contribute to their effects on local-global bias, how these environmental characteristics might interact with biological factors, and psychological factors which might mediate their effects.

Local-global bias does not follow a fixed developmental trajectory and variability in local-global bias may be more widespread than has previously been acknowledged. For example, urbanised, educated women sometimes nonetheless presented with a local bias. This finding also demonstrates that neither urbanisation nor education in and of themselves is sufficient to produce a global bias.

Rather, we suggest that urbanisation and education may *potentiate* a global bias but that a global bias may be realised only if other criteria are met. Sociocultural factors such as SES, environmental stressors and social power are implicated as possible limiting factors; however, their effects are neither tested nor confirmed in this thesis.

# Table of Contents

# List of figures and tables

# Chapter one: General introduction

## 1.1 Thesis overview

In this first chapter, we present a theoretical overview of the processes which underpin local-global bias and the ways in which environmental factors - specifically urbanisation, education and the cultural treatment of men and women - may interact with biological factors - specifically sex and age - to shape local-global bias.

Throughout the empirical chapters of the thesis, local-global bias is indexed by performance on the local-global similarity-matching Navon task. Accordingly, the first chapter is aimed specifically at understanding the theoretical basis for experience-dependent variability in performance on this task. In order to do so, however, it will often be necessary to draw inferences based on evidence from a range of local-global tasks, given the paucity of the available data.

In chapter two we examine the effects of urbanisation and education on local-global bias in Namibian adults. Traditional Namibians have already been demonstrated to possess a local bias, which diminishes as a function of urban exposure (Caparos, Ahmed, Bremner, de Fockert, Linnell & Davidoff, 2012). However, the extent to which the urban environment might impact local-global bias for traditional Namibians and urban Namibians has not previously been tested. Furthermore, education is highly confounded with urbanisation in the Namibian populations, and we make the first attempts to examine their separate effects.

In chapter three we examine the effect of education on two Eastern-European Roma populations. These populations provide an ideal group for examining the effects of education disconfounded from urban exposure. We also examine the effects of literacy.

In chapter four we return to the Namibian populations to examine the effects of urbanisation and education on local-global bias during childhood. We were also able to test a small sample of traditional Namibian children who were attending mobile schools. This allows us to begin to examine the effects of education separated from urban exposure.

In chapter five we summarise and compare the empirical findings from chapters two to four. We relate those findings back to the theoretical framework laid out here in chapter one.

## 1.2 Background

### *1.2.1 Local-global perceptual bias*

Common knowledge tells us that our visual interpretation of the world is subjective; one of the main functions of the visual system is to simplify the vast array of information brought to it by the optic nerve and to prioritise the information which is likely to be the most functionally important. This need to simplify and prioritise certain information over others inevitably means that our visual experiences are based on just one of any number of possible interpretations.

To some extent we are able to control which information is prioritised through top-down control of visual attention. For example, when viewing a painting one might take a step back (in an attentional sense) and absorb the gist of the scene for a moment (prioritising *global* information), then after a while be drawn to a specific feature of interest to examine in more detail (prioritising *local* information).

Yet even though some degree of flexibility is available to us, we are also constrained by ingrained biases to prioritise certain kinds of information over others. With regards to local-global information, research in western adult populations converges to suggest a general processing bias towards the global features of an image (the ‘big picture’ or, the ‘forest’) over more local features (the fine details or, the ‘trees’).

For Western adult participants, even when the task does not specifically require it, global features are typically processed faster and earlier than local features (e.g. Scherf, Behrmann, Kimchi & Luna, 2009), cause more processing interference than local features (e.g. Navon, 1977), and are also weighted more heavily in the final interpretation of local-global stimuli (e.g. Caparos et al., 2012). In other words, Western participants show a general processing bias for the global level of structure.

### *1.2.2 Cross-cultural differences in local-global bias*

Our local-global biases, and other kinds of perceptual biases, however, are not readily apparent to us in our day-to-day interactions with the visual world. Indeed, it is often difficult to avoid feeling that our own subjective visual experiences are in some way ‘correct’ and to recognise that other people may perceive the world in different, though equally valid ways. It is only thanks to the systematic study of perceptual organisation that our awareness of such biases has grown.

The majority of such research to date, however, has been conducted on Western, educated and, typically, adult populations. Generally speaking, also, the focus remains on understanding the commonalities of vision rather than seeking to understand the extent of and root causes of any individual differences.

Of course, the similarities in human visual processing far outweigh the differences, and it is important to build a general understanding of the processes involved. However, focusing on a narrow band of people to build general models of visual processing will inevitably lead to limitations in the usefulness and accuracy of those models.

A global perceptual bias, for example, was once considered to be a universal quality of neurotypical adult perception (e.g., Navon, 1977) that separated human visual processing from that of our primate relatives and virtually all other animals (see, e.g., Avarguès-Weber, Dyer, Ferrah & Giurfa, 2015). Only through cross-cultural comparisons, however, do we now know that global bias is not a predetermined or inevitable feature of the human visual system.

Specifically, evidence that global bias is not a universal quality of human adult perception comes from a comparison of Western, educated and urbanised participants with participants from a remote African tribe living a traditional lifestyle with no formal education and very little exposure to the Westernised, urbanised world. Participants from this remote African population, the Himba of Northern Namibia (see e.g., Bollig & Heinemann, 2002), demonstrated a local bias which was equally as strong as the global bias of the Western control group (Caparos et al., 2012; See also Davidoff, Fonteneau & Fagot, 2008) as measured by a local-global similarity matching task.

Participants from the two populations were given a local-global similarity-matching task where they were asked to say which of two hierarchically structured comparison figures best matched a similarly structured reference figure (see figure 1). Caparos et al showed that the likelihood of perceiving one or the other comparison figure as being the most suitable match depended on the observer's culture or environment. Whereas Western participants made matches based on similarities at the global level of structure about 80% of the time, Himba living in remote villages made matches based on the *local* level of structure also about 80% of the time. In fact, the local bias of the Himba was greater than any other previously documented for either a typical or atypical population.

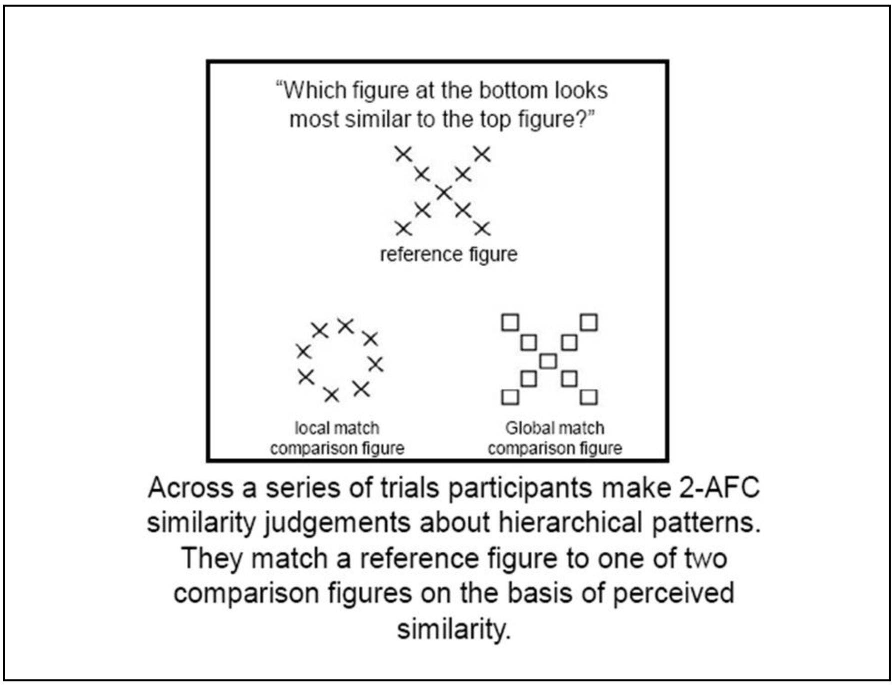



Figure 1. Illustration of the local-global hierarchical-figure (Navon) similarity matching task.

The matching behaviours of Himba participants, furthermore, were shown to be affected by how much they had been exposed to the urban environment. Caparos et al compared the choices of Himba living traditionally in remote villages who had never been to town, or who had been to town once, twice, or more than three times. They also compared the choices of these traditional Himba with another group of Himba who had relocated to the Namibian town of Opuwo (population c. 7,500; National Planning Commission, 2015). As the Himba became more urbanised they made increasingly more global-similarity choices (Caparos et al., 2012). These findings show that environmental factors contribute to local-global perceptual bias and challenge the preconception that a global bias represents the norm.

### *1.2.3 Environmental influence: urbanisation and education*

Remote African cultures, such as the Himba, clearly offer a better approximation to the environments in which our ancestors evolved than the Western populations upon which most of our knowledge of perceptual processing is based. Based on the evidence from traditional-living Himba, it seems likely that far from a global bias being a universal characteristic of human perception, rather, a local bias may well have been the more prevalent over much of human history. The global bias of Western participants, then, is perhaps best considered as an adaptation to the requirements of more modern lifestyles.

Indeed, it is testament to the adaptive nature of our minds that we are able to thrive in conditions so far removed from those in which we evolved. This ability to adapt to specific environmental demands is known as phenotypic plasticity (e.g., West-Eberhard, 2003). As a general principle, it is acknowledged that natural selection will not always favour just one single 'best' strategy that evolves to meet the needs of the entire species, but rather that in many cases the best strategy will depend on certain parameters of the physical and/or social environment (e.g., Crawford & Anderson, 1989).

That local-global bias varies according to environmental factors, within a group of genetically similar participants (Caparos et al., 2012), strongly suggests that at least to some extent perceptual bias is regulated by these mechanisms of phenotypic plasticity. Although it is noted that not all plasticity is *necessarily* adaptive (e.g., see Nettle & Bateson, 2015), it seems likely that the demands created by certain environmental factors may create a drive towards a local bias (as in the case of the traditional Himba), whilst other factors may create a drive towards a global bias (as in the case of most Western populations studied to-date).

The findings of Caparos et al (2012) strongly implicate urban exposure, and/or other environmental factors which may be confounded with urban exposure, as an important source of variance in local-global perception. Earlier researchers too have found marked differences in the visual processing of remote traditional African participants and their urbanised African counterparts. Most notably, it has long been documented that, relative to Western participants, remote peoples show a reduced sensitivity to visual illusions which depend on contextual integration (Rivers, 1905; Segall, Campbell & Herskovits, 1963;

Stewart, 1973; Ahluwalia 1978; Wagner, 1977), but that this sensitivity becomes increased in genetically similar populations living in urbanised conditions (Stewart, 1973; Ahluwalia 1978; Wagner, 1977).

Particularly in developing countries, however, levels of urbanisation tend to be confounded with access to formal education (see e.g., Lewin, 2009). When the effects of both urbanisation and education have been disconfounded from each other in a fully factorial design, in fact both urbanisation and education were shown to impart separable effects on developmental sensitivity to contextual illusions (Wagner, 1977). Since urbanisation and education were largely confounded in the Caparos et al study, education, then, is also implicated as a likely contributor to the cross-cultural differences that have been observed in local-global perceptual bias.

### *1.2.4 Biological influence: age and sex*

Nature has equipped us with the ability to adapt our perceptual strategies according to the demands of our physical and socio-cultural environments. Yet, our neural mechanisms are not limitlessly malleable, and are necessarily constrained by our biology.

Local-global perceptual processing has been shown to develop slowly, continuing to mature well into childhood and even into late adolescence (e.g. Scherf et al., 2009). A bias for the global similarity-match on similarity-matching paradigms typically does not develop until around age 6 in Western children (Kramer, Ellenberg, Leonard & Share, 1996; Vinter, Puspitawati & Witt, 2010; Poirel, Mellet, Houdé & Pineau, 2008) and is accompanied by specific neurological changes to the visual system (Poirel, Simon & Cassotti, 2011; Poirel, Leroux, Pineau, Houdé & Simon, 2014). Maturational processes, in combination with distinct environmental pressures, then, doubtlessly are an important factor in determining the development of local-global bias.

Furthermore, evidence suggests that the age-dependent maturation of local-global processing may to some extent be gender/sex-specific. At least two studies have shown sizeable differences in the local-global similarity matching strategies of boys and girls between the ages of 4 and 12-years-old (Kramer et al., 1996; Tzuriel & Egozi, 2010); at all ages, boys in the two studies made global-similarity matches more often than girls. It has been suggested that differences in boys' and girls' matching strategies may relate to differential (sex-dependent) levels of early prenatal testosterone exposure (e.g., Kramer et al., 1996), which may regulate processes of hemispheric lateralisation (see, e.g., Toga & Thompson, 2003, for review).

Post-pubescent levels of sex hormones have also been implicated in gender/sex differences in the local-global processing of adults. Although gender differences in the rates of local-global similarity-matching are typically no longer observed on similarity-matching tasks in adults (Basso & Lowery, 2004; Scheringer & Pletzer, 2016), several studies have indicated that global bias may present more strongly in Western men than women when other measure of local-global processing are used (Razumnikova & Vol'f, 2011; Müller-Oehring, Schulte, Raassi, Pfefferbaum & Sullivan, 2007; Pletzer, Petasis & Cahill, 2014; Roalf, Lowery & Turetsky, 2006. See, however, Kimchi, Amishav & Sulitzeanu-Kenan, 2009). Levels of the sex hormones testosterone and progesterone have been implicated as causal factors in these differences (Pletzer et al., 2014; Scheuringer & Pletzer, 2016).

Experience-dependent variability in local-global bias, then, likely cannot be understood solely in terms of environmental factors such as urbanisation and education but must also be considered in terms of the interactions between those external environmental factors and intrinsic biological factors such as age and sex.

### *1.2.5 Gender as an environmental factor*

Gender differences in local-global perceptual processing have typically been understood through biological level explanations (see 1.2.4). At the same time as acknowledging that there may be a biological component to the observed gender differences in local-global processing, however, the potential effects of socially-defined aspects of gender must also be taken into consideration. Biological influence need not be deterministic and, for example, may be amplified or dampened according to experience-dependent factors.

Gender and experience, however, are often heavily confounded, and it is this fact – namely that gender plays such a large role in determining one's experiences throughout the lifespan - that makes it all the more important to study gender differences in cognitive development within the context of environmental setting and experience (Halpern, 2004; Linn & Petersen, 1985; Levine, Vasilyeva, Lourenco, Newcombe, & Huttenlocher, 2005; Tzuriel & Egozi, 2010).

Local-global processing has been suggested to be influenced by a number of psychological factors, including a number of psychological dimensions along which culturally fuelled gender differences are likely to emerge (e.g., power: Smith & Trope, 2006; mood: Gasper & Clore, 2002, etc.). Thus, gender is implicated not only as a potential biological constraint to environmental influence on local-global bias (i.e., sex), but also as a source of environmental variance in its own right (i.e., the differential cultural treatment of males and females).

Since the roles of biological and socio-cultural aspects of sex and gender cannot easily be differentiated from each other experimentally, the term gender, as used throughout this thesis, will refer to both biological and cultural aspects. The term sex on the other hand will be reserved for occasions when it is intended to reference specifically the biological aspects of gender only.

## 1.3 Conceptualising experience-dependent differences in local-global bias

### *1.3.1 The need for an integrated theory*

Whilst much still remains to be documented about what the extent of the environmental impact on local-global bias may be, furthering our understanding of *how* experience-dependent differences might come about must also be of utmost importance. Although there has been much recent interest in cross-cultural differences in visual perception, as yet there is no comprehensive theory of how those differences might emerge.

An integrated theory of experience-dependent differences in local-global bias will aid not only our understanding of perceptual organisation but will also contribute more widely to areas of developmental, and cross-cultural psychology. Indeed, cross-cultural differences in the extent of global bias (for populations where a global bias is the norm) have been suggested to broadly index more general differences in cognitive style, which also vary as a function of culture (see, e.g., Nisbett, Peng, Choi & Norenzayan, 2001). When the relevance of local-global bias is understood within this much broader framework, it is clear that the documentation of cross-cultural differences in local-global bias will be an important task for understanding the effects of culture on cognition more broadly.

Based on the available extant data and literature, a working model - or, conceptual schema - of how individual differences in local-global bias may arise is put forward in the next section and discussed with reference specifically to urbanisation, education, age, and gender, which have already been identified as candidate environmental and biological drivers of local-global bias. This schema is not put forward here with a view to testing how well it stands up to the evidence provided by the empirical research presented in the subsequent chapters of this thesis. Rather, the schema is presented in order to elucidate the theoretical framework we will use to interpret the empirical research presented in the following chapters.

The schema presented here represents only a very preliminary schema of how individual differences in local-global bias as measured by the local-global similarity-matching Navon task might arise. Clearly, extensive further research far beyond the remit of this thesis will be required in order to validate and/or refine each of the individual components of the schema and to clarify how well the schema fits with the numerous other measures of local-global bias that are already in common usage.

### *1.3.2 Schema overview*

The local-global processes that are reflected by the similarity-matching Navon task likely recruit and are influenced by a range of cognitive resources. Furthermore, environmental and biological factors may exert their effects at one or more of several different stages of this process to bring about individual and group differences. Figure 2 depicts a conceptual schema of the possible mechanisms through which these experience-dependent differences in local-global bias might arise.

At the lowest level, differences in the local-global perceptual biases of individuals or specific groups of people may relate to differences (either structural or functional) in the local-global perceptual apparatus of the visual regions of the brain. Systematic differences in the local-global perceptual apparati of different groups of people might arise due to factors such as physical differences in the surrounding visual environment, different sampling techniques (e.g., via attention or behaviour) which mediate the processing of visual input from the visual environment, or different top-down functional demands placed on perceptual processing according to what the visual information will be used for. Over time, all of these factors may shape the perceptual apparati.

Additionally, some recent theories suggest that visual perception may not come about in isolation, but rather may be influenced by and integrated with other sources of non-visual information from outside of the perceptual domain. In particular, it has been suggested by some that local-global perceptual processing may be intimately related to local-global *conceptual* processing Although not without controversy (see e.g., Firestone & Scholl, 2016), evidence has been put forward to suggest that activation of either local or global processing at one level (perceptual or conceptual) may activate reciprocal local or global processing at the other (see, e.g., Liberman & Trope, Stephan, 2011; Förster & Dannenberg, 2010). If this is the case, any culturally-mediated differences in local-global *conceptual* apparatus would also be likely to strongly impact how local-global visual information is processed and interpreted at the perceptual level.

Yet other theories, however, suggest that perceptual processing may be fully encapsulated from and impenetrable to cognition (e.g., Firestone & Scholl, 2016). Even so, cross-cultural differences in local-global conceptual processing may well impact attentional allocation and/or patterns of behaviour in ways which might have consequences for the development of local-global perceptual apparati when the cumulative effects are considered.

Furthermore, as outlined above, local-global similarity-matching tasks, whilst typically thought of as perceptual tasks, are likely to entail a conceptual – as opposed to purely perceptual – component (see e.g., Darwet, Fujita & Wakslak, 2010; Firestone & Scholl, 2016). As such, it is not impossible that cross-cultural differences in local-global conceptual processing may also exert some direct influence on similarity-matching, in addition to any effects on perceptual processing.

Environmental factors, through these various means, conceivably, may influence the relative extent to which local versus global perceptual and conceptual processing mechanisms become developed and, ultimately, whether a local or a global bias becomes established. For example, in Western children, global perceptual processing is believed to follow a more protracted developmental trajectory than local perceptual processing, which is believed to reach adult-like levels at an earlier age (e.g., Burack, Enns, Larocci & Randolph, 2000). For traditional African children (or other populations who may retain a local bias), however, it is quite possible that, for example, environmental pressure to become more skilled in local perceptual processing could result in a longer and more extensive maturational process of the local perceptual apparatus but a less extensive maturation of the global perceptual apparatus. The equivalent argument can also be extended to the developmental processes of local and global conceptual apparatus.

In other words, humans may be born with the capacity to develop local and global (perceptual and conceptual) apparati to greater or lesser extents within certain parameters which represent the full range of potential human capabilities (referred to in the schema as the 'potential range'). The specific demands of the environmental pressures to which we are exposed will then determine the extent to which those local and global perceptual and conceptual capacities are realised (referred to in the schema as 'actual range'), depending on the extent to which the corresponding apparatus becomes developed.

Certain environmental circumstances may favour the development of local processing mechanisms, whereas other environmental circumstances may instead favour the development of global processing mechanisms, giving rise to local and global biases respectively. The schema is necessarily ambiguous with regards to whether these local and global mechanisms are part of a single continuum or whether they may be fully, or partially, independent from each other as such questions remain unanswered in the existing literature (see below for a brief consideration of these issues).

However, broadly speaking, the environmental drivers of local-global perceptual-conceptual development could relate to either physical and/or socio-cultural properties of the environment. Urbanisation and education, for example, are both multidimensional, multifaceted factors composed of both physical (buildings, pictures, etc.) and socio-cultural (cultural norms, learned knowledge, etc.) aspects. Physical aspects of the environment will play a large part in determining the characteristics of the visual environments and the visual statistics to which we are exposed. Socio-cultural factors, on the other hand, will be important in determining what that visual information will be used for, how it will be conceptualised, and the meanings that will be assigned to it.

The potential for environmental influence on local-global bias, may, furthermore, extend beyond any direct effects of the environment on the local and global perceptual and conceptual apparatus discussed above. Environmental factors are likely also to impact any number of other mechanisms which themselves are often alleged to have consequences for local-global processing.

The schema presented in figure 2 in particular highlights the potential involvement of physiological and psychological state, and cognitive flexibility. The word state in this context takes its wider meaning and encapsulates emotional state (e.g., subjective power, affect, etc.) as well as factors such as stress and arousal. The decision to include these factors in the schema is based on their importance within the available literature on local-global processing (as discussed in following sections). It is noted however that there may be other mechanisms involved which have not been represented in the schema, but which future research may nonetheless demonstrate to be important.

Each psychological element in the schema represents a different level at which environmental forces may act to create individual and group differences in local-global bias. Any influence of environmental factors, however, will also be constrained at every level of processing by biological factors, including age (e.g., developmental stage) and sex (e.g., hormonal regulation). Thus, there are likely to be many interacting factors which govern whether a given individual will go on to develop a local or a global perceptual bias.

The individual components of the schema are discussed in greater theoretical detail and with reference to the relevant literature in the following sections, and later in relation to urbanisation, education and gender.

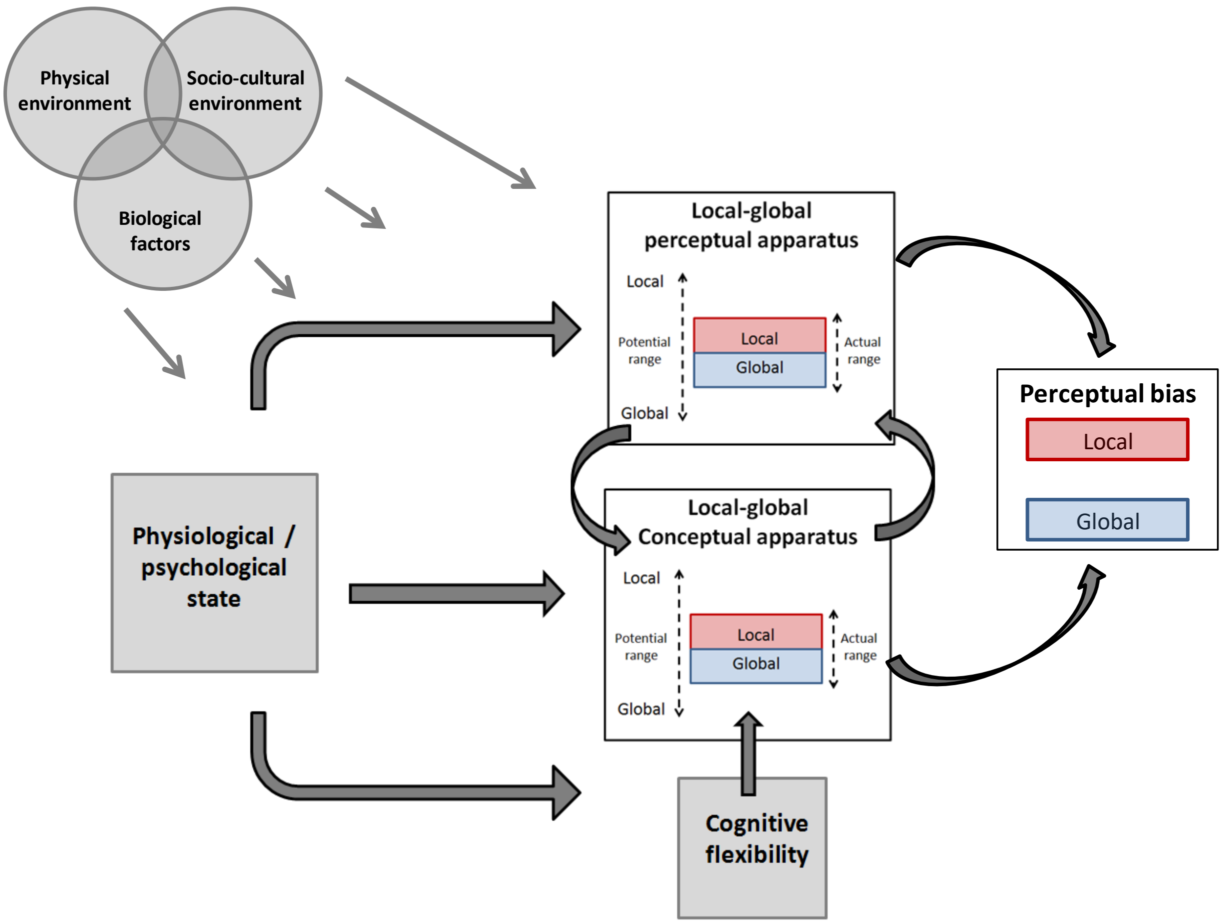



Figure 2. A working schema of how experience-dependent differences in local-global bias might emerge.

### 1.3.3 Perceptual component of the schema: Local-global perceptual apparatus

The precise inner workings of our local-global perceptual apparatus remain unverified. However, one theory (the dual systems model) suggests that local and global processing may be facilitated by separate systems. For example, it is suggested that there may be at least two processing subsystems, one of which is primarily responsible for processing fine details and local features, and the other primarily for processing configurations and global features (Kimchi, 1992; Robertson & Lamb, 1991). Indeed, behavioural evidence suggests that local and global perceptual processing rely on separate mechanisms with differing developmental trajectories (e.g., Burack et al., 2000).

Furthermore, evidence also suggests that local and global perceptual processing relate to different structures in the brain. For example, V1 cells are connected by a network of long-range and short-range connections and these two types of connection have different functional significance. Long-range connections are thought to be important for global perceptual processes (Káldy & Kovács, 2003; Kovács, Kozma, Feher, & Benedek, 1999; Kovács, Polat, Pennefather, Chandna, & Norcia, 2000; Behrmann & Kimchi, 2003) whereas short-range connections are thought to be important for local processes (Das & Gilbert, 1997, 1999).

Particularly relevant to the discussion of individual differences in visual perception are recent suggestions that individual differences in the perceptual apparatus of visual areas may correlate directly with differences in perceptual experience. For example, some researchers have suggested that the enhanced local perception in ASD individuals may be related to atypical local neural connectivity (e.g. Kéïta, Mottron, Dawson, & Bertone, 2011), and variability in V1 cortical thickness of neurotypical adults has been linked to individual differences in sensitivity to contextual illusions (Schwarzkopf, Song, & Rees, 2011). What is more, environmental factors have been shown to affect performance on a task of global perception (the contour integration task or, CIT) which is thought to index the extent of long-range horizontal connections in V1 (Szwed, Ventura, Querido, Cohen, & Dehaene, 2012).

Taken together these findings suggest that environmental experiences can impact low-level perceptual mechanisms, which in turn can impact perceptual experience. Furthermore, the fact that local and global perceptual processes can be differentiated from each other at both the structural and behavioural level appears consistent with the idea that certain properties of the environment may encourage the development of mechanisms which support local perceptual processing, whereas other properties may encourage the development of mechanisms which support global perceptual processing.

However, although commonly invoked, the existence of separate local and global perceptual systems (as opposed to two opposite ends of a spectrum, or, indeed, separate processes within a single system; see e.g., Darwet et al., 2010, for a brief discussion on these distinctions) remains hypothetical. Furthermore, full theories of whether or not these proposed systems may be fully independent or interactive are yet to be put forward. This lack of clarity in the literature means that inevitably there is ambiguity in the schema put forward in figure 2. As such the red (local) and blue (global) boxes in the schema are not intended to literally represent a dual-systems model and could equally represent local-global apparati that comprise a dual-process or continuum model of local-global processing.

### 1.3.4 Conceptual component of the schema*:* Local-global conceptual apparatus

Just as perceptual processing is believed to be characterised by local and global processing styles (Kimchi, 1992; Robertson & Lamb, 1991), so too has it been proposed that conceptual processing may also be characterised by similar local and global processing styles, either as a result of distinct local and global systems (e.g., Förster & Dannenberg, 2010) or as a result of a local-global processing continuum (e.g., Liberman, Trope, Stephan, 2007).

Individual differences in local-global conceptual processing may to some extent have a direct impact on local-global similarity-matching because similarity-matching tasks will involve some degree of conceptual reasoning

(see e.g., Darwet et al., 2010; Firestone & Scholl, 2016). The relative extent of the influences of local-global conceptual processing and local-global perceptual processing on similarity-matching outcome cannot easily be disambiguated from each other; however, similarity-matching tasks are most typically thought of as indexing perceptual rather than conceptual bias.

As outlined above, it has been proposed by certain authors that our higher-level conceptualisations of the world and our lower-level perceptions of the world may be intrinsically connected in such a way that they can never be fully independent of each other (Barsalou, 1999; Finke, 1985; Gilbert; 1991). Expanding on this idea, several theories, with roots in social psychology, have emerged to explain a wealth of evidence that purportedly suggests that local-global processing at the perceptual level is fundamentally linked to local-global processing at the conceptual level.

Most notably, *Construal level theory* (CLT: Liberman, Trope, Stephan, 2007; Trope & Liberman, 2003; Liberman & Trope, 2008) and the *Global versus local processing model: a systems account of global versus local processing* (GLOMOsys: Förster & Dannenberg, 2010) have been highly influential in recent discussions of the perceptual-conceptual link. Both GLOMOsys and CLT are supported by procedural priming studies which appear to show a link between local-global conceptual processing (or, concrete-abstract construal) and local-global perceptual processing (see e.g., Förster & Dannenberg, 2010; Liberman & Trope, 2011).

These priming studies have often been interpreted as evidence that a perceptual-conceptual link produces bidirectional carry-over effects; priming someone to attend to local (or global) aspects of perceptual stimuli can lead to increased local (or global) processing at a conceptual level on subsequent tasks, and, vice versa, priming people to attend to local (or global) concepts can lead to increased local (or global) processing at a perceptual level (see e.g., Förster & Dannenberg, 2010, for review).

Despite the wealth of purported evidence, claims of a perceptual-conceptual link on the basis of these studies remain controversial amidst several failed replications (Klauer & Singmann, 2015; Field, Wagenmakers, Newell, Zeelenberg & van Ravenzwaaij, 2016), evidence of experimenter effects (Guilder & Heerey, 2018), doubts over the validity/efficacy of attempts to prime perceptual breadth (Fang et al., 2017) and overall calls for more stringent testing procedures (Guilder & Heerey, 2018; Firestone & Scholl, 2016). At the most extreme end of the argument, some authors maintain that perceptual processing is fully encapsulated from and entirely uninfluenced by conceptual processing (Firestone & Scholl, 2016).

The sheer number of open responses to Firestone & Scholl's (2016) proposal (both in support of and in rebuttal of) is evidence that the issue is far from resolved. For this reason, the bidirectional link between local-global perceptual and conceptual apparatus that is represented in the schema in figure 2 should be interpreted somewhat cautiously until future research can establish what immediate impact processing at one level may have on processing at the other level.

Nonetheless, regardless of whether real-time activation at one level can impact activation at the corresponding level, in a broader sense, one might expect that over time development at one level may have implications for development at the other level. As outlined above, the development of local and global conceptual processing mechanisms may be expected to exert an influence on the development of local and global perceptual mechanisms for example because of increased top-down allocation of attentional resources to either local or global features of visual stimuli (through either covert or overt attentional shifts), changes in behavioural patterns that may influence visual input or processing demands that may lead to specialised perceptual learning.

Any cultural factor which influences local-global processing at the conceptual level, then, may, at least in theory, also have a follow-on effect on local-global processing at the perceptual level. This may be either through an as yet unconfirmed perceptual-conceptual processing link or mediated by changes to attentional allocation and/or changes to behaviours in accordance with local-global conceptual processing biases which over time may influence local-global perceptual processing.

It is possible, if not likely, that some cultural settings may activate local conceptual processing styles more strongly whilst other cultural settings may activate global conceptual processing styles more strongly. Local-global conceptual processing, then, represents an important level at which environmental factors may contribute to experience-dependent differences in local-global perceptual bias.

### 1.3.5 Other components of the schema

As has already been acknowledged in the above sections, the debate over whether or not perceptual processing is penetrable by other cognitive and psychological processes remains unresolved. Claims of findings that a wide range of psychological factors may influence both perceptual and conceptual local-global processing, as summarised in the following sections, therefore, are of course by no means incontrovertible. Whilst the claims that various psychological factors may impact local-global perceptual processing are particularly controversial, the idea that local-global conceptual process may be subject to outside influence may perhaps however be less controversial.

The motivation for the inclusion of these sections within the current discussion, and within the schema in figure 2, stems from their importance within the local-global literature rather than an attempt to validate any one particular theory. The pathways represented by the arrows in the schema in figure 2 as such should be regarded as hypothetical.

#### *1.3.5.1 Physiological and psychological state*

Local-global conceptual processing is not the only psychological factor that it has been claimed may impact local-global perceptual processing. Indeed, it has been suggested that a number of psychological and physiological variables may impact local-global processing at both the perceptual and conceptual level. For example powerlessness, negative mood and high anxiety have all been associated with more local processing, whereas high power, positive mood, and high arousal have all been associated with more global processing (e.g., power: Smith & Trope, 2006; Smith & Galinsky, 2010; mood: Gasper, 2004; Gasper & Clore, 2002; Isen & Daubman, 1984; Huntsinger  Clore, & Bar-Anan 2010; anxiety: Douglas, Derryberry & Reed,1998; arousal: Mahoney, Brunýe, Giles, Lieberman & Taylor, 2011; Corson & Verrier, 2007; Fiedler & Stroehm, 1986; Giles, Mahoney, Brunýe, Taylor & Kanarek, 2013).

According to GLOMOsys (Förster & Dannenberg, 2010), a wide range of psychological variables (power, mood, arousal etc.,) may trigger activation of one or other of the local or global processing systems, resulting in a processing shift to the processing style associated with the activated system (either local or global; note that although the authors speak of processing *systems* this distinction is not crucial). The CLT model differs from GLOMOsys somewhat in that the same/similar psychological variables are suggested to be associated with proximal versus distal psychological distance (e.g., high/low power: Smith & Trope, 2006; Smith, Wigboldus, & Dijksterhuis, 2008), which in turn is proposed to lead to a more local or more global processing style. Both models, however, assert that psychological state can directly impact local-global processing (see also the *Levels of focus* theory; Gasper and Clore, 2002, for a similar assertion).

Controlling for changes to other psychological states (e.g., mood), arousal has also been shown to impact local-global processing. A heightened state of arousal (in the absence of changes to subjective mood, or other subjective psychological/emotional states) appears to increase global processing of affectively-neutral information (Corson & Verrier, 2007; Fiedler & Stroehm, 1986; Giles, Mahoney, Brunýe, Taylor & Kanarek, 2013), including for local-global visual stimuli (Mahoney, et al., 2011). For example, caffeine-induced physiological arousal has been shown to accentuate global processing biases for local-global hierarchical stimuli; higher arousal was linked to a higher frequency of global-similarity matching on a local-global hierarchical similarity-matching (Kimchi & Palmer, 1982) task, and also to faster responses to global targets in the Navon letters (Navon, 1977) task (Mahoney et al., 2011).

The mechanisms by which arousal might influence local-global perception are as yet unclear. However, one possibility is that arousal may 'up-regulate' right hemispheric processing (which has been linked to global processing; e.g., Robertson & Lamb, 1991), perhaps through increases in the release of norepinephrine (also referred to as noradrenaline) and serotonin (see Mahoney et al., 2011, for a review).

Conversely, however, there is also some suggestion in the literature that *aversive arousal* may have quite different implications for local-global bias as compared to valence-neutral changes in arousal. Whereas valence-neutral arousal may enhance global processing (e.g., Mahoney et al., 2011), aversive arousal on the other hand has been suggested to have a narrowing effect on perceptual scope, facilitating local processing and hindering global processing (e.g., Tucker & Williamson, 1984; Derryberry & Reed, 1998; Derryberry & Tucker, 1994; see Förster & Dannenberg, 2010, for review).

Taken all together, there is considerable evidence to suggest that psychological and physiological states may impact local-global processing, however, the same caveats regarding the methodological issues with priming studies and the lack of robust evidence that local-global perceptual (as opposed to conceptual) processing is penetrable also apply. Furthermore, because most of our understanding of how physiological and psychological factors may impact local-global processing is based on priming experiments where a particular state (e.g., arousal, high power) has temporarily been induced, little is known about what the long-term effects on local-global bias and local-global processing might be of sustained differences in levels of arousal, power, mood, etc., brought about by real-life circumstances.

It is possible, for example, that a chronic state of powerlessness might inhibit the development of mechanisms which support global processing, or that a chronic state of heightened arousal (e.g., from excessive use of stimulating technology) might inhibit the development of mechanisms which support local processing. Sustained exposure to environmental factors which influence psychological and physiological state may perhaps lead to more permanent and ingrained effects on local-global processing.

#### *1.3.5.2 Cognitive flexibility*

Cognitive flexibility, in the literature, has been linked broadly to a more global processing style. For example, a psychologically distal perspective (thought to induce a global processing style; e.g., Liberman et al., 2007) is reported to encourage spontaneous creative solutions (Förster, Friedman & Liberman, 2004; see, e.g., De Dreu et al., 2008, for evidence of the relationship between creativity and cognitive flexibility) and cognitive flexibility has also been associated with the tendency to use broader cognitive categories (indicating a global processing style; De Dreu et al., 2008). One other set of studies has shown that higher trait measures of behavioural activation leads to more flexible thinking only when participants have been primed with global (i.e., through directing participants to attend the global structure in the Navon letters task) but not local processing (De Dreu, Nijstad & Baas, 2011), which further suggests a link between global processing and cognitive flexibility. The extent to which, and the circumstances under which, global processing and cognitive flexibility are linked, however, are not yet well understood.

Indeed, under certain circumstances cognitive flexibility may even lead to a reduction in global bias, both under conditions of free choice and when task conditions favour a local strategy. For example, cognitive flexibility has been linked to an increased ability to flexibly attend either local or global aspects of visual stimuli, according to task demands (Guinote, 2007; Baumann & Kuhl, 2005); in other words, cognitive flexibility may facilitate shifts to the non-dominant processing mode. Furthermore, even in situations which do not specifically favour a local or a global processing style, cognitive flexibility may reduce the dominance of global processing in Western participants. On a local-global similarity match Navon task, cognitive flexibility was associated with a reduction in global matches, due to a reduced tendency of individual participants to always make matches at the same level of similarity. Participants who scored higher for cognitive rigidity on the other hand tended to match more consistently at the global level of structure (Caparos, Fortier-St-Pierre, Gosselin, Blanchette & Brisson, 2015).

In this latter study, cognitive flexibility/rigidity mediated the group difference in local-global similarity matching of politically left-oriented and right-oriented participants. Although both groups of participants strongly favoured the global-similarity match, this bias was reduced in the left-oriented participants and was mediated by their reduced cognitive rigidity. Cognitive flexibility therefore is implicated as an important factor which may account for group differences in local-global similarity matching performance, at least in certain circumstances.

Interestingly, some of the other psychological factors that have been suggested to facilitate global processing (discussed in the previous section) have simultaneously been suggested to facilitate cognitive flexibility. For example, priming positive affect (Baumann & Kuhl, 2005) and high power (Guinote, 2007) have both been linked to more flexible thinking and the ability to attend selectively either to local or to global visual information depending on functional relevance, and so too may moderate levels of arousal (Pesce, Tessitore, Casella, Pirritano & Capranica, 2007).

In situations where there is no immediate functional demand for local processing, power, positive affect, and other factors, may play the more general role of enhancing global processing (e.g., Smith & Trope, 2006). In addition, they may also play a separate role in facilitating the flexible allocation of attentional resources in line with current situational demands (Guinote, 2007; Bauman & Kuhl, 2005). One theory is that power, positive affect and other factors may allow greater access to extended semantic networks which promote more holistic (global) processes, but which also allow access to response alternatives which facilitate shifts to the non-dominant response mode (see Bauman & Kuhl, 2002, 2005; De Dreu et al., 2011; see also Förster & Dannenberg, 2010).

Other work has suggested that when participants are primed to focus on the ‘big picture’ but *not* the fine details, high trait behavioural activation (i.e., high sensitivity to reward and approach motivation) is associated with increased cognitive flexibility (De dreu et al., 2011). High behavioural activation has also been linked to high power (Galinsky, 2003; Keltner, 2003) and positive affect (Amodio, Master, Yee, & Taylor, 2008; Carver, 2006; Gray, 1990). As such, this may suggest that factors such as power, affect, and so forth, may have a greater impact on cognitive flexibility (and by extension local-global processing) in situations which call for more global forms of processing. This is consistent with the suggestion that power-related (and by extension, likely other psychological state-related) differences in perception may be especially likely in situations where inhibition of detailed information is required, because of the tendency of lower-power participants to process fine details regardless of their relevance (Guinote, 2007).

Taken together, these findings may suggest that psychological state-related factors may be particularly important for explaining individual variance in local-global processing under circumstances which promote a more global processing style. In this case, one perhaps might expect to see such effects more strongly in populations where environmental pressures ordinarily favour the development of global processing.

### *1.3.6 Environmental components of the model*

Although urbanisation, education and gender have already been identified as environmental factors which are likely to be particularly important for experience-dependent differences in local-global bias, the following sections will look more broadly at how environmental factors in general may impact the development of local-global bias, without reference to these specific environmental factors. The specific ways in which urbanisation, education and gender may contribute to these effects will all be addressed in sections that follow.

#### *1.3.6.1 The physical environment*

Evidence suggests that developing visual mechanisms are sensitive to the characteristics and statistics of our visual environments. For example, it has been suggested that the visual system becomes fine-tuned to afford higher sensitivity to features that occur frequently in natural scenes (Geisler, 2008; Sigman, Cecchi, Gilbert & Magnasco, 2001; Simoncelli & Olshausen, 2001), and animal studies have shown that visual input during development can impact both structural and functional features of the visual system (e.g., Blakemore & Cooper, 1970).

In one study, two groups of kittens were raised predominantly in the dark, with their only early visual experiences being limited to horizontal lines in one group and vertical lines in the other group. Later, when exposed to natural environments the cats that had been exposed only to vertical stripes had difficulties perceiving horizontal contours and those that had been exposed only to horizontal lines had difficulties perceiving vertical contours (Blakemore & Cooper, 1970). Although this is an extreme example, what this study could be taken to suggest is that the visual system responds to the functional demands which are placed upon it and adapts flexibly to accommodate those demands.

The idea that environment-dependent visual input could contribute to individual differences in perception is not a new one. Indeed, the idea that the properties of the visual environment which a person inhabited, and their environment-dependent visual experience, could influence perceptual processing was a common theme amongst early cross-cultural researchers (e.g., Segall et al., 1966).

More recently, the idea that differences in the visual environment may be a driving force in the emergence of culturally-specific patterns of perception has come from studying the effects of exposure to 'visual clutter' (Miyamoto, Nisbett & Masuda, 2006). The visual clutter account of cross-cultural differences in perception arose from the analysis of the visual statistics of images of American and Japanese towns and cities. It was found that Japanese towns and cities were more contextually ambiguous and contained more elements than American ones, suggesting that objects in Japanese scenes therefore looked more embedded in the field (Miyamoto et al., 2006).

Using a procedural priming technique, American and Japanese observers were exposed to images of either the American or Japanese environmental scenes and then tested on a change blindness task which measured attentional allocation to focal objects and to contextual information. Observations from unprimed participants on a similar change blindness task had previously shown a bias of American observers to attend focal objects, and a bias of Japanese observers to attend contextual information (Masuda and Nisbett, 2006). These findings from unprimed participants are consistent with a wide body of research suggesting that East Asian participants may process visual stimuli more holistically than Western participants (e.g., Doherty, Tsuji, Phillips, 2008; McKone, et al., 2010). For the primed participants, however, both American and Japanese participants showed evidence that perception of contextual information was stronger when they had been primed with the Japanese scenes, and perception of focal information was stronger when they had been primed with American scenes (Miyamoto et al., 2006).

It was suggested that the difference in behaviour of participants primed with the Japanese scenes and participants primed with the American scenes could be attributable to the different levels of visual clutter in the priming materials. Furthermore, it was suggested that differing levels of visual clutter in the lived environments of Westerners and East Asians may contribute to the broad cultural differences that have been observed in visual processing.

It is suggested that the more visual clutter a person's environment contains, the harder it will be to disambiguate objects from the field (Miyamoto et al., 2006). High levels of visual clutter may provide environmental pressure to develop more global processing strategies in order to overcome the additional challenges to scene parsing. More generally, the visual clutter account of cross-cultural differences in visual perception illustrates the possibility that the specific statistical properties of one's visual environment (including, but not limited to, visual clutter) may promote the development of specific processing strategies as a function of utility.

In a broad sense, the visual environment we are exposed to will depend on physical properties of the environments we inhabit (e.g., remote areas or urban areas). However, visual input will also be determined by culturally driven choices about the activities which we engage in within our broader environments (e.g., looking after the cattle or attending school) as well as culturally driven differences in eye movements and visual sampling (see, e.g., Blais, Scheepers, Fiset, & Caldara, 2008; Caldara, Zhou & Miellet, 2010; Kelly, Miellet & Caldara, 2010, for evidence that culture mediates eye movement and fixation patterns).

#### *1.3.6.2 The socio-cultural environment*

Culture and cognition are fundamentally linked, and the cultural environment we grow up in undoubtedly affects the way that we conceptualise the world around us in a profound way (see, e.g., Norenzayan, & Nisbett, 2000; Nisbett, Peng, Choi, & Norenzayan, 2001; Kitayama & Uskul, 2011). In other words, not only does culture shape the information that we have access to, but also the very cognitive processes by which we conceptualise that information.

These higher-level conceptualisations of the world are believed by some to be intrinsically connected to our lower-level perceptions of the world (Barsalon, 1999; Finke, 1985; Gilbert; 1991). If so, culturally-mediated differences in higher-level cognition may have significant impact on lower-level perception. Indeed, it has been suggested by some that local-global conceptual processing may have a profound effect on local-global perceptual processing, although this assertion remains hotly debated (e.g., Firestone & Scholl, 2016).

With regards to local-global conceptual processing, it has been proposed that any event may be internally represented, or construed, either in detailed, concrete, local terms or in broad, abstract, global terms (Construal level theory, CLT: see e.g., Liberman et al., 2007). The terms ‘concrete’ and ‘abstract’ in this sense are used broadly synonymously with ‘local’ and ‘global’ (see Bargoon, Henderson, & Markman, 2013). CLT places emphasis on ‘psychological distance’ (proximal versus distal) as a key determining factor in whether an event will be construed in a more concrete (local) or a more abstract (global) way.

According to CLT, any factor that increases a person’s psychological distance (social, spatial, temporal, or hypothetical) from an object will also lead to the formation of a more abstract (global) mental representation of that object, at both the conceptual and the perceptual level (Trope & Leiberman, 2003). The theory suggests that because concrete (local) information is often lacking for more distal events, by necessity, they tend to be represented on a more abstract/global level of construal, and, with time, this repeated association results in a fixed mental link between abstraction and distance.

A second, similar theory, GLOMOsys (Förster & Dannenberg, 2010), emphasises familiarity versus novelty, respectively, rather than different degrees of psychological distance, as the differentiating force that determines whether an event is processed in more local or more global terms. The two theories also diverge in that GLOMOsys considers local-global processing as two separate systems whereas CLT considers concrete-abstract (akin to local-global) processing as falling on a continuum.

The separate systems versus continuum distinction need not necessarily be incompatible, however, given that differential levels of activation of two systems may lead to a continuum in terms of the processing output. Trope and Leiberman’s (2003) definition of psychological distance and Förster & Dannenberg’s (2010) definition of novelty/familiarity are also similar in that they both emphasise the distinction between direct and indirect experience. Anything which is out of the direct experience of the ‘here and now’ requires mental representation and entails psychological distance (according to CLT), and, similarly, because direct knowledge cannot be gained also entails novelty (according to GLOMOsys).

Thus, although the two theories diverge in several ways, they are similar enough that they will not be differentiated between in the remainder of this thesis. Both theories favour the notion that local-global perceptual and local-global conceptual processing is intimately linked, and both theories suggest that the distinction between direct and indirect experience may be particularly relevant for determining processing style.

From a cross-cultural perspective, what is missing from both models is the idea that the neural apparatus which supports global and local processing may differ systematically according to culture-dependent experiences. Thus, whilst individuals from all cultures are more than likely to have both global and local processing strategies available to them, it need not be the case that the global and local processing strategies available to one individual from a given culture will be equivalent to the global and local processing strategies available to another individual from a different culture.

The use of different levels of abstraction, for example, has been shown to develop as a function of utility (see Burgoon et al., 2013). It is likely, therefore, that culture-dependent functional demands on local-global (concrete-abstract) conceptual processing may impact the development of the underlying local-global conceptual apparatus.

Indirect evidence suggests that certain cultures might, in general, promote a more abstract (global) processing style, whilst others might, in general, promote a more concrete (local) processing style. For example, it has been suggested that cultural emphasis on the relative importance of direct and indirect experience varies between cultures (see, e.g., Everett, 2005). Since direct versus indirect experience has been linked to concrete versus abstract (local versus global) processing styles (either because of the relationship to psychological distance and/or familiarity-novelty), habitual differences in emphasis on direct versus indirect experience may ultimately lead to cultural differences in local-global conceptual processing and thence local-global perceptual processing.

Some accounts of remote cultures suggest that the values and traditions of those cultures may place higher cultural importance on immediate, direct personal experience. For example, it is noted that the Amazonian tribe the Pirahã avoid talking about knowledge that extends beyond immediate personal experience and do not discuss abstract entities or abstract generalisations (Everett, 2005). Pirahã communication is reportedly constrained (both linguistically and culturally) to more immediate and concrete concepts, and there is a high cultural value placed on the distinction between experience and non-experience (Everett, 2005). Although it is noted that the Pirahã may be an extreme case, nonetheless to some extent these, or similar, tendencies may be generalisable to remote cultures more widely.

It is possible that a cultural emphasis on immediate personal experience may favour a tendency to construe events as more concrete and detailed mental representations (consistent with CLT) or to be processed at a more local conceptual level (consistent with GLOMOsys). Conversely, other ways of living may place greater emphasis on psychologically distant, indirect experience and may promote broader, more abstract, conceptualisations and a more global processing style.

#### *1.3.6.3 Physical and socio-cultural environmental interaction*

Our experience with the visual world is not a passive one. We are not merely exposed to visual information, but, rather, we actively engage with that information and exploit it for our specific needs and goals. Socio-culturally-driven factors will determine top-down preferences for how visual information from the physical environment will be processed, in accordance with what that information is to be used for.

Literacy acquisition is perhaps a good example of how not only visual input but also the functional requirements for that visual input are important for determining visual processing. Mere exposure to the written word, for example, is likely to have very different implications for the visual system as compared to actually learning to meaningfully interpret that visual input. This kind of perceptual learning illustrates the fact that we all become experts at processing available visual information in line with our specific functional needs.

It has been shown that even relatively short-term visual training in adulthood can result in relatively long-term changes in sensitivity to visual stimuli (e.g. Schwarzkopf & Koutzi, 2008; Szwed et al., 2012). Furthermore, the effects of perceptual learning extend even to stimuli which violate statistical principles prevalent in naturally occurring images (Schwarzkopf & Koutzi, 2008). Taken together, these findings show that the visual system is highly capable of flexibly exploiting image regularities in line with functional demands. Furthermore, it is suggested that even this short-term perceptual training is likely to result in the retuning of neural mechanisms, rather than simple transient changes in visual sensitivity (Schwarzkopf & Koutzi, 2008).

Cross-culturally, not only may statistical image regularities vary depending on physical environment, but the functional utility assigned to those regularities is likely also to vary considerably as a result of culturally-driven functional demand. It is quite plausible that this interaction between physical and socio-cultural environment may lead to perceptual learning which favours a local processing style in some situations, and perceptual learning which favours a global processing style in others. This naturally occurring perceptual learning, over the course of one’s lifetime, is of course likely to have far deeper effects on the visual system than short-term training in a laboratory setting.

#### *1.3.6.4 Biological and environmental (physical and/or socio-cultural) interaction*

Age and sex have been identified as two biological factors (of which there may be others) that may constrain environmental influence on local-global bias; certain environmental influences, for example, might be felt more strongly at certain developmental stages over others or, by one sex over the other. With regards to cross-cultural research, this may mean that group differences that are observed at one age might not be observed at other ages, or that group differences that are observed in one gender might not be observed in the other.

With regards to age, it is possible that the developmental timing of the onset and conclusion of certain processes or, the rate and pace of development of those processes may vary depending on environmental parameters (e.g., Jandó, et al., 2012). For example, for populations where a preference for a global matching strategy on local-global similarity matching tasks is observed in adulthood, environmental factors might govern both the age at which a developmental shift begins, as well as the pace of development and the overall timeframe over which that development occurs.

A second important factor regarding age concerns the fact that environmental experiences at one age might have very different consequences to the equivalent environmental experiences at another age. For example, the effects of environmental experience of one kind (e.g., exposure to the urban environment) whilst the brain is in one stage of development might be quite different to the effects at a different stage of development or once the brain has reached maturity. Such an effect could result from the existence of a developmental window of sensitivity during which the environment may exert a stronger influence (or, indeed, a critical window of development). Alternatively, even in the absence of any window of sensitivity, the effects of any experiences later in life will depend on the cumulative effects of preceding experiences earlier in life.

Similar observations can be made for the possible interactions between sex (as biologically defined) and environment. Environmental effects may not necessarily be felt equally by males and females if for example there may be hormonally-modulated differences in underlying sensitivity to environmental drivers of local-global bias, or to local-global information itself. What is more, any sex-environment interaction may further be impacted by developmental stage; for example, sex-environment interactions may well differ pre- and post-puberty.

## 1.4 Overview of the current research

### 1.4.1 General research aims

The research in this thesis will adopt a naturalistic design to examine real-life occurrences of differences in local-global bias. The first and primary aim of this study will be simply to extend the documentation of these naturally existing differences, about which so little is known. The second aim will be to begin to pull apart the separable effects that the environmental factors urbanisation, education, and gender may exert on local-global bias, with consideration given also to the biological factors sex and age. To this end, local-global bias was measured using a local-global similarity matching Navon task (see figure 1) across a diverse sample of participants, who differed in respect of their levels of exposure to the urban environment and/or their levels of formal education.

The current research will extend the pioneering work of Caparos et al. (2012; see also Davidoff et al., 2008) which has shown that the local-global bias of a Namibian tribe (the Himba) becomes more global as a function of exposure to the urban environment. Local-global bias will be examined in both traditional and urbanised Namibians across a range of ages from 4-years-old to adulthood.

Regression modelling will be used within-group (traditional and urban) to assess the influence of the extent of urbanisation and extent of education for males and females of different ages in each environment. Between-group analyses (ANOVA; logistic regression) will then be used to gain a broader perspective on the overall extent to which the environment may exert its effect on local-global bias. Between-group analyses will be performed across group (traditional Namibians, urban Namibians - subdivided into less urbanised and more urbanised - and urban British), gender, and age. The urbanised British group is included as a Western control group on the assumption that they are broadly representative of the Western samples upon which our current understanding of local-global processing is primarily (and, disproportionately) based.

In addition to the Namibian populations, local-global bias will also be examined in a second set of participants whose local-global bias is, to our knowledge, as yet undocumented. Urbanisation and education were heavily confounded in the Namibian sample. In order to disconfound the two, local-global bias was measured in two Eastern-European Roma populations who had received approximately equivalent exposure to the urban environment but who differed in their overall levels of formal education. The Roma sample consisted of one group of Hungarian participants, the majority of whom had completed compulsory education and had learned to read and write, and another group of Romanian participants for whom education and literacy were not the norm.

Consistent with the analytic approach adopted for the Namibian sample, the influence of education (and, here also literacy as a specific component of education) was assessed within-group for each Roma population and gender. Between-group analyses were then used to gain a broader perspective on the overall extent of environmental influence, again with an urbanised group of British participants serving as a Western control.

Although urbanisation was broadly controlled for between the two Roma populations, socio-economic status, however, was not; whilst both groups of Roma participants (but not the British) came from populations of wide-spread poverty, the situation for the Romanian Roma participants was considerably worse. Results therefore are discussed also with some consideration to the possible effects of these adverse living conditions.

Similar consideration of poverty and adverse living conditions is applied to some extent also to the discussion of the results from the Namibian samples. However, it must be noted that for neither the Eastern-European nor the Namibian samples is the research design adequately set up to specifically test any effects of socio-economic status, or indeed any other variables along which our samples may diverge.

### 1.4.2 Application of the schema to the current research

The schema summarised in figure 2 and outlined in section 1.3 will not directly be tested by the research material presented in this thesis. Rather, it is intended that the schema may serve as a useful conceptual framework within which to discuss experience-dependent differences in local-global bias. As many aspects of the schema remain unverified, there will often be multiple hypotheses available for the interpretations of the results and, as far as possible, all candidate hypotheses will be afforded equal weight.

Urbanisation, education and gender have been identified as three environmental factors which may contribute to individual differences in local-global bias. As far as possible, any effects attributable to these factors will be discussed both in terms of physical and socio-cultural aspects of the environment, and at all levels of the perceptual process at which they may exert their effects.

The effects of gender as a culturally-defined variable and the effects of sex as a biologically-defined variable, however, cannot be differentiated between by the current research design. As such, any effects attributable to gender will be discussed both in terms of possible cultural and biological mechanisms.

Since age has also been identified as a likely important biological factor, where possible, the effects of urbanisation, education, and gender will be examined across the span of development. Furthermore, where possible an effort will be made to consider the age at which particular environmental experiences will have occurred and the consequences that the timings of those experiences may have.

The following subsections provide an overview of some of the extant literature on urbanisation, education and gender which has informed the hypotheses laid out in the subsequent empirical chapters and which will aid the interpretation of the empirical data that is therein presented. The effects of these three specific sources of environmental variance (urbanisation, education and gender) are discussed here in relation to the conceptual framework laid out in the schema of figure 2 and discussed in section 1.3.

#### *1.4.2.1 Urbanisation*

Urbanisation is on the increase across the globe. This move towards urbanisation brings with it a unique set of physical, cultural and lifestyle changes. The exact nature of these changes will vary somewhat from country to country but will often include profound changes to social organisation, patterns of family life and work situations, as well as increased stressors, higher levels of crime and violence, and better access to formal education (see Tacoli, 2012). The impact of urbanisation on people's ways of life, however, is perhaps most evident in certain parts of the developing world, where it is still the case that away from the towns and cities village life is based around traditional practices and customs with little outside influence from the modernised, Westernised world.

Anthropological reports of traditional peoples suggest that there may be fundamental differences in the ways that traditional peoples from remote backgrounds as compared to modernised, Westernised peoples conceptualise the world around them (Eisenstein, 1994). The Himba for example, have virtually no understanding of the abstract concepts of numeracy and mathematics, yet no doubt have their own culture-specific conceptualisations which would be difficult for the Westernised mind to grasp.

It has been suggested that, at least for certain traditional groups, there may be a cultural emphasis on direct experiences and a tendency to avoid abstract communications. Everett's (2005) description of the Pirahã (see earlier section), for example, strongly suggests a focus on more concrete, psychologically proximal and familiar conceptualisations (i.e., ones that fall within the bounds of personal experience and personal knowledge) which are likely to resonate with a more local conceptual style (see e.g., CLT: Libermann & Trope, 2003; GLOMOsys: Förster, & Dannenberg, 2010).

Along these lines, the transition away from the traditional cultural environment that is likely to accompany increased exposure to the urban environment could facilitate changes to habitual cognitive patterns in such a way that would promote a more global conceptual style. Education (discussed below), which is often confounded with urbanisation, is likely to entail considerable training of abstract conceptual processes (mathematics, science, literature). However, even in the absence of any formal educational training, contact with modern technologies, manufactured goods and so forth is likely to considerably alter one's outlook on the world.

Urban environments also are typically more socially diverse, and particularly so in comparison to culturally isolated traditional communities. This exposure to social diversity is one further example of the ways in which the urban environment may encourage a more psychologically distal perspective. For example, interactions with people from different cultural backgrounds to one's own may require abstract, global processing of new and unfamiliar knowledge that extends beyond one's own direct, personally acquired knowledge.

Beyond socio-cultural dynamics, the physical urban environment can also be characterised by a number of distinguishing visual features. As one example, independent of the cultural setting (East Asian versus Western), visual clutter in images of environmental scenes has on average been shown to increase as a function of urbanicity (Miyamoto et al., 2006). Based on this reasoning, it has been noted that the visual clutter account of cross-cultural differences in visual perception (Miyamoto et al., 2006; discussed above) is also consistent with the cross-cultural differences observed between the local-global biases of urbanised and remote populations (Caparos et al., 2012). Visual clutter, however, is just one example, of which there may be many more, of how the perceptual properties of the man-made urban environment and the natural environment (in conjunction with the culture-dependent demands of what that information is to be used for) may place different perceptual and attentional demands on the visual system.

It has been suggested, for example, that interactions with the urban environment, compared to interactions with nature, may require higher levels of divided attention (Berman, Jonides & Kaplan, 2008). Divided attention over multiple items, in turn, has been shown to increase sensitivity to changes at the global level of structure of Navon-like stimuli (Austen & Enns, 2000). The urban environment has been likened to a dynamic system of bottom-up signals which capture attention dramatically and involuntarily to compete with numerous top-down attentional demands that of themselves already call for divided attention (see e.g., Berman et al., 2008).

Such top-down attentional demands (e.g., the need to avoid bumping into fellow pedestrians) may mean that there are less top-down resources available to suppress the unwanted abundance of bottom-up ‘noise’ signals (e.g., from a flashing billboard), which may lead to even further divided attention. The increased need for divided attention in the urban environment, then, could in principle promote sensitivity to global features in general.

The natural environment, on the other hand, is thought to assert far fewer top-down demands, capturing attention predominantly in a bottom-up manner, and far more modestly than the urban environment (Berman et al., 2008). Thus, in the absence of exposure to the urban environment and man-made artefacts (such as in the case of the traditional Himba), top-down attentional resources may be more widely available to enable selective attention. Indeed, traditional Himba appear to possess a remarkable ability to selectively attend local or global levels of structure based on task relevance (Caparos et al., 2013), and to spatially focus on task-relevant stimuli whilst ignoring irrelevant peripheral distracters (Linnell, Caparos, Fockert, Davidoff, 2013). This enhanced top-down control may be important for enabling the processing of local features.

Urbanised Himba, on the other hand, appear to lose this unique ability to spatially focus and demonstrate a defocusing of spatial attention at a level similar to that of Western participants (Linnell et al., 2013). This defocusing may hinder the ability to process local information in isolation from the surrounding contextual information, or in other words may promote a more integrated or global processing strategy (Linnell et al., 2013).

Although untested, the defocusing effect that accompanies urban exposure in the Himba may perhaps be related to an increase in arousal (see Linnell, Caparos, & Davidoff, 2014). On a behavioural measure of arousal, traditional Himba show evidence that they may be in a particularly low state of arousal (Linnell et al., 2013). Possible sources of arousal in the urban environment include the aforementioned highly dynamic nature of the urban environment, the increased social stressors (Lederbogen et al., 2011) and other environmental stressors (see, e.g., Tacoli, 2012) that are more prevalent in the urban environment, and perhaps changes to diet such as increased sugar and caffeine intake (e.g., see Mahoney et al., 2011 for the effects of caffeine on perception and attention).

Whereas moderate levels of environmental stressors may have a general effect of moderately elevating levels of arousal, acute or chronic exposure to stressful situations may however exert quite different effects. Certain factors such as socioeconomic status and gender are likely to increase the risk of exposure to the negative stressors associated with the urban environment (e.g., Tacoli, 2012). Whilst arousal is generally associated with increased global processing (e.g., Mahoney et al., 2011), this may not necessarily be the case for acute or chronic stress. Aversive arousal, for example, has been suggested to cause a narrowing of perceptual breadth, which would be more likely associated with increased local processing (Tucker & Williamson, 1984; Derryberry & Reed, 1998; Derryberry & Tucker, 1994).

#### *1.4.2.2 Education*

It is hard to imagine that the years of intense educational training that we are exposed to – on top of the cumulative effects, at the societal level, of centuries of schooling – do not have a profound impact on the way that we conceive of the world around us. Yet whilst in much of the developed world education is taken virtually as a given, this is certainly not the case universally.

Literacy acquisition may represent one important aspect of education, with the potential to impact local-global processing at both the conceptual and perceptual levels. Literacy acquisition will lead to exposure to the written language, the content of which may differ in many ways to that of verbal communications. Written texts, for example, may be more complex in grammatical structure as well as in narrative structure and knowledge content, all of which may encourage a broader, more global processing style (see, e.g., Carr, 2010 for a historical perspective on the cognitive effects of the written word). Furthermore, since there is no direct shared experience between writer and reader, and the reader is often required to take on an unfamiliar perspective, this may further create a psychologically more distal perspective.

Education and literacy are also likely to have a significant impact on visual input. Particularly in less developed countries where education may not necessarily be the norm, going to school versus not going to school may expose children to very different perceptual environments indeed. Most notably, schooling brings with it extensive visual experiences of the printed word and pictographic material.

Learning to read has far reaching consequences for the visual system (Dehaene, 2009; Dehaene et al., 2010) and has been suggested to involve a form of perceptual learning that requires fast parallel information processing, under pressure, more often than other forms of visual cognition (Szwed et al., 2012). Ex-illiterate participants who learnt to read in adulthood, but not illiterate participants, were able to reach normal adult levels of visual function on a version of the contour integration task or CIT (Szwed et al., 2012).

The CIT requires the ability to perceive global structure, and performance is thought to index the extent of long-range horizontal connections in V1 (e.g., see Kovács, 2000), which in turn have been suggested to be functionally important for global processing. Those who never learn to read may have little environmental pressure to develop this particular form of processing skill in the same way as those who do. For those who do learn to read, however, the intensive perceptual training required for reading may alter the functioning of relatively early visual processes in a way which may support or enhance global processing.

The long-range horizontal connections thought to be important for contour integration have also been suggested to be important for the processing of certain forms of pictorial information, such as the perceptual organisation of two-tone images (see Yoon, Winawer, Witthoft, & Markman, 2007). Two-tone (or 'Mooney') images are made by converting grey-scale photographs or other images into pure black and white. They are often comprised of spatially separated distinct contours and strong edges which can be grouped in many ways, and this spatially separated information must be integrated in order to disambiguate the image. The image can only be understood at the global level and the 'perceptual whole' must be perceived in order for the picture to 'make sense'.

When the corresponding grey-scale photograph is presented alongside, for Western adults, the perceptual reorganisation required for recognition tends to be rapid and effortless. However, when two-tone image recognition was compared between Western adults and a remote tribal population, the recognition of remote tribal participants was strikingly poor (Yoon et al., 2014). It was suggested that the poor performance of the remote population is likely to relate to the fact that they had had little or no prior experience with interpreting pictographic material.

Just as learning to read requires perceptual training, it is likely that interpretation of pictographic material is also dependent on considerable perceptual training, perhaps accumulated over many years of exposure. The findings from two-tone image recognition suggest that 'pictorial literacy', as with general literacy, may stimulate the development of mechanisms which support global processing.

Perceptual learning shows us that we become experts at processing visual information for our specific functional needs. Just as educational training requires specific forms of perceptual learning (e.g., learning to read and learning to interpret pictures), so too will other forms of specialised activities outside of the school environment. For remote populations who follow traditional lifestyles the forms of perceptual learning required for daily life are likely to differ considerably to those required for the educational environment.

It is possible that whereas the perceptual skills required for educational purposes may promote global processing, the perceptual skills required for traditional life may be more likely to promote local processing. Traditional peoples, for example, may become fine-tuned to the intimate details of the natural world, upon which their livelihood is likely to depend. For example, identifying specific plants for medicinal and culinary uses or recognising the tracks of specific animals may require rapid and specialised processing of local details.

Many of the proposed effects of education, above, will have consequences not only at the level of the individual, but also at the level of society more generally. Even if an individual has not personally attended school themselves, living in a cultural setting where education is the norm will expose those individuals to ample pictorial material and shared cultural knowledge owed to the accumulated effects of modern schooling.

The broader cultural setting will also have considerable implications for the functional utility of formal educational training. In settings for example where resources are scarce and poverty is wide-spread, educational attainment may have particularly high implications for one's personal earning power and social status. Lack of education or exclusion from ways of life that depend on it may bring with it a loss of personal perceived power, and greater exposure to environmental stressors.

#### *1.4.2.3 Gender*

Clearly, gender can have considerable impact on one's experiences throughout the life-span, impacting both our overt behaviours (e.g., Newcombe, Bandura & Taylor, 1983) which determine the experiences we are exposed to as well as our internal appraisals of those experiences (e.g., Olff, Langeland, Draijer, & Gersons, 2007). With regards to urbanisation and education, then, it cannot be supposed that equivalent exposure in terms of simple measures such as years of urban-living or years of formal education can be equated for men and women. Urban living, particularly amongst the urban poor, for example has been shown to lead to systematically greater exposure to environmental stressors and the negative aspects of urban-living for women than for men (Tacoli, 2012) and the functional utility of formal education, for example, is likely to be greater for men than for women in societies where cultural norms dictate that the man should be the breadwinner.

Differential treatment of males and females in society will inevitably lead to gender-specific patterns of experience, and in certain cases these systematic differences may have the potential to impact local-global bias. Local-global bias may be impacted by culturally-defined notions of gender in a number of ways. Local-global bias has been suggested to be impacted by a number of psychological state-related factors, including ones which can be expected to vary considerably as a function of gender. Across cultures, typically, men have been shown to possess higher levels of interpersonal power (e.g., Carli, 1999), and command more social influence than women (e.g., Carli, 2001). It is therefore highly likely that men will experience states of high psychological power, which may be associated with enhanced global processing and/or enhanced cognitive flexibility (e.g., Smith and Trope, 2006; Guinote, 2007), far more frequently than women.

For populations whose living conditions are particularly adverse, such as for example the Romanian Roma, and to a lesser extent the Hungarian Roma and urban Namibian samples, individuals may be particularly at risk to situations of power-deprivation and increased exposure to stressors; in such situations it is possible that gender-inequalities may become exacerbated and/or that any influence on local-global processing and executive functioning (e.g., cognitive flexibility) may become inflated (see e.g. Clearfield & Niman, 2012, for evidence that poverty impacts cognitive flexibility).

Adverse living conditions are likely to coincide with increased exposure to environmental stressors and sources of negative affective arousal. Whilst aversive arousal in general has sometimes been linked to a narrowing of perceptual scope (Tucker & Williamson, 1984; Derryberry & Reed, 1998; Derryberry & Tucker, 1994), a considerable body of empirical work shows that men and women differ substantially in their psychological and neurobiological stress and arousal responses (e.g., Goldstein et al., 2010; Nielsen, Ahmed, Cahill, 2013; Andreano, Arjomandi & Cahill, 2008; see Olff, et al., 2007 for a review of gender differences in the response to both acute and chronic stress and trauma. See also Lebron-Milad et al., 2012 for related sex-differences in response to fear).

These different stress and arousal responses seem likely to stem at least in part from biological underpinnings. For example, whilst functional imaging studies have shown sex-differences to be present irrespective of women's menstrual cycle timing, sex differences are particularly high when comparing men to women in their late follicular or luteal (high hormone) phases (Goldstein et al., 2010; Nielsen et al., 2013; Andreano et al., 2008), strongly suggesting some degree of hormonal modulation.

It has also been shown that these different response strategies may have implications for local-global processing, at least in the capacity of memory for gist and detail (Nielsen et al., 2013; Cahill and Van Stegeren, 2003). Whereas men show enhanced memory for gist (global information) but not details (local information) of negatively emotionally arousing stories compared to neutral stories, women in their luteal phase by contrast showed enhanced memory for details but not for gist of the same emotionally arousing stories compared to the neutral stories (Nielsen et al., 2013). These differences may relate to gender-specific hemispheric activation of the amygdala in response to arousal (e.g., see Cahill and Van Stegeren, 2003). Further research will be needed to determine whether gender-specific stress responses may have implications for local-global processing beyond memory, and specifically for local-global perceptual bias, however, this remains an open possibility.

Whilst hormonal modulation has been proposed as one likely mechanism through which sex-specific responses to stress and arousal might operate/arise, this by no means presupposes that environmental factors do not also play a role. It is worth reiterating also that differential responses at the biological level do not necessitate a biological origin. Gender differences in cognitive appraisal (i.e., the subjective interpretation of the stressful event) and coping processes (e.g., active versus defensive) for example have been implicated in determining not only psychological but also biological stress responses (Olff, Langeland & Gersons, 2005).

Particularly in regards to the appraisal of stressful events, considerable gender differences have been shown (see Olff et al., 2007 for review). Women are more likely to report threat and loss appraisals (e.g., Cole & Sapp, 1988; Mak, Blewitt & Heaven, 2004) to appraise events as more stressful (e.g., Eisler & Skidmore, 1987) and to report lower levels of perceived control (e.g., Mak et al., 2004) in their appraisals of stressful events, as compared to men. Differences in appraisal may relate to certain aspects of brain functioning; for example, it has been suggested that women may be more sensitive to threat signals (e.g., Kemp, Silberstein, Armstrong & Nathan, 2004) and may also show greater levels of arousal in response to aversive cues (Lang, Bradley & Cuthbert, 1998) than men.

The extent to which the above findings may relate to socio-cultural and to biological aspects of gender remains unclear. What is clear, however, is that both biology and culture are likely to play some role in shaping local-global bias in men and women. Female hormonal regulation, for example, has been shown to influence responses to local-global hierarchical figures (Pletzer et al., 2014; Scheuringer & Pletzer, 2016. See section 1.2.4 above) and memory for local-global aspects of emotionally arousing material (Nielsen et al., 2013), in both instances with higher female sex-hormones being related to more local strategies. Culture, on the other hand, will determine the different environmental experiences to which men and women are exposed as well as the functional relevance of those experiences.

Gender as a man-made construct, however, varies from culture to culture. Cultures vary for example in terms of standards of gender equality and the extent to which the gender roles of men and women (and boys and girls) belong to separate spheres and entail separate duties. Indeed, the *gender stratification theory* of gender differences in cognitive ability (Baker & Jones, 1993), suggests that precisely these kinds of differences in the cultural treatment of gender can have substantial moderating effects on observed gender differences (e.g., Guiso, Monte, Sapienza & Zingales, 2008; Rilelly, Okabe, Germine, Wilmer, Esterman & De Gutis, 2016), albeit with somewhat mixed empirical support (see e.g., Reilly, 2012). By extension of the underlying principles of gender stratification theory, it might be expected that culture-dependent treatments of gender may also impact the extent of any gender differences that may exist in local-global bias.

The Namibian and Eastern-European populations reported on here, in general are expected to represent cultures which are less gender-equal and have greater separation of male and female roles as compared to the Western control group (as discussed in greater detail in chapters 2 and 3). The consideration, then, of culture-dependent gender-based differences in experience will be of particular importance to the current study.

### 1.4.3 Summary of research aims, methodologies, and hypotheses

We investigate the roles of urbanisation, education and gender on the development of local-global bias in three groups of populations, traditional and urban Namibians (TN and UN; Namibian sample), Romanian and Hungarian Roma (Eastern-European Sample), and urban British (UB; the Western control group). For the Namibian and British samples, we tested the effects of these variables in both adults and children.

Our measures of local-global bias are derived from two versions of the local-global similarity matching task (see figure 1). The first version is the same version used by Caparos et al. (2012) and is a computerised version consisting of 36 experimental trials, and the second version is a card-based version with just 3 trials. It was necessary to use a shorter and more portable version of the task for the work in Eastern-Europe due to the very difficult testing conditions. It was also necessary to use this shorter version for the developmental work, because a pilot study showed the computer version to be too demanding for the youngest children (age 4).

We used two measures to index local-global bias. The primary measure we use to index local-global bias was *Frequency of global-similarity choices* (continuous variable). *Frequency of global-similarity choices* shows the relative proportion of trials for which a participant made a global-similarity match. We also derived a categorical measure based on *Frequency of global-similarity choices*, to index each participant's *Preferred matching style* (local, global, or mixed).

In chapters one and three, when using the categorical measure, we could only categorise participants as having either a local or a global *Preferred matching style* because too few participants used a combination of local and global matching. As such, for chapters one and three, a local *Preferred matching style* was defined as *Frequency of global-similarity choices* < 0.5 and a global *Preferred matching style* was defined as *Frequency of global-similarity choices* > 0.5. For chapter two, however, we were able to include the third category, *Mixed matching style (Frequency of global-similarity choices* ≥ 0.33 & ≤ 0.67)

Along with these measures of local-global bias, we extracted two additional variables from the computerised task. First, we measured reaction times, as this was a readily available measure. Exposure times are known to impact local-global processing (e.g., Hoar and Linnell, 2013), and so it was important to take this factor into account.

We also derived a measure which it was supposed might provide an indirect measure of cognitive flexibility. We calculated how many times a participant switched between using local and global matching strategies. This measure, *Number of switches,* was included on the premise that it might provide an indirect measure of cognitive flexibility as higher levels of cognitive flexibility have been associated with a reduced tendency to always make similarity-matches at the same level of structure (Caparos et al., 2015). We were unable to derive the same measure from the card version as there were only 3 trials. However, for the card version of the task a *Mixed matching style* indicated that the participant had made at least one switch, whereas a local or a global *Preferred matching style* indicated that the participant had not made any switches. Therefore, it was also supposed that a *Mixed matching style* might also provide an indirect measure of high cognitive flexibility. These measures were not intended to be optimal measures of cognitive flexibility, but rather, these were additional measures which could easily be obtained.

To analyse the results, we used two broad strategies. First, we performed within-group analyses (except with the British group) to test the effects of urbanisation and/or education in each environmental context. This allowed us to see how generalisable the findings were to different environmental contexts, and, additionally it allowed for a more sensitive way of analysing the data as more subtle effects would have been masked if we had only used between-group comparisons. Based on the same reasoning, we performed these within-group analyses separately for males and for females. This allowed us to see how generalisable the effects of urbanisation and education were across genders, and furthermore, we had reason to suspect that combining the male and female data would mask the subtler effects.

In addition to the within-group analyses, we then performed between-group analyses across population and gender. This allowed us to illustrate the overall extent of the effects of urbanisation and education, and to compare Namibian and Eastern-European samples to the Western control group. This was important, because these analyses provide important insight into how well findings obtained from Western samples can adequately be used for deriving general models of perception. Between-group analyses also allowed us to test for main effects of gender and gender interactions.

Based on the literature reviewed in this chapter, we predicted that urbanisation and education would have the general effect of increasing global bias. It was unclear whether men/boys and women/girls would be impacted in similar ways or whether there would be differences in either the extent of any effects, or in the general pattern of effects for males and for females. However, it was predicted that gender effects would be in the general direction of increased global bias in males.

# Chapter two: The effects of urbanisation, education and gender on the local-global bias of adult Namibians from remote and urban environments

## 2.1 Chapter overview

Previous research has suggested that exposure to the urban environment and urban living may provide the necessary environmental pressure to encourage a global bias in a population (the Himba) that, in the absence of this exposure, otherwise expresses a local bias. Our results reported in this chapter replicate the previous finding of a local bias in a remote Namibian population. In addition, we also show for the first time that urban Namibians who became urbanised early, have spent a long time in the urban environment, spend their time predominantly in the urban environment and who have received formal education, by contrast, demonstrate a global bias.

The findings further showed that extent of urbanisation, years of education and gender all impact local-global bias, but that none of these factors works in isolation and that there are no simple blanket-effects. Education on the one hand appears to mediate the relationship between urban exposure and global-similarity matching in urban Namibian men yet has no observable relationship with global-similarity matching in urban Namibian women. Gender on the other hand appears to have a separate moderating effect on the relationship between urban exposure and global-similarity matching such that local-global bias in educated females was only affected by relatively large amounts of urban exposure whereas local-global bias was more readily affected by exposure in males of equivalent educational background. We discuss the results in relation to physical and socio-cultural environmental factors and biological factors which may impact local-global bias in our sample.

## 2.2 Introduction

### 2.2.1 Background

As laid out in chapter one (see section 1.2.2), global bias is not a predetermined feature of the neurotypical adult visual system. At least one population, the Himba tribe of Namibia, has been studied where a local bias is retained even in adulthood (Caparos et al., 2012; Davidoff et al., 2008). On a local-global similarity matching task (see methodology section of this chapter; see also Figure 1, chapter one) Himba participants from remote villages made matches based on perceived similarity at the local level of structure on 84% of trials, whereas urbanised British participants in the Western control group made matches based on perceived similarity at the local level on just 23% of trials (Caparos et al., 2012).

The Himba lead a traditional way of life in the remote semi-desert landscape of the Kunene region of Namibia (see e.g., Bollig & Heinemann, 2002). It has been proposed that it is this remote lifestyle which accounts for their local bias (e.g., Caparos et al, 2012) and although as yet untested it is likely that remote populations in general may also possess this local bias (as indicated by their well-documented diminished susceptibility to context-dependent illusions: Rivers, 1905; Segall et al, 1963; Stewart, 1973; Ahluwalia, 1978; Wagner, 1977. Note that although illusion strength typically does not correlate well with measures of local-global bias at the individual level, the two tend to correspond well at the group level).

In an extension of the hypothesis that the remote environment promotes a local processing bias, it has further been suggested that the urban environment may promote a global processing bias (Caparos et al., 2012). Within the Himba, the strength of the local bias was shown to be diminished as a function of exposure to the urban environment. Participants from remote villages who had made occasional visits to town showed a weaker local bias than those who had never been to town; in fact, the local bias of the Himba diminished as a linear function of the number of these occasional visits to town (0, 1, 2, 3+ visits. Caparos et al., 2012).

Furthermore, members of the same tribe who had been raised traditionally but relocated to town in early adulthood showed a bias that, at the group level, was intermediate between that of the remote members of the tribe and the Western control group, making matches at the local level of structure on 62% of trials (Caparos et al., 2012). Taken together, these findings strongly suggest that urban exposure, or some other factor or combination of factors relating to urban exposure in this specific population, impacts local-global bias. Yet at the same time these findings also give rise to a number of questions.

That such a small amount of exposure to the urban environment as a handful of visits to town could produce any measurable effect suggests that urban exposure has a profound impact on local-global bias. Yet at the same time, Himba who had been living in town for a considerable length of time (average of 6 years) made global similarity-matches far less often than their urban British counterparts, and in fact still made similarity-matches most often at the local level of structure. If on the one hand even very limited urban exposure in the form of just a handful of visits to town is sufficient to significantly impact local-global bias, it seems natural to ask *why then does this far more substantial urban exposure in the form of relocation to town not have a more sizeable effect?*

It is perhaps misleading, however, to try to equate the effect seen in the urban Himba with a simple extension of the visits effect. It is important to note, for example, that it need not be the case that the same aspects of urban exposure (or factors associated with urban exposure) that contribute to the visits effect in traditional Himba will also underpin the effect of more sustained exposure in the urban Himba group.

The schema presented in chapter one (see figure 2, chapter one) suggests that local-global bias can be impacted by various kinds of external influences (physical and/or socio-cultural) and perhaps at a number of points along the processing chain (local-global perceptual processing, local-global conceptual processing, physiological/psychological state, cognitive flexibility). It is likely that for any given individual a combination of factors will contribute to whether a local or a global bias will prevail. In order to better understand the factors which are both driving (relative to traditional Himba) and limiting (relative to the Western control) global bias in the urban Himba participants, it will be necessary to consider the urban Himba more closely as a distinct group.

### 2.2.2 The local-global bias of urban Himba relative to traditional Himba

Urban exposure – in its broad definition – has been implicated as one likely causal factor for the diminished local bias of urbanised Himba relative to traditional Himba. Urban exposure, as outlined in chapter one (section 1.4.2.1) may promote a global bias via a number of means. 1) Physical properties of the urban environment, such as high levels of visual clutter (see Miyamoto et al., 2006) or dramatic bottom-up signals which divide attention (e.g., Berman et al., 2008) may encourage the use of more global processing strategies. 2) The urban environment may be linked to higher levels of arousal (e.g., traditional Himba appear to show lower behavioural measures of arousal compared to urban British; Linnell, Caparos, & Davidoff, 2014). An effect of urban exposure on arousal would be compatible with the urban environment being associated with increased stressors (Lederbogen et al, 2011, Tacoli, 2012), a more dynamic profile (e.g., Berman et al., 2008) and generally a faster pace of life. Heightened arousal, in turn, has been shown to promote a more global perceptual processing strategy (Mahoney et al., 2011). 3) The urban environment may promote a more psychologically distant and abstract perspective, for example because of the increased social diversity, and/or (in the case of traditional populations) exposure to modern conceptualisations of the world. This greater need for abstract representation and psychological distancing may promote a more global conceptual processing style. A more global conceptual processing style and greater psychological distancing may in turn activate a reciprocal more global processing style at the perceptual level also (Lieberman & Förster, 2009; see Trope & Lieberman, 2011, for review; however, see Firestone & Scholl, 2016, for a discussion of the caveats).

Urban exposure, in the case of the Himba, however, is largely confounded with education. Although the visits effect demonstrated in traditional Himba cannot be accounted for in terms of level of education, the increase in global-similarity matching of urban Himba as compared to traditional Himba could be. As outlined in chapter one (section 1.4.2.2), education may exert an effect in a number of ways. 1) The perceptual learning required for learning to read (e.g., Szwed et al., 2012) and/or learning to interpret pictures (e.g., see Yoon et al., 2007) may promote a global perceptual processing strategy. 2) Formal education has been shown to increase abstract thinking (Greenfield & Bruner, 1966) and the use of abstract language (Klein, Ventura, Licata & Semin, 2010), which suggests that education may foster a more global conceptual processing style. An increased focus on global conceptual processing may encourage increased global processing at the perceptual level also, either directly, (e.g., Lieberman and Förster, 2009; see Trope and Lieberman, 2011, for review) or indirectly over time (see general introduction). 3) Education may be an important factor for employability, and therefore wealth. In this way education may be linked with improved quality of life and improved social standing. Such factors are likely to impact psychological state, perhaps heightening feelings of positive affect and powerfulness, both of which may be linked to increased global perceptual processing (e.g., Gasper & Clore, 2002; Smith & Trope, 2006). Urbanisation and education, then, both provide equally valid (and indeed not mutually-exclusive) explanations for the difference between the similarity-matching of traditional and urbanised Himba.

### 2.2.3 The local-global bias of urban Himba relative to urban British

These same factors – urbanisation and education – which might account for the difference in local-global bias between traditional and urbanised Himba may also account for the difference between the urban Himba and the Western control group. Both the extent of urban exposure and formal education received by the Western control group in Caparos et al's (2012) sample (London based university undergraduate students) far outweighs that of the urbanised Himba. The urban Himba group was comprised of Himba who had relocated to the small town of Opuwo (Population approx. 7500, National Planning Commission, 2015) at an average age of 21, and had on average been living in Opuwo for 6 years. Very few, if any, would have received any university-level education. The Western control group, by contrast, was comprised of psychology undergraduate students attending university in a highly urbanised area of London (see Caparos et al, 2012).

The fact that the majority of the urban Himba in the 2012 study (Caparos et al, 2012) had relocated to town in adulthood may initially suggest that local-global bias does not become set in stone during childhood and that urban exposure even in adulthood can exert a substantial effect. From an evolutionary perspective, if acquiring local-global bias in line with one's specific environment is an important strategy for personal gain, then it may make sense for this adaptive ability to be preserved even later in life. However, this hypothesis has not been directly tested and this is not the only available explanation for the results.

Although the majority of urban Himba had relocated to town in early adulthood, age of moving to town ranged from as young as 9 years old. If the participants who had relocated to town early in life consistently made matches at the global level of structure, it is not necessary to assume that participants who became urbanised later in life made global-similarity matches any more frequently than Himba who remained in the traditional villages.

A second factor to be taken into consideration is that it is not possible to establish what the pre-urbanisation local-global bias would have been for this urban group. It is likely that not all participants had originally come from villages as remote and unaffected by modernisation as the villages where the traditional Himba were tested. One possibility therefore is that even before relocation to town in adulthood there may have been baseline differences in local-global bias compared to Himba from very remote villages. The issue of adult plasticity therefore remains an open question.

In a similar vein, even if some degree of plasticity remains in adulthood it is unclear whether there would be limitations to this plasticity. That is, separate to the issue of adult plasticity, childhood and/or adolescence may represent a uniquely sensitive period for the development of local-global bias. Some researchers argue that human development can be segmented into discrete biological stages: infancy, childhood (3-6), middle childhood (7-11), adolescence (12-17) and adulthood (e.g., Bogin, 1997). It is suggested that plasticity may be particularly enhanced during the transitional periods between these stages (West-Eberhard, 2003), that the capacity for plasticity is reduced through the course of development (Feldman & Brecht, 2005; Zevin & Seidenberg, 2004) and that hormonal changes around the end of puberty may mark the end of much plasticity (Daw, Sato, Fox, Carmichael & Gingerich, 2004). It is therefore possible that experience-dependent factors such as urban exposure may exert a stronger impact during development than during adulthood. It is also possible that urban exposure during development and urban exposure during adulthood may have separable effects (e.g., see Lederbogen et al., 2011, for dissociable effects of urban upbringing and current urban living on the neural correlates of social stress).

Within the West, developmental studies utilising similarity-matching tasks typically report a developmental shift from local preference to global preference at around 6 years of age (e.g., Kramer et al., 1996, at 7 years of age; Vinter et al., 2010, at 5 years of age; Poirel et al., 2008, at 6 years of age) which roughly coincides with the transition period from childhood to middle childhood (see, e.g., Bogin, 1997). At age 6, children who utilised a global similarity-matching strategy presented with grey matter loss (synaptic pruning) in localised areas of primary visual cortex that was not evident in children of the same age who still utilised a local similarity-matching strategy (Poirel et al., 2014), suggesting that there are neural correlates of these age-dependent shifts in behaviour (see also Poirel et al., 2016).

It is suggested that this transitional period around 6 years of age may represent a particularly important developmental window for the development of global bias (Poirel et al., 2008). However, age related changes in local-global processing of hierarchical stimuli have been shown to continue to unfold well into late childhood (Burack, Enns, Laocci & Randolph, 2000; Enns, Burack, Larocci & Randolph, 2000; Kimchi, Hadad, Behrmann & Palmer, 2005; Porporino, Larocci, Shore & Burack, 2004) and even into late adolescence (Scherf, Behrmann, Kimchi & Luna, 2009). This protracted development of local-global processing may suggest a very wide window of sensitivity over which environmental influences may be felt and may accumulate.

That local-global bias takes such a long time to develop fully in Western populations may also suggest that the changes which accompany a shift to global bias may require prolonged environmental pressures and perhaps cannot occur rapidly. One possibility is that there may be a dose-effect relationship such that incremental increases in the duration of urban exposure and/or education may have additive effects on the development of global bias. The urban group from the 2012 cohort (Caparos et al., 2012) had on average received 6 years of exposure to the urban environment (years of education not reported). It may be that with more prolonged exposure urban Himba may begin to resemble Western participants in their matching strategy.

This possibility of a dose-effect relationship of environmental drivers such as urban exposure or education need not be incompatible with the previously alluded to possibility of a developmental sensitive period. For example, greater doses of urban exposure and/or education may be required to produce an effect in adulthood as compared to in childhood due to a reduction in sensitivity with age. In other words, although we will not test the hypothesis directly, it is possible that any dose-effect relationship may be age-dependent.

This possible difference in the required 'dosage' of urban exposure and/or education that may be necessary for promoting a switch to a global bias is not the only difference that may exist in regard to the development of a global bias during childhood versus during adulthood.  It is possible also that these two scenarios may require fundamentally different processes. For example, the role, if any, that cognitive flexibility may play in the 'typical' development of local-global bias in Western children is unknown. However, nonetheless, it may be reasoned that the shift from a local bias to a global bias in adulthood, when the original local bias may be more firmly entrenched, may require a considerable degree of cognitive flexibility. If so, it may be the case that the process of developing a global bias in childhood and the process of developing a global bias in adulthood may to some extent be dependent on different environmental factors.

Clearly, there is still a long way to go before the precise drivers which the development of local-global bias may be subject to can be fully understood. The above discussion, however, shows that it is possible that the lower rate of global-similarity matching of the urban Himba compared to the British sample could in theory relate entirely to the differences in levels of urban exposure and education outlined above.  On the other hand, however, it is also possible that there may be some other unaccounted-for factor/s which may limit the extent to which a global bias may develop in urban Himba, even with more extensive urbanisation and education.

If for example, aspects of traditional Himba culture may promote a greater emphasis on concrete conceptualisations and a local conceptual processing style then these cultural ties (if maintained) may counteract and limit the effects of that urban exposure and education. That is, urbanised Himba may have a greater functional need to engage in local styles of conceptual (and perhaps perceptual) processing as compared to Westernised participants, due to their ties to traditional culture. Since local-global bias relates to the relative strength of the local versus global percept, then if the functional need imparted on certain urban Himba for local processing remains stronger than the functional need for global processing (as may be the case for some) then a global bias would not be expected to develop.

It is important, also, to remember that the development of local-global bias may not only be dependent on quantifiable factors such as extent of urban exposure and education. Equally the qualitative experiences of urban exposure and/or education and the ramifications of that exposure may be important factors to consider also. Poverty, for example, in Namibia, is widespread in its towns and cities (World bank, 2009). A significant proportion of urban

Himba are likely to face considerable adversities and be exposed to high levels of environmental stressors due to the difficulties associated with this level of hardship. By contrast it is likely that very few of the Western control participants would ever have been exposed to the same kinds of environmental stressors.

Although it is difficult to predict how associated factors such as chronic stress (which seems a likely consequence of urban poverty) may impact local-global bias, it is possible that the additional stresses involved with urban poverty may foster a psychological/physiological state less conducive to both global and flexible processing. For example, although heightened arousal has been linked to enhanced global processing on the one hand (Mahoney et al., 2011), on the other hand aversive arousal has been linked to a narrowing of perceptual scope (Derryberry & Tucker, 1994) and negative affect and feelings of powerlessness that may be associated with stressful situations have been linked to reduced global processing (e.g., Gasper & Clore, 2002; Smith and Trope, 2006) and reduced flexible processing (Baumann & Kuhl, 2005; Guinote, 2010).

Notwithstanding the difference which exists in the levels of urbanisation of the urban Himba and the Western controls, then, important differences in the qualitative experiences of urban life are also likely to exist between the two groups. A similar observation can be made in regards to education. For the Western control group, formal education is a standard part of life for virtually all members of society, whereas this is not the case for Himba. Becoming educated in a cultural setting where it is the definitive norm may be quite a different experience to becoming educated in a society where formal education is a comparatively new addition to the culture. Furthermore, it is quite possible that there may be differences in terms of the educational content and quality of education received by the two populations.

Given that gender has such a strong influence in determining the kinds of experiences to which we are exposed, this broader consideration of possible qualitative differences in experience may also have particularly important bearings on the discussion of gender which follows.

### 2.2.4 Gender

To our knowledge, gender differences in local-global similarity-matching strategy (frequency of global similarity-matches) have never been reported in adult populations, even in experiments specifically aimed at testing for them (Basso & Lowery, 2004; Scheringer & Pletzer, 2016). This is contrary to several studies which have shown a tendency for boys to make more global-similarity choices than girls of the same age during childhood (Kramer, Ellenberg, Leonard & Share, 1996, for children aged 4-12; Tzuriel & Egozi, 2010, for children aged 6-7), suggesting that an initial gender gap in childhood may disappear by adulthood. One possibility to reconcile the divergent findings of these child and adult studies is that under certain environmental conditions (e.g. highly modernised urban environments) global bias may reach its full expression in both genders, eliminating gender differences that may exist at earlier stages of development.

However, the absence of any gender difference at the behavioural level for a particular measure need not suggest that there is no difference at the level of processing (e.g., Weiss et al., 2003; Schoning et al., 2007; Clayson; Clawson & Larson, 2011). Indeed, when reaction times to similarity-matches were also considered it was found that when women made global-similarity matches they took longer to do so than men (Scheringer & Pletzer, 2016). In other words, even though men and women did not differ in their overall choices, it took longer for women to reject the local similarity-match than it did for men, suggesting that the processing leading to those choices may have differed somewhat.

It is difficult to predict whether this gender difference in reaction time data relates to different strategies of men and women at the level of decision making and response, or whether it may reflect a more fundamental difference in perceptual experience which more conventional measures of similarity-matching (i.e., frequency of global-similarity choices) are simply not sensitive enough to detect. Consistent with the latter, a handful of studies have indeed reported gender differences in measures of global advantage (i.e., faster response times to globally defined, as compared to locally defined, targets) for hierarchical Navon-like figures in the general direction of reduced global advantage in women compared to men (Roalf, Lowery & Turetsky, 2006; Razumnikova & Volf, 2011; Pletzer et al., 2014; however, see Kimchi, Amishav, & Sulitzeanu-Kenan, 2009).

Some authors have appealed to biological-level explanations for these reports of gender differences in local-global processing (see, e.g., Pletzer, 2014; Kramer et al., 1996; Toga & Thompson, 2003, for review). For example, it has been suggested that gender differences in local-global processing may be accounted for by hormone-modulated lateralisation and hormone-dependent hemispheric activation. It has been argued that lateralisation may be hormone-modulated and that lateralisation may be more pronounced in males (see, e.g., Toga & Thompson, 2003). It has also been argued that progesterone may selectively enhance left hemispheric functioning (which has been linked to local processing; Kaplan, 1983; Robertson & Delis, 1986; Fink et al, 1997; Heinze et al., 1998; Lamb et al., 1989; Van Kleeck et al., 1989) and that testosterone may selectively enhance right hemispheric functioning (which has been linked to global processing; see, e.g., Pletzer, 2014). Evidence suggests that progesterone levels may modulate local-global processing of hierarchical figures in women (Pletzer et al., 2014) and that testosterone levels may modulate local-global processing of hierarchical figures in both men and women (Pletzer et al., 2014), and may modulate the choice of matching strategy during local-global similarity-matching tasks (Scheringer & Pletzer, 2016).

It is possible that sex-related gender differences in local-global processing may be more pronounced in populations where a global bias is not as firmly established as it is in the West (where men and women may both reach ceiling levels). If men and women (and/or boys and girls) may have differing levels of underlying biological sensitivity to environmental drivers of local-global bias (i.e., men may have a heightened sensitivity to drivers of global bias relative to women), for example, this may be expressed by a stronger global bias of men relative to women in environmental circumstances which provide only a moderate drive towards global bias. Urbanised Himba could potentially represent one such group. Although no overall gender differences were reported in the 2012 urban Himba sample (Caparos et al., 2012), this analysis did not take into account factors such as extent of urbanisation and education (which potentially may amplify or dampen gender differences), and so gender differences may have been masked. For these reasons, in the current study, the effects of gender will be examined in relation to the effects of urbanisation and education.

At the same time as acknowledging that there may be a strong biological component to any observed gender differences in local-global processing, it is important to remember that biological influence need not be deterministic and may be amplified or dampened according to experience-dependent factors. For example, whilst it is generally noted that there is strong evidence for hormonal effects on brain lateralisation, experience-dependent plasticity too has a significant role to play (Toga & Thompson, 2003).

Indeed, more generally, it has been recognised that there is a need to study sex/gender differences in cognition within the context of environmental setting and experience (Halpern, 2004; Linn & Petersen, 1985; Levine et al, 2005; Tzuriel & Egozi, 2010; Newcombe, Bandura & Taylor, 1983). This argument has perhaps most often been invoked in relation to gender differences in spatial processing ability. Some of the largest gender differences in cognition are seen in spatial processing ability, where men and boys consistently outperform women and girls on tasks such as mental rotation (see e.g., Tzuriel & Egozi, 2010, for review). Whilst such skills are not a direct measure of local-global processing, it has been proposed that performance on these tasks is mediated by local-global processing strategy (e.g. Tzuriel & Egozi, 2010). Within this field there is a growing body of support to show that the size of the gender difference, as well as overall performance scores, is sensitive to a number of environmental (e.g., Levine et al., 2005) and psychological (e.g., Estes & Felker, 2012) factors, and that appropriate intervention strategies can eliminate the performance gap altogether (Tzuriel & Egozi, 2010; Newcombe, et al., 1983). Furthermore, evidence suggests that gender-dependent visual experiences relating to culturally-defined gender-specific patterns of behaviour are likely to feed into these gender differences. For example, in one study school-aged Western boys were shown to have more out-of-school experiences of a spatial nature than girls, and the extent of these spatial experiences was shown to correlate with measures of spatial processing ability (Newcombe et al., 1983).

The above discussion makes it clear that the study of gender differences in local-global bias requires sensitivity to the notion of gender being culturally as well as biologically defined. To this end, it is important to consider the gender dynamics of the specific populations involved in the current study. Traditional Namibian culture is highly genderised (see LaFont, & Hubbard, 2007) such that males and females take on separate roles and duties and males are traditionally afforded higher positions of social power both in the community and within interpersonal relationships. Colonisation is thought to have further contributed to gender inequalities; for example, under colonial law women were classified as minors and deprived of many of the rights and privileges of men (see LaFont, & Hubbard, 2007). Much legal reform of gender issues has taken place since independence in 1990 (for example the Married Persons Equality Act of 1996); however, in practice it is widely acknowledged that large discrepancies in power remain in both rural and urban communities (see LaFont, & Hubbard, 2007). Furthermore, research suggests that in general the benefits of urban living are not felt equally by men and women and in developing nations particularly it is often the women who are most negatively impacted by urban poverty (Tacoli, 2012).

These cultural differences in the treatment of men and women, in combination with biological aspects of gender, may well have consequences for local-global bias. The gender imbalances in power distribution and exposure to negative stressors which may exist amongst urban Himba may perhaps be expected to lead to a reduction in global processing and/or cognitive flexibility in women (as outlined in chapter one, section 1.4.2.3). For example, powerlessness has been associated with reduced global processing (Smith & Trope, 2006) and aversive arousal with narrowed perceptual scope (Derryberry & Tucker, 1994). Both powerlessness (Guinote, 2010) and acute stress (Liston, McEwen, Casey, 2009) have also been associated with impaired cognitive flexibility. This may have implications for our measure of local-global bias because higher cognitive flexibility has been associated with a reduced tendency to always make similarity matches at the same level of structure (global or local similarity) (Caparos et al, 2015) and additionally because of the aforementioned role that cognitive flexibility may play in facilitating a transition from an established perceptual bias to a new perceptual bias.

### 2.2.5 The current research

In the current experiment, a broad and heterogeneous sample of urbanised Namibians (Himba and other denominations) was recruited to perform the same similarity-matching task used in Caparos et al. (2012). Although the current research builds primarily on conclusions drawn from specifically Himba participants it is assumed that these conclusions can be extended to urban Namibians in general. All urban Namibian participants were resident in the town of Opuwo and very few had ever lived in an urban area larger than Opuwo. This allowed us to examine the effects of urban exposure and education whilst broadly controlling for other environmental factors (social, geographical, political, etc.) that may exist as confounds between distinct urban populations.

There was considerable within-group variation as to 1) the age at which urban exposure had first occurred, 2) the accumulated time that had been spent in the urban environment (accounting for time away from town), 3) the timeframe over which the process of urbanisation had occurred (time since the initial exposure), 4) the proportion of time spent in the urban environment (it was not uncommon for participants to divide their time between the town and the villages), and 5) years of formal education. These variables do not represent an exhaustive list of possible sources of within group variations in urban exposure and education; however, these variables were the ones that could be easily ascertained during the brief interviewing stage of the testing procedure.

Naturalistic designs make it difficult to isolate the individual effects of such variables with any degree of certainty, especially in cases where the variables themselves may be heavily confounded. Nonetheless, observations of the relationships between these five measures of urbanisation and education and local-global bias may be a useful tool to begin to assess the likelihood of several possible scenarios such as 1) whether there may be a sensitive period in development during which urban exposure may have a stronger impact on local-global bias, 2) whether there may be a dose-effect relationship such that time spent in the urban environment promotes global bias, with additional time spent in the urban environment adding to the effect, 3) whether the effect of urban exposure may be drawn out over a long period of time or whether saturation may be reached relatively early, 4) whether intermittent exposure may be as effective as sustained exposure or whether time away from the urban environment detracts from the effect of urban exposure and 5) whether higher levels of education may also be associated with global bias, as is yet to be demonstrated.

For reasons both at the biological and at the societal level, gender can be thought of as one further potential source of variance on the similarity-matching task, particularly in the urban Namibian sample. It is intended that looking at urbanisation and education through the lens of gender may add to our understanding of environmental drivers of local-global bias, and that, equally, looking at gender through the lens of urbanisation and education may improve our understanding of gender differences in local-global bias. Furthermore, observing whether the relationship between local-global bias and urbanisation and education follows the same basic pattern in men and women will allow better judgement of the generalisability of the relationship as well as perhaps providing insight into the kinds of physical and/or socio-cultural aspects of the environment that may mediate the relationship.

Finally, we are also interested in establishing what extent of urbanisation and/or education is necessary for urban Namibians to be distinguishable from traditional Namibians and under what, if any, conditions urban Namibians may come to resemble Western participants. If even the most urbanised and educated of the urban Namibians do not present with as strong a global bias as the British participants then this may suggest either that a small town cannot exert the same effects as a large city and/or more basic levels of education cannot exert the same effects as more extensive levels of education or, alternatively, given that the two populations are so vastly different, that socio-cultural factors may curb the development of global bias in the Himba even in the event of extensive urban exposure and education. If on the other hand the most urbanised and educated of the urban Namibian participants do resemble the British participants, then this may suggest that even a small town and/or a basic level of education is sufficient to exert the full effects of urbanisation and/or education.

# 2.3 Methodology

## 2.3.1 Participants

Participants were recruited from three populations, traditional Namibians (TN), urban Namibians (UN), and urban British (UB). All participants were aged 16-45.

### *2.3.1.1 Traditional Namibians*

All TN participants were from the Himba tribe and were monolingual in Otjiherero. Testing took place in 2011-2013 in Himba villages in the Kunene region of Namibia. Participants had never resided in town. Participants took part on a voluntary basis and were given gifts of maize/sugar/soap/petroleum jelly, valuing approximately $N20 as compensation for their time. Consent was gained from village chiefs prior to testing.

23 males with an average age of 26, (range =16 - 40, SD = 8.3), average number of visits to Opuwo of 6.30, (range = 0-50, SD = 10.2), average years of formal schooling of 0.57 (Range 0-8, SD = 1.7). Seventeen had never been to school. Of the 5 who had received some formal education, average years of schooling was 2.17 (range = 0.5-8, SD = 2.9) and 4 had basic literacy skills.

30 females with an average age of 26, (range = 16-40, SD = 7.7), average number of visits to Opuwo of 12.70, (range = 0-100, SD = 23.611, SEM = 4.3), average years of formal schooling of 0.25 (Range = 0-3, SD = 0.8). Twenty-six had never been to school. Of the 4 who had received some formal education, average years of schooling was 1.88 (range = 0.5-3 SD = 1.3) and 1 had basic literacy skills. Two further females were tested but were not included in the final data set because they failed to correctly identify the correct Navon match on at least 4 out of the 5 control trials (see Stimuli and Procedure section below).

### *2.3.1.2 Urban Namibians*

Many urban Namibian participants were bilingual or multilingual and all were fluent in Otjiherero. Testing took place 2011-2013 in the town of Opuwo. All urban Namibian participants were currently residing in Opuwo and had received a minimum of 6 months exposure to an urban environment at least the size of Opuwo. The majority of participants were from the Herero tribe (Herero originate from the same family as Himba). Other demographics included were Himba, Zemba and Ovambu. Participants were recruited by word of mouth and were compensated with N$20 for their time. Participants under 18 were compensated with non-monetary gifts of equivalent value.

32 males with an average age of 26, (range =16 - 45, SD = 8.2), average years of formal schooling of 6.80 (Range 0-18, SD = 5.4). Nine had never been to school. Participants had lived in Opuwo, or a town at least the size of Opuwo on average from age 12.6 (Range 0-28, SD = 9.0), and had spent in total 10.1 (Range 0.5-29, SD = 9.3) years in the urban environment (accounting for time away from the urban environment). 2 further males were tested but were not included in the final data set because they failed to correctly identify the correct Navon match on at least 4 out of the 5 control trials.

22 females with an average age of 24, (range = 17-45, SD = 9.0), average years of formal schooling of 9.89 (Range 0-18, SD = 3.3)1 had never been to school. Participants had lived in Opuwo, or a town at least the size of Opuwo on average from age 14.50 (Range 0-44, SD = 11.0), and had spent in total 8.03 (Range 0.5-23, SD = 7.3) years in the urban environment (accounting for time away from the urban environment). 1 further female was tested but was not included in the final data set because they failed to correctly identify the correct Navon match on at least 4 out of the 5 control trials.

#### ***2.3.1.3 Urban British***

All participants were psychology undergraduates at Goldsmiths, University of London, taking part for course credits. 61 males, average age 22 (Range= 18-38, SD=5.1) and 61 females, average age 21 (Range=18-45, SD=4.5) were included. Testing took place in a lab-class environment and participants were rewarded with course credits. 1 further male was tested but was not included in the final data set because he failed to correctly identify the correct Navon match on at least 4 out of the 5 control trials. Data from 124 further females were collected but were not included in the final data set. The 61 female participants included in the final data set were selected at random from the total pool of 185 participants using an SPSS random number generator. The other female participants were excluded so as to avoid *Gender* and *Group* being correlated, which may have been problematic for the analyses. Of the 124 participants not selected for inclusion, 3 failed to correctly identify the correct Navon match on at least 4 out of the 5 control trials.

### 2.3.2 Stimuli and procedure

Each display consisted of three hierarchical Navon figures (Navon, 1977) arranged with one on top and two below in a triangular arrangement, at equal distance from each other (see figure 1). Figures were made from geometrical shapes (circles, crosses and squares) at both the local and global level of structure. For Namibian participants, stimuli were presented on a 14” rugged laptop. At a viewing distance of 70cm each figure subtended 3.0° and each local element 0.5°. The centre of each figure was 4.2° form the display centre. For British participants, stimuli were presented on desktop computers and visual angle was controlled by adjusting viewing distance. Measured pieces of string were used (across participant groups) to help maintain viewing distances. However, due to the nature of the testing conditions it was not possible to maintain more precise viewing distances (e.g., through the use of a chin-rest). The experiment was run in e-prime 2.

The figure at the top of the display was always the reference figure, and the two at the bottom were the comparison figures. Participants indicated which of the two comparison figures "looks most like" the reference figure by pressing the left button (or for British participants by pressing the 'c' key on a keyboard) on a button box to indicate the figure on the left side of the screen, or the right button (or 'x' key) to indicate the figure on the right side of the screen.

The experiment consisted of 41 experimental trials and 2 practice trials. For the first practice trial one comparison figure matched the reference figure at the global level of structure but not the local, and the other comparison figure matched at the local but not the global level (as with the test trials). For the second practice trial one comparison figure was identical to the reference figure, and the other shared no similarity (as with the control trials). Data was not saved for the practice trials.

Of the 41 experimental trials, there were 36 test trials in which one comparison figure matched the reference figure at the global level of structure but not at the local level, and the other comparison figure matched at the local level but not the global level.

The other 5 trials were control trials in which one comparison figure matched the reference figure at both the local and global level of structure (it was identical to the reference figure, and therefore was the correct response) and the other comparison figure shared no similarity with the reference figure at either the global or the local level. Participants who made more than one mistake across the 5 control trials were excluded from analysis, and were not included in the study (8 in total).

Each display remained on screen until a response was made (unlimited exposure), and the next trial followed automatically. Reaction times were recorded. Comparison figures which matched the reference figure at the global or at local level occurred equally often on the right or left side of the display and the order of the trials was randomised.

Traditional Namibians were tested in a testing tent positioned in a shady spot at traditional villages. Urbanised Namibians were tested either in a testing tent positioned in a shady spot or in a moderately lit testing room, in the town of Opuwo. Instructions were given through a translator in Otjiherero for Himba participants. For British participants, written instructions were presented on screen.

Literacy was assessed by asking participants to read and then write the sentence "There are many people in Opuwo" in Otjiherero.

## 2.3.4 Analyses

### 2.3.4.1 Overview

Results are based on the 36 experimental trials for which there was no identical match between the reference figure and either of the two comparison figures. For each of these trials, one comparison figure matched the reference figure on the local but not the global level of structure, and the other comparison figure matched on the global but not the local level. Participants were required to make 2-AFC responses based on perceived similarity at either the local or the global level of structure to indicate which of the two comparison figures best matched the comparison figure.  Data from the 5 trials for which there was an identical match to the reference figure are not included in the analyses but were used to filter only those participants who made correct identity matches.

Three continuous DVs (*Frequency of global-similarity choices*, *Number of switches*, and *Reaction time*) and one categorical DV (*Preferred matching strategy: local or global*) were extracted from participants' matching behaviours and were assessed according to a number of IVs relating to urbanisation, education and gender. To assess the roles of urbanisation, education, and gender in determining matching behaviours, two broad analytical approaches were adopted: within-group analyses and between-group analyses.

Within-group analyses were intended to provide a more fine-grained perspective on the effects of urbanisation and education, whereas between-group analyses were intended to provide a broader perspective. In many cases the sample sizes are comparatively small for the analyses, and in such cases the results should be interpreted as largely exploratory.

### 2.3.4.2 Measures

Three continuous DVs (*Frequency of global-similarity choices*, *Number of switches*, and *Reaction time*) and one categorical DV (Preferred matching strategy) were extracted from participants' matching behaviours. *Frequency of global-similarity choices* has conventionally been the primary, and often sole, measure of local-global similarity matching. It was intended that including *Number of switches*, *Reaction time* and *Preferred matching strategy* alongside *Frequency of global-similarity choices* would allow for a more nuanced interpretation of the findings.

For the within-group analyses, the independent variables were based on self-reported measures of urbanisation and education. Different measures of urbanisation were obtained for UN and TN participants, because of their inherently different relationships with the urban environment. For UN participants, several measures of urbanisation were obtained, and from these measures an additional composite measure was created. Within-group analyses were primarily conducted separately for men and women, with each gender treated as a separate subpopulation. However, *Gender* was also used as an IV in order to investigate within-group gender-based interactions with urbanisation and education.

For the between-group analyses, TN and UN groups were redefined to include only participants who were representative of the group stereotype. The aim was to create distinct groups of participants that differed in terms of levels of urbanisation and/or education at the between-group level but which were broadly homogenous at the within-group level. For TN participants, this meant excluding 9 participants with any form of formal education, and for UN participants, conversely, this meant excluding 11 participants without any form of formal education and/or basic literacy skills. UN participants were then further categorised into two groups, depending on their levels of urbanisation (more extensive or less extensive). UB participants formed the western control group, giving a total of four levels of the independent variable *Group*. Between-group comparisons were made across *Group* and *Gender*.

#### 2.3.4.2.1 Operationalisation of the dependent variables (DVs)

*Frequency of Global-Similarity choices (continuous)*

*Frequency of global-similarity choice* was defined as the frequency with which a participant made similarity matches at the global rather than local level of structure over the 36 experimental trials. A *frequency of global-similarity choice* score of 0 indicates that the participant always made matches at the local level of structure, and a score of 1 indicates that the participant always made matches at the global level of structure.

*Number of Switches (continuous)*

*Number of switches* was defined as the number of times that a participant switched between global-similarity and local-similarity matching strategies over the 36 experimental trials.

*Reaction time (continuous)*

*Reaction time* was defined as the mean time taken from stimulus presentation to participant response over the 36 experimental trials. Stimulus displays remained in place until a response was made, and a response to one display triggered the immediate presentation of the next display.

*Preferred matching strategy (Categorical: local or global matching strategy)*

Participants were categorised either as having a preferred global matching strategy if *Frequency of global-similarity choices* was more than .5 or a preferred local matching strategy if *Frequency of global similarity choices* was less than .5. One participant who made equal numbers of global- and local- similarity matches was not assigned to either category.

Had a larger sample been available, it may have been possible to include a third category of participants who chose a mixed matching strategy, matching sometimes at the local and sometimes at the global level of structure. However, on the whole participants were fairly consistent in their matching strategies, and there were too few participants who used a mixed matching strategy (*Frequency of global-similarity choices* > .25 & < .75) to warrant the inclusion of this additional category, and its addition would have led to a destabilising effect on the statistical modelling.

#### 2.3.4.2.2 Operationalisation of the independent variables (IVs)

Urbanisation and education measures were obtained for UN and TN participants only. Urbanisation was measured according to different criteria for UN and TN, due to their inherently different relationships with the urban environment. For UN, multiple measures of urbanisation were obtained, and from these a further composite measure was also created.

*Age of initial urbanisation* (measure applies to UN participants only)

This measure was defined as the age at which the participant had received 6 months cumulative exposure to an urban environment, at least the size of Opuwo. Cumulative exposure included extended periods of stay in the urban environment during which the participant considered themselves to be 'living' in the urban environment rather than merely 'visiting'.

*Years since initial urbanisation* (measure applies to UN participants only)

This measure was defined as the number of years since the participant had received 6 months cumulative exposure to an urban environment, at least the size of Opuwo.

*Cumulative years of urbanisation* (measure applies to UN participants only)

This measure was defined as the cumulative total number of years spent in an urban environment, at least the size of Opuwo, taking account of any extended periods away from the urban environment. Extended periods away from the urban environment included only periods where the participant considered themselves to be 'living' rather than merely 'visiting' the non-urban environment. The cumulative calculation begins from the time of the first extended period of stay in the urban environment.

*Proportion of time spent in the urban environment* (measure applies to UN participants only)

This measure was defined as the proportion of time spent in an urban environment since the first extended period of stay in an urban environment, relative to any extended periods away from the urban environment. A score of 1 indicates that the participant has lived exclusively in the urban environment, since the time that they first began living in an urban environment.

*Extent of urbanisation* (measure applies to UN participants only)

This composite measure of urban exposure was created based on only those measures of urbanisation above which were significantly correlated with *Frequency of global-similarity choices* (the DV of principle concern) after controlling for *Gender*. Controlling for Gender was intended to ensure that correlations between the final measure and *Frequency of global-similarity choices* were not biased in favour of one gender over the other. The variables which were correlated with *Frequency of global-similarity choices* after controlling for gender were *Age of initial urbanisation, Years since initial urbanisation, and Proportion of time spent in the urban environment.* Participants were ranked for each of these three measures of urbanisation. Ranking provided a parsimonious method for combining these measures which were based on different scales. The average ranking across the three measures became their score for the composite variable, *Extent of urbanisation.*

*Number of visits to town* (measure applies to TN participants only)

This measure was defined as the total number of visits made to Opuwo, or other towns and cities at least the size of Opuwo (e.g., Oshakati, Windhoek etc.) to-date. *Number of visits* are based on recall and are therefore likely to exclude visits made early in childhood. The length of each visit was not recorded; however, no participants reported ever having 'lived' in the urban environment, as opposed to merely visiting it.

*Years of education* (measure applies to UN and TN participants only)

This measure was defined as the number of years, measured to the nearest month, spent in formal education. The measure includes attendance at mobile schools and as such it is noted that the quality of that education may not be equivalent across participants, and especially between-groups.

*Group*

TN participants with any formal education were excluded from between-group analyses, leaving a group of unschooled TN. UN participants without any formal education were also excluded from between-group analyses, and the remaining UN participants were further divided by a median-split on the variable *Extent of urbanisation* to create a group of schooled urbanised participants with less extensive exposure to the urban environment, UN-, and a group of schooled urbanised participants with more extensive exposure to the urban environment, UN+. An arbitrary median-split method was favoured both because there was no obvious natural way of splitting the data and because splitting the data in any other way would have resulted in problematically small sample sizes in certain subpopulations. The median-split method offered an unbiased solution to these problems. The final group, UB was comprised of participants who were all currently attending higher education and currently residing in London.

*Gender*

For the within-group analyses *Gender* was only used as an IV for the purpose of examining gender-based interactions. For the between-group analyses, however, *Gender* was included as an IV alongside *Group.*

**2.3.4.3 Analytical procedure**

To assess the roles of urbanisation, education, and gender in determining matching behaviours, two broad analytical approaches were adopted: within-group analyses and between-group analyses (see above). It was intended that whereas within-group analyses would allow for a more fine-grained perspective on the effects of urbanisation and education within specific subpopulations, between-group analyses would provide the necessary broader perspective on how urbanisation and education might affect matching behaviours across populations. The within-group analyses and between-group analyses therefore were intended to complement each other.

Within-group analyses were performed for UN and TN separately because there were theoretical reasons to suspect that the effects of urbanisation and education need not be the same for different populations, and, furthermore, because urbanisation could not be measured according to the same criteria for the two groups. Men and women's data were also considered separately, within each group, for the similar reason that there were theoretical reasons to suspect that the effects of urbanisation and education need not be the same for men and women. Men's and women's data were, however, combined for the purpose of examining gender-based interactions. Within-group analyses were based primarily on correlations and regression modelling with each of the three continuous DVs, and each population and subpopulation included as heterogeneous a sample as possible in terms of levels of urbanisation and education.

By contrast, for the purposes of the between-group analyses, each group was comprised of as *homogenous* a sample as possible, with levels of urbanisation and education varying maximally at the group level and minimally at the within-group level. To this end, only participants who matched the group stereotype in terms of level of urbanisation and education were retained in the analyses and *Group* was reclassified into four levels, TN, UN-, UN+ and UB.

Between-group analyses were based primarily on ANOVA comparisons of mean scores for each of the three continuous DVs across *Group* and *Gender*. A categorical analysis of local-global similarity matching was also conducted with the intention that this analysis would aid interpretation of the analysis of group means for the continuous variable *Frequency of global-similarity choices. Frequency of global-similarity choices* was used to create the categorical variable *Preferred matching strategy* (local or global), and logistic regression was used to determine whether *Group* and/or *Gender* contributed to the likelihood of participants presenting with either a local or a global *Preferred matching strategy*.

With the exception of the between-group categorical analysis, all other within-group and between-group analyses were performed in nested sets for each of the three continuous DVs, with the aim that analyses of one DV may inform the interpretation of each of the others.

### 2.3.4.3.1 Within-group analyses (UN and TN)

The initial stages of analyses aimed to first examine the roles of urbanisation and education on each of the three continuous DVs for UN and TN separately. These analyses were performed within-group separately for UN and then for TN to avoid any additional confounds relating to the different group identities. Men and women were also treated separately within each group as there were theoretical reasons to suspect that men and women may respond differently to environmental drivers of local-global bias either due to innate biological differences and/or to socially constructed differences between the sexes.

Within-group analyses began by testing simple correlations between IVs (the different measures of urbanisation and education) and each of the three continuous DVs. In the event that both urbanisation and education showed significant correlations with the same DV, the relative effects of urbanisation and education were then examined using regression modelling. As all analyses were conducted in nested sets for each of the three continuous DVs, equivalent regression modelling was performed for all DVs even in the event that measures of urbanisation and education were only correlated with one of the DVs.

For UN participants, initially, the role of urbanisation was examined using separate measures, with the assumption that each measure may provide some unique insight into the relationship between urban exposure and matching behaviour. The four measures obtained were *Age of initial urban exposure*, *Years since initial urban exposure*, *Cumulative years of urban exposure* and *Proportion of time spent in the urban environment since initial urban exposure*. For practical reasons associated with the relatively small sample sizes, it was then necessary to derive one simplified overall measure of urbanisation for UN participants before comparing the roles of urbanisation and education alongside each other in a regression model. This was necessary because of the loss of power that is associated with a low ratio of cases to variables. Furthermore, several of the individual measures of urbanisation were expected to share overlapping relations to the DVs and it was necessary to avoid both overcrowding the model and risking issues of multicollinearity.

As it was expected that patterns of simple correlations between each of the four individual measures of urbanisation and the DVs may be different for men and women, partial correlations controlling for *Gender* were used to determine which of the individual measures should be used to form the overall composite measure. Since *Frequency of global-similarity of choices* was our DV of primary interest, only individual measures of urbanisation which correlated with *Frequency of global-similarity choices* after partialling out any effect of *Gender* were used to create the composite variable. Partialling out the effect of *Gender* was intended to have the effect of ensuring that our final measure of urbanisation, *Extent of urbanisation*, was not biased towards one gender over the other.

For TN participants, a different measure of urbanisation was required, to account for the fact that overall levels of urban exposure were, by definition, far lower than those of UN participants. Previous research has linked increased occasional visits to town to increased *Frequency of global-similarity choices* in TN participants (Caparos et al, 2012). Here we adopted that same measure of urban exposure for our TN within-group comparisons. Whilst there was considerable variability in the *Number of visits to town* made by TN participants, very few TN participants had ever been to school and so there was very little variance in *Years of education*. For this reason, it was acknowledged from the outset that any analyses would be underpowered to detect any potential effects of education and, as such, due care is required particularly in the interpretation of any null effects involving *Years of education* in the TN sample. Simple correlations were conducted between *Number of visits* and *Years of Education* and each of the 3 continuous DVs.

For TN participants, no further analyses of the effects of urbanisation and education were performed, based on the aforementioned rationale that regression modelling would only be performed in the case that urbanisation and education were jointly correlated with at least one of the DVs. For UN participants, however, the relative contributions of *Extent of urbanisation* and *Years of education* were assessed through regression modelling, subsequent to the initial examination of simple correlations.

Regression models of the main effects were performed separately for men and women, for the aforementioned reason that the two groups may be best conceptualised as separate subpopulations. Where appropriate, possible mediation effects were assessed through hierarchical regression models and confirmed by a Sobel test of mediation.

Interactions involving *Gender* (i.e., *Gender by Extent of urbanisation* and *Gender by Years of education*) were assessed in separate stand-alone regression models. This was necessary because regression models are known to be underpowered to detect interaction effects in field studies (McClelland & Judd, 1993, cited in Howell, 2010, p.561), particularly when sample sizes are small.

Finally, for UN men only (due to sample limitations), one group of unschooled and less extensively urbanised participants was singled out as potentially representing a unique sample within the wider sample of schooled UN men. Within the entire group of UN men, only 9 participants had never been to school. All of these UN unschooled men tended to score on the lower end of the measure *Extent of urbanisation*. In order to test the possibility that UN men who had never been to school may differ from UN men who had been to school, the matching behaviours of the 9 unschooled men were compared with the matching behaviours of the 9 least urbanised of the formally educated men (not including three participants with less than 4 years of schooling), using between-subjects t-tests. This ensured that *Extent of urbanisation* was not a confounding variable between the two groups, presenting a unique opportunity to examine the role of education disconfounded from urbanisation.

#### 2.3.4.3.2 Between-group analyses (TN, UN-, UN+, and UB)

In order to compare across groups, first, participants who did not match the group stereotypes were deselected from the analyses. For UN participants, it was rare to have never been to school, and those who had not received any formal education also tended to be relatively less urbanised and tended to be male. As such, the few UN participants who had never been to school were removed from the analyses so as to create a sample more representative of the overall group stereotype, and also to disconfound *Years of education* from both *Extent of urbanisation* and *Gender* as far as practically possible. After removing all unschooled UN participants, the remaining schooled UN participants were divided into two separate groups, UN+ and UN-, based on a median-split procedure on *Extent of urbanisation*. UN+ consisted of the most urbanised schooled UN participants and UN- the least urbanised. This division was intended to represent the fact that more urbanised and less urbanised members of the population may represent quite different subpopulations, with respectively different backgrounds and histories. For the TN sample, participants with any level of formal education were removed from the analysis as they were deemed to be non-stereotypical of the general TN population. Had a larger and more diverse sample of participants been available, an ideal analysis would also have included an educated TN sample as well as *uneducated* UN- and UN+ samples. Means for each of the three continuous DVs were then compared using two-way between-subjects ANOVAs performed across *Group* (TN, UN-, UN+ and UB) and *Gender.*

In order to further understand the local-global similarity choices made by individual participants from each population and subpopulation, the continuous measure *Frequency of global-similarity choices* was converted into the categorical measure *Preferred matching strategy*.

Particularly for groups where mean *Frequency of global-similarity choices* is intermediate, the mean value may be a poor representative of the matching behaviour of individuals. This is because an intermediate value could be accounted for either by the majority of participants adopting a mixed matching strategy, or, by some participants adopting a local matching strategy and others adopting a global matching strategy. Especially in the case of the latter, average *Frequency of global-similarity choices* offers a poor representation of the majority of participants in the group and a categorical measure may offer additional insight into participants' matching-behaviours.

Binary logistic regression was used to compare category membership on the DV (local or global *Preferred matching strategy*) across *Group* and *Gender*. Due to the sample size being relatively small for logistic regression, independent variables and their interactions (i.e., *Group*, *Gender*, and *Group by Gender* interaction) were added to the model based on their statistical relevance, so as to conserve power. To the extent that the final model was based on statistical relevance, rather than specific theory, these analyses should be considered as exploratory.

# 2.4 Results

## 2.4.1 Within-group analyses

Within-group analyses of the effects of urbanisation and education were performed separately for UN and TN participants.

### 2.4.1.1 Within-group analyses: UN participants

Within-group analyses for UN began by testing simple correlations between the four individual measures of urbanisation and *Years of education* and each of the three continuous DVs, *Frequency of global-similarity choices*, *Number of switches,* and *Reaction time*. Analyses were performed separately for men and women.

The four individual measures of urbanisation were then combined into one single composite measure so as to allow a direct comparison of the effects of urbanisation and education within regression modelling. Main effects of *Extent of urbanisation* and *Years of education* were compared separately for men and women, and where appropriate additional mediation analyses were performed. Interactions between *Gender* and *Extent of urbanisation* and *Gender* and *Years of education* were performed in separate stand-alone regression models.

Finally, in order to further examine the role of education disconfounded from urbanisation, the matching behaviours of schooled and unschooled men with equivalent urban exposure were compared using between-subjects t-tests. Equivalent analyses could not be performed for women as there were too few unschooled female participants.

#### 2.4.1.1.1 Initial assessment of the roles of Urbanisation and Education in UN participants

Four individual measures of urbanisation, and one measure of education were obtained for each UN participant: *Age of initial urbanisation*, *Years since initial urbanisation*, *Cumulative years of urbanisation*, *Proportion of time spent in the urban environment since initial urbanisation*, and *Years of formal education*. Simple correlations were performed between each of the four measures of urbanisation and the one measure of education and the three continuous DVs, *Frequency of global-similarity choices*, *Number of switches,* and *Reaction time*. As it was not clear that any relationships between our measures of urbanisation and education and performance on the Navon task should be the same in men and women, analyses were carried out for men and women separately.

#### *2.4.1.1.1.1 Frequency of global-similarity choices*

Table 1 below shows the correlations between the individual measures of urbanisation and education and *Frequency of global-similarity choices* for men and women. With regards to urbanisation, for men, despite the larger sample size relative to women (32 as compared to 22), none of the correlations reached significance. However, both *Age of initial urbanisation* and *Cumulative years of urbanisation* tended towards significance, in the direction of UN men urbanised earlier in life and with more years of urban exposure tending to make more global-similarity matches. For women, two variables, *Age of initial urbanisation* and *Proportion of time spent in the urban environment since initial urbanisation*, correlated significantly with *Frequency of global-similarity choices*, whereas the other two variables, *Years since initial urbanisation* and *Cumulative years of urbanisation* did not. With regards to education, *Years of education* was significantly correlated with *Frequency of global-similarity choices* for men, in the direction that more highly educated men made more global-similarity choices, but was uncorrelated for women.

Table 1. Table to show simple correlations between the individual measures of urbanisation and education and the DV, *Frequency of global similarity choices*, for UN participants. Fisher's Z tests compare the correlations for men and women; a significant Z score indicates a significant difference between the two correlations.

| | Age of initial urbanisation | Years since initial urbanisation | Cumulative years of urbanisation | Proportion of time spent in urban environment since initial urbanisation | Years of Education |
|---|---|---|---|---|---|
| **Men** (N =32) | r=-.327 *p*=.068 | r=.240 *p*=.185 | r=.344 *p*=.054 | r=.152 *p*=.405 | r=.481 *p*=.005** |
| **Women** (N =22) | r=-.446 *p*=.037* | r=.217 *p*=.332 | r=.283 *p*=.201 | r=.423 *p*=.050* | r=.099 *p*=.662 |
| **Fisher's Z test** | Z=0.48 *p*=.631 | Z=0.08 *p*=.936 | Z=0.23 *p*=.818 | Z=-1.01 *p*=.313 | Z=1.44 *p*=.150 |

Note: *** = $p<.001$, ** = $p<.01$, * = $p<.05$

#### *2.4.1.1.1.2 Number of switches*

Correlations between the same measures of urbanisation and education and *Number of switches* are shown below in table 2. There were no significant correlations, although it is noted that for women both *Age of initial urbanisation* and *Cumulative years of urbanisation* reached near significant correlations with *Number of switches*, with women urbanised earlier or with more cumulative exposure tending to make more switches. In both of these instances, however, the correlations in the men's data were not close to significance, and indeed tended in the opposite direction.

Table 2. Table to show simple correlations between the individual measures of urbanisation and education and the DV, *Number of switches*, for UN participants. Fisher's Z tests compare the correlations for men and women; a significant Z score indicates a significant difference between the two correlations.

| | Age of initial urbanisation | Years since initial urbanisation | Cumulative years of urbanisation | Proportion of time spent in urban environment since initial urbanisation | Years of Education |
|---|---|---|---|---|---|
| **Men (N =32)** | r=.207<br>*p*=.255 | r=-.262<br>*p*=.147 | r=-.266<br>*p*=.141 | r=-.171<br>*p*=.348 | r=-.207<br>*p*=.354 |
| **Women (N =22)** | r=-.411<br>*p*=.057 | r=.310<br>*p*=.161 | r=.412<br>*p*=.057 | r=.198<br>*p*=.378 | r=-.252<br>*p*=.164 |
| **Fisher's Z test** | Z=2.19<br>*p*=.028* | Z=-1.99<br>*p*=.047* | Z=-2.41<br>*p*=.016* | Z=-1.26<br>*p*=.208 | Z=0.16<br>*p*=.873 |

Note: *** = *p*<.001, ** = *p* <.01, * = *p* <.05

*2.4.1.1.1.3 Reaction time*

Correlations between the same measures of urbanisation and education and similarity-matching *Reaction times* are shown below in table 3. Noticeably, all correlations for men tended in the direction of faster response rates with greater urban exposure, but in the direction of *slower* response rates with greater urban exposure for women. However, no correlations were significant, or even near-significant, for either men or women.

Table 3. Table to show simple correlations between the individual measures of urbanisation and education and the DV, *Reaction time*, for UN participants. Fisher's Z tests compare the correlations for men and women; a significant Z score indicates a significant difference between the two correlations.

| | Age of initial urbanisation | Years since initial urbanisation | Cumulative years of urbanisation | Proportion of time spent in urban environment since initial urbanisation | Years of Education |
|---|---|---|---|---|---|
| **Men (N=32)** | r=.200<br>*p*=.272 | r=-.113<br>*p*=.539 | r=-.143<br>*p*=.436 | r=-.183<br>*p*=.317 | r=-.269<br>*p*=.137 |

| | | | | | |
|---|---|---|---|---|---|
| **Women (N=22)** | r=-.212 *p*=.344 | r=.240 *p*=.282 | r=.322 *p*=.144 | r=.254 *p*=.254 | r=-.208 *p*=.353 |
| **Fisher's Z test** | Z=1.42 *p*=.078 | Z=-1.21 *p*=.113 | Z=-1.62 *p*=.053 | Z=-1.51 *p*=.066 | Z=-.022 *p*=.413 |

Note: *** = *p*<.001, ** = *p* <.01, * = *p* <.05

#### ***2.4.1.1.2*** **Creating a composite measure of urbanisation for UN**

A single composite measure of urban exposure was created in order to be able to examine the effects of urbanisation and education alongside each other in a regression model. With small sample sizes, it was important to keep the number of predictor variables low and including all individual measures of urbanisation in the regression model would have considerably reduced power.

To determine which measures of urbanisation should be used in creating the composite variable, partial correlations were run for each of the four individual measures and *Frequency of global-similarity choices* (the primary DV of interest) whilst controlling for *Gender*. Table 4 shows the outcomes of these correlations. Three of the variables, *Age of initial urbanisation*, *Cumulative years of urbanisation* and *Proportion of time spent in urban environment since initial urbanisation*, were significantly correlated with the DV after partialling out the effect of *Gender*. In contrast, the final variable, *Years since initial urbanisation*, did not correlate with the DV and was not incorporated into the final composite measure of urbanisation.

Table 4. Table to show partial correlations between the individual measures of urbanisation and the DV, *Frequency of global-similarity choices*, for UN participants, whilst controlling for *Gender*.

| | Age of initial urbanisation | Years since initial urbanisation | Cumulative years of urbanisation | Proportion of time spent in urban environment since initial urbanisation |
|---|---|---|---|---|
| **Controlling for Gender** (df = 51) | r=-.386 *p*=.004** | r=.227 *p*=.102 | r=.314 *p*=.022* | r=.272 *p*=.049* |

Note: *** = *p*<.001, ** = *p* <.01, * = *p* <.05

The composite measure of urbanisation was created by first ranking participants on each of the remaining 3 measures of urban exposure from most urbanised to least urbanised (so that all measures were based on the scaling), and then taking the average of these rankings across the 3 variables. This new variable was named *Extent of urbanisation*.

The internal reliability of this new measure was deemed to be reasonably good based on the measure of Cronbach's alpha. *Removing Proportion of time spent in the urban environment since initial urbanisation* would have further increased the reliability of the measure. However, here it was not of any primary concern whether the individual variables all measured the same aspect of urban exposure, and so all three variables were retained. In itself, however, this finding may suggest that *Proportion of time spent in the urban environment* may be tapping into a unique aspect of urbanisation that is not measured by *Age of urbanisation* and *Cumulative years of urbanisation*, whereas these latter two variables may be measuring similar aspects of urbanisation.

Table 5 shows the simple correlations between Extent of urbanisation and each of the 3 continuous DVs for UN men and women. *Extent of urbanisation* was only significantly correlated (both for men and women) with *Frequency of global-similarity choices* and not with *Number of Switches* or *Reaction time*. Note that whereas none of the correlations between the individual measures of urbanisation and *Frequency of global-similarity choices* reached significance in the male sample (see table 1), the correlation with the new composite variable does. Note also that, for women, there was additionally a near significant correlation between *Extent of urbanisation* and *Number of switches*, which may have reached significance with a slightly larger sample size.

Table 5. Table to show simple correlations between Extent of urbanisation and each of the 3 continuous DVs, *Frequency of global-similarity choices*, *Number of switches* and *Reaction time*, for UN participants. Fisher's Z tests compare the correlations for men and women; a significant Z score indicates a significant difference between the two correlations.

| | Frequency of global-similarity choices | Number of switches | Reaction time |
|---|---|---|---|
| **Men**<br><br>**(N=32)** | r=.350<br><br>*p*=.050* | r=-.286<br><br>*p*=.113 | r=-.248<br><br>*p*=.171 |
| **Women**<br><br>**(N=22)** | r=.521<br><br>*p*=.013** | r=.419<br><br>*p*=.052 | r=.351<br><br>*p*=.109 |
| **Fisher's Z test** | Z=1.42<br><br>*p*=.078 | Z=2.51<br><br>*p*=.006** | Z=-2.10<br><br>*p*=.036* |

Note: *** = *p*<.001, ** = *p* <.01, * = *p* <.05

#### 2.4.1.1.3 Comparing the effects of Urbanisation and Education in UN

The effects of *Extent of urbanisation* and *Years of education* were examined alongside each other in regression modelling to assess their unique contribution to explaining the variance in each of the 3 DVs. As different patterns of correlations were shown for men and women (see previous sections), separate regressions were performed for each gender. Where appropriate, follow-up tests of mediation were also performed. For men only (due to sample limitations), the role of education was further assessed by comparing group means on the 3 DVs for schooled and unschooled participants with equivalent urban exposure in between-subjects t-tests. Finally, *Gender* interactions with both *Extent of urbanisation* and *Years of Education* were examined in separate stand-alone regression models.

Before conducting the regression models detailed above, preliminary regression models with the main effects of *Extent of urbanisation* and *Years of education*, for each gender and each DV, were conducted to assess the linearity of the residuals. Generally, all models showed, to some extent, a non-linear pattern of residuals. To address the somewhat unsatisfactory nature of the DVs, following Conover and Iman (1981), a rank transformation procedure was applied to all continuous IVs and DVs.

The overall numbers of participants, as well as the ratio of cases to variables, were relatively small for regression modelling. As such, the following procedures are best thought of as exploratory, and results best interpreted with some degree of caution.

##### *2.4.1.1.3.1 Frequency of global-similarity choices*

###### *2.4.1.1.3.1.1 Men's data*

###### *2.4.1.1.3.1.1.1 Regression modelling*

The overall regression model for the main effects of *Ranked extent of urbanisation* and *Ranked years of education* was a significant predictor of *Ranked frequency of global-similarity choices* ($F(2,29)=8.128$; $p<.001$), and accounted for approximately 30% of the variance ($R^2 = .359$; adjusted $R^2 = .315$). *Ranked years of education* ($t=2.709$; $p=.011$; standardised $\beta = .514$, 95% CI for B = -0.261, -0.508) but not *Ranked extent of urbanisation* ($t=.656$; $p=.517$; standardised $\beta = .125$, 95% CI for B = -0.269, 12.161) significantly accounted for unique variance within the regression model. The direction of the effect was such that more educated men made more global-similarity choices.

Examination of the simple correlations between raw (unranked) scores for *Frequency of global-similarity choices* and *Extent of urbanisation* (see table 5 above) showed that the two variables were significantly correlated for men ($r=.350$, $p=.050$), without the presence *of Years of Education*. Using the ranked data, this significant relationship between Extent *of urbanisation* and *Frequency of global-similarity choices* disappeared when placed in the regression model alongside *Years of education*, indicating a possible mediatory effect of *Years of education*.

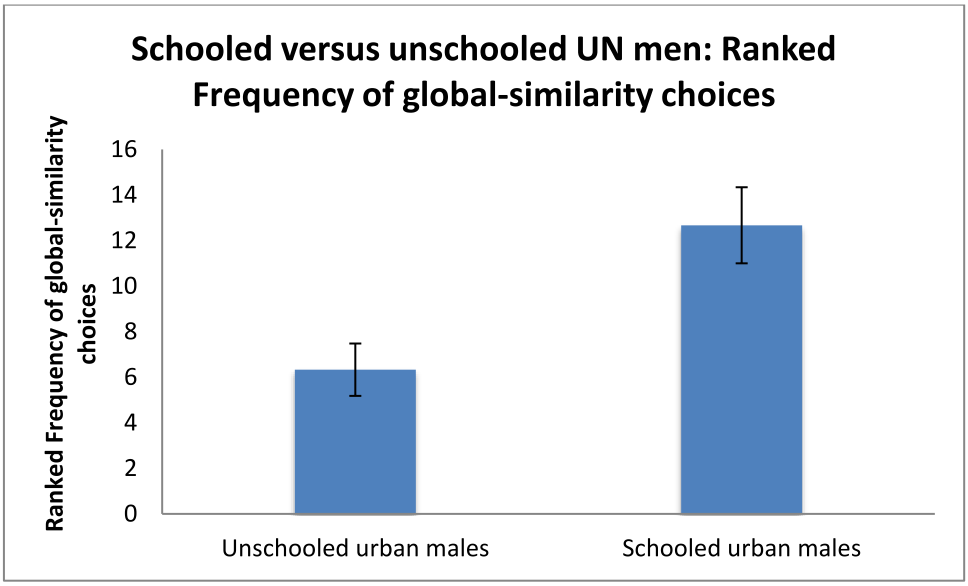
The initial criteria for a mediatory effect were met by confirming that the pathways between each of the two Ranked IVs and the Ranked DV, and between each of the two ranked IVs themselves, were all significant. Simple correlations confirmed that *Ranked extent of urbanisation* and *Ranked frequency of global-similarity choices* were significantly correlated (r=.444, *p*=.011) as were *Ranked years of education* and *Ranked frequency of global-similarity choices* (r=.591, *p*<.001) and *Ranked extent of urbanisation* and *Ranked years of education* (r=.621, *p*<.001).

To formally test the mediatory effect, the regression model was rerun as a hierarchical regression with *Ranked extent of urbanisation* entered first and both *Ranked extent of urbanisation* and *Ranked years of education* entered together in the second stage. Based on these outcomes, the unstandardised regression coefficients of *Extent of urbanisation* (the IV, with *Years of education* not present in the model) and *Years of education* (the mediator, with *Extent of urbanisation* also present in the model) and their associated standard errors were entered into an online Sobel calculator (www.quantpsy.org). The Sobel test of mediation confirmed the mediatory effect of *Years of education* on *Extent of urbanisation* (Z= .194; *p*=.047).

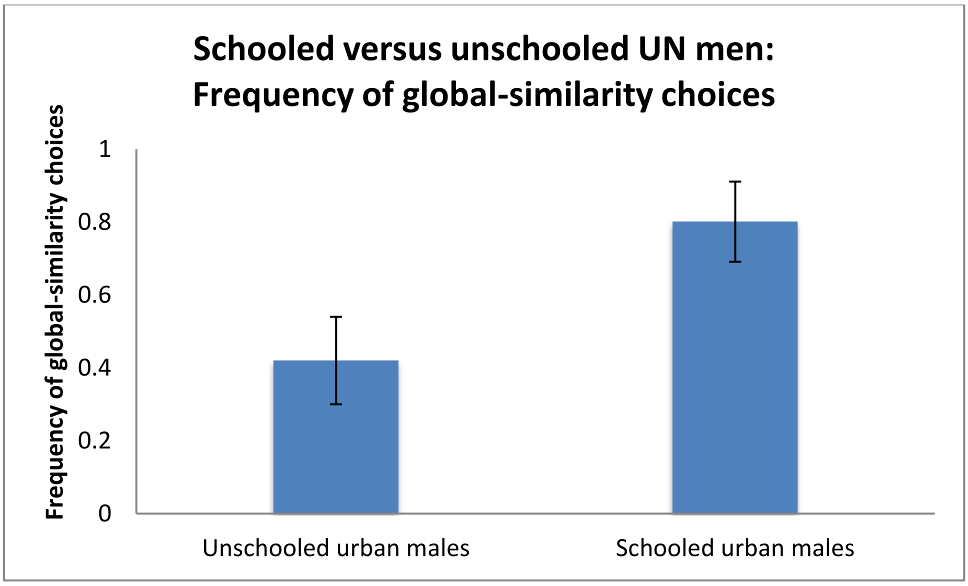
###### *2.4.1.1.3.1.1.2 Comparing schooled versus unschooled men*

In order to test the possibility that men who had never been to school may differ from men who had been to school, mean *Ranked frequency of global-similarity choices* for the 9 unschooled men and the 9 least urbanised of the formally educated men (not including three participants with less than 4 years of schooling) were compared. The unschooled male participants made significantly fewer global-similarity choices compared to the schooled male participants, as represented by their significantly lower *Ranked frequency of global-similarity choices* (*t*(16)=-3.124, *p*=.007, 95% CI= -10.631, -2.035). Cohen's effect size value (*d*=1.480) suggested a high practical significance. This difference was attributable only to level of *Schooling* and not to urbanisation*,* as the two groups did not differ in their Extent of urbanisation (*t*(16)=0.657, *p*=.521, 95% CI= -7.750, 4.084, *d*=.310), or any of the individual measures of urbanisation.

(a)




(b)




Figures 3(a) and 3(b). Graphs to show mean ranked (a) and unranked (b) *Frequency of global-similarity choices* for schooled and unschooled UN men with low levels of urbanisation. Error bars represent +/- 1 SEM.

*2.4.1.1.3.1.2 Women's data*

*2.4.1.1.3.1.2.1 Regression modelling*

The overall regression model for the main effects of *Ranked extent of urbanisation* and *Ranked years of education* was a significant predictor of *Ranked frequency* of global-similarity choices ($F(2,19)=4.922$; *p*=.019), and accounted for approximately 25% of the variance ($R^2$ = .341; adjusted $R^2$ = .272). Contrary to the findings for the men's data, *Ranked extent of urbanisation* (*t*=3.060; *p*=.006; standardised β = .580, 95% CI for B = 0.181, 0.965) but not *Ranked years of education* (*t*=0.100; *p*=.922; standardised β = .019, 95% CI for B = -0.377, 0.414) significantly accounted for unique variance within the regression model. The direction of the effects was such that more urbanised women made more global-similarity choices than less urbanised women.

The initial criteria for a mediatory effect could not be met because not all pathways between each of the two Ranked IVs and the Ranked DV, and between each of the two ranked IVs themselves, were significant. Ranked years of education was not significantly correlated with Ranked frequency of global-similarity choices (r=.129, *p*=.566) and Ranked years of Education also was not significantly correlated with Ranked extent of urbanisation (r=.190, *p*=.396). On this basis, no formal test of mediation was conducted. The effect of schooling versus no schooling also could not be investigated in the women's data, as only one UN woman had never been to school.

*2.4.1.1.3.1.3 Gender interactions*

Interaction terms for the *Gender by Extent of urbanisation* and *Gender by Years of education* were created from the product of the standardised scores for each pair of IVs. Interaction terms were entered into the regression models alongside the IVs from which they were constructed.

*2.4.1.1.3.1.3.1 Gender by Urbanisation*

The overall regression model was a significant predictor of *Ranked frequency of global-similarity choices* ($F(3,50)=6.870$; *p*<.001), and accounted for approximately 25% of the variance ($R^2$ = .292; adjusted $R^2$ = .249). *Ranked extent of urbanisation* significantly accounted for unique variance within the regression model (*t*=4.078; *p*<.001; standardised β = .485, 95% CI for B = 0.244, 0.721) and *Gender* almost significantly (*t*=1.773; *p*=.082; standardised β = .211, 95% CI for B = -14.197, 0.903). However, the interaction was non-significant (*t*=.659, *p*=.531; standardised β = .078, 95% CI for B = -3.066, 4.504); gender did not moderate the effect of *Extent of urbanisation*.

*2.4.1.1.3.1.3.2 Gender by Education*

The overall regression model was a significant predictor of Frequency of global-similarity choices ($F(3,50)=5.028$; p<.001), and accounted for approximately 20% of the variance ($R^2$ = .232; adjusted $R^2$ = .186). Years of e*ducation* significantly accounted for unique variance within the regression model (t=2.769; p=.008; standardised β = .370, 95% CI for B = 0.059, 0.605) and *Gender* also significantly (t=2.361; p=.022; standardised β = .309, 95% CI for B = -17.221, -0.665). However, the interaction was non-significant (t=-1.231, p=.224; standardised β = -.159, 95% CI for B = -8.780, 0.698)*; Gender* did not moderate the effect of

*Years of education*. Rather, the results suggest that *Gender* may exert its own effect on *Frequency of global-similarity choices,* in the direction of fewer global-similarity choices for women.

##### *2.4.1.1.3.2 Number of switches*

The same analytical procedure was applied to the second continuous DV, *Number of switches.*

###### *2.4.1.1.3.2.1 Men's data*

###### *2.4.1.1.3.2.1.1 Regression modelling*

The overall regression model for the main effects of *Ranked extent of urbanisation* and *Ranked years of education* was not a significant predictor of *Ranked number of switches* (F(2,29)=1.393; *p*=.264), and accounted for very little of the variance ($R^2$ = .088; adjusted $R^2$ = .025). Neither *Extent of urbanisation* (*t*=1.121; *p*=.271; standardised β = .254) nor *Years of education* (*t*=0.273; *p*=.787; standardised β = .062) significantly accounted for unique variance within the regression model.

###### *2.4.1.1.3.2.1.2 Comparing schooled versus unschooled men*

In order to test the possibility that men who had never been to school may differ from men who had been to school, mean *Ranked number of switches* for the 9 unschooled men and the 9 least urbanised of the formally educated men (not including three participants with less than 4 years of schooling) were compared. Schooled and unschooled male participants did not differ in their *Number of switches* (*t*(16)=0.439, *p*=.667, 95% CI=-7.660, 11.660, *d*=.207).

###### *2.4.1.1.3.2.2 Women's data*

###### *2.4.1.1.3.2.2.1 Regression modelling*

Contrary to the male-only data, for women, the overall regression model for the main effects of *Ranked extent of urbanisation* and *Ranked years of education* was a significant predictor of *Ranked number of switches* (F(2,19)=6.742; *p*=.006), and accounted for approximately 35% of the variance ($R^2$ = .415; adjusted $R^2$ = .354). Both *Extent of urbanisation* (*t*=-3.304; *p*=.004; standardised β = -.590, 95% CI interval for B = 0.210, 0.938) and *Years of education* (*t*=2.203; *p*=.040; standardised β = .394, 95% CI for B = -0.754, -0.019) significantly accounted for unique variance within the regression model. Whereas greater levels of education had the effect of *reducing* the number of switches, conversely, greater levels of urbanisation had the effect of *increasing* the number of switches that female participants made.

###### *2.4.1.1.3.2.3 Gender interactions*

Interaction terms for the *Gender by Extent of urbanisation* and *Gender by Years of Education* models were created from the product of the standardised scores for each pair of IVs. Interaction terms were entered into the regression models alongside the IVs from which they were constructed.

###### *2.4.1.1.3.2.3.1 Gender by Urbanisation*

The overall regression model was not a significant predictor of *Ranked number of switches* ($F(3, 50)=2.358$, $p=.083$), and accounted for only approximately 5% of the variance ($R^2=.124$, adjusted $R^2=.071$). Neither Ranked extent of urbanisation ($t=-0.014$, $p=.989$; standardised $\beta=-.002$, 95% CI for B = -0.270, 0.247) nor *Gender* ($t=-0.662$, $p=.511$; standardised $\beta=-.088$, 95% CI for B = -10.855, 5.528) significantly accounted for unique variance within the regression model. However, the interaction itself was significant ($t=-2.568$; $p=.013$; standardised $\beta = -.340$, 95% CI for B = 1.119, 9.332).

Simple correlations showed that the correlation between *Ranked extent of urbanisation* and *Ranked number of switches* was positive and significant for women ($r=-.515$; $p=.014$) but negative and non-significant for men ($r=.292$; $p=.105$). More urbanised women made more switches than less urbanised women, whereas more urbanised men if anything made fewer switches than less urbanised men. Despite the *Gender by Extent of urbanisation* Interaction being significant, however, the overall model itself was not significant and accounted for very little of the variability in *Number of switches*. On this basis, the meaningfulness of any *Gender by Extent of urbanisation* interaction should be treated as questionable at best.

###### *2.4.1.1.3.2.3.2 Gender by Education*

The overall regression model was not a significant predictor of *Ranked number of switches* ($F(3,50)=1.347$, $p=.270$), and accounted for very little of the variance ($R^2 = R^2=.075$, adjusted $R^2=.019$). Neither *Ranked extent of education* ($t=1.818$, $p=.075$; standardised $\beta=.267$, 95% CI for B = -0.553, 0.41) nor *Gender* ($t=-0.125$, $p=.901$; standardised $\beta=-.018$, 95% CI for B = -9.658, 8.347) significantly accounted for unique variance within the regression model, although it is noted that the effect of *Extent of education* did tend towards significance. The *Gender by Extent of education* interaction was also non-significant ($t=-0.032$; $p=.975$; standardised $\beta =-.005$, 95% CI for B = -4.842, 5.464).

#### *2.4.1.1.3.3 Reaction time*

##### *2.4.1.1.3.3.1 Men's data*

###### *2.4.1.1.3.3.1.1 Regression modelling*

The overall regression model for the main effects of *Ranked extent of urbanisation* and *Ranked years of education* was not a significant predictor of *Frequency of global-similarity choices* ($F(2,29)=2.513$; $p=.099$), and accounted for only around 10% of the variance ($R^2 = .148$; adjusted $R^2 = .089$). Neither Ranked extent of urbanisation ($t=1.531$; $p=.137$;

standardised β = .335) nor *Ranked years of education* (*t*=0.331; *p*=.743; standardised β = .072) significantly accounted for unique variance within the regression model.

*2.4.1.1.3.3.1.2 Comparing schooled versus unschooled men*

In order to test the possibility that men who had never been to school may differ from men who had been to school we compared mean *Ranked reaction time* for the 9 unschooled men with the 9 least urbanised of the formally educated men (not including three participants with less than 4 years of schooling). Schooled and unschooled male participants did not differ in *Reaction time* (*t*(16)=0.155, *p*=.879, 95% CI= -8.458, 9.791, *d*=.073).

*2.4.1.1.3.3.2 Women's data*

*2.4.1.1.3.3.2.1 Regression modelling*

As with the male-only data, for women, neither the overall regression model nor the main effects of *Ranked extent of urbanisation* and *Ranked years of education* was not a significant predictor of *Frequency of global-similarity choices* (F(2,19)=1.188; *p*=.327), and accounted for very little of the variance ($R^2$ = .111; adjusted $R^2$ = .018). Neither *Ranked extent of urbanisation* (*t*=-1.422; *p*=.171; standardised β = -.313, 95% CI for B = -0.148, 0.775) nor *Ranked years of education* (*t*=0.855; *p*=.403; standardised β = .188, 95% CI for B = -0.656, 0.275) significantly accounted for any unique variance within the regression model.

*2.4.1.1.3.3.3 Gender interactions*

Interaction terms for *Gender by Extent of urbanisation* and *Gender by Years of education* were created from the product of the standardised scores for each pair of IVs. Interaction terms were entered into the regression models alongside the IVs from which they were constructed.

*2.4.1.1.3.3.3.1 Gender by Urbanisation*

The overall regression model was a significant predictor of *Ranked reaction time* (F(3,50)=3.926; *p*=.014), and accounted for approximately 15% of the variance ($R^2$ = .191; adjusted $R^2$ = .142). *Ranked extent of urbanisation* (*t*=0.769, *p*=.446; standardised β=.098, 95% CI for B = -0.370, 0.148) did not significantly account for any unique variance within the regression model. However, both *Gender* (*t*=-2.045, *p*=.046; standardised β= -.260, 95% CI for B = -16.477, -0.021) and the *Gender by Extent of urbanisation interaction* (*t*=-2.607, *p*=.012; standardised β= -.332, 95% CI for B = 0.631, 8.866) did significantly account for unique variance within the model.

The main effect of G*ender* is explained by the fact that women were overall faster than men. Simple correlations show that the correlation between *Ranked extent of urbanisation* and *Ranked reaction time* was significant and positive for men (r=.371; *p*=.037) but non-significant and negative for women (r=-.277; *p*=.212). In other words, more urbanised men made faster responses than less urbanised men, whereas women, if anything, made slower responses as they became more urbanised.

*2.4.1.1.3.3.3.2 Gender by Education*

The overall regression model was not a significant predictor of *Ranked reaction time* (F(3,50)=2.356, *p*=.083), and accounted for only around 5% of the variance ($R^2$=.124, adjusted $R^2$=.071). Neither *Years of education* (*t*=1.543, *p*=.129; standardised β= .220, 95% CI for B = -0.523, 0.073) nor *Gender* (*t*=-1.478, *p*=.146; standardised β= -.207, 95% CI for B = -15.534, 2.546) significantly accounted for any unique variance within the regression model. The *Gender by Years of education* interaction was also non-significant (*t*=-.448, *p*=.656; standardised β= -.062, 95% CI for B = -4.488, 5.862).

**2.4.1.2 Within-group analyses: TN participants**

Within-group analyses for TN consisted of testing simple correlations between *Number of visits to town* and *Years of education* and each of the three continuous DVs, *Frequency of global-similarity choices*, *Number of switches,* and *Reaction time*. Analyses were performed separately for men and women.

Regression modelling equivalent to that performed on the UN data was not performed for the TN data because there were no instances where both *Number of visits to town* and *Years of education* were significantly correlated with any of the DVs, either for men or for women.

**2.4.1.2.1 Initial assessment of the roles of Urbanisation and Education in TN participants**

One measure of urbanisation and one measure of education were obtained for each TN participant: *Number of visits to town*, and *Years of formal education*. Simple correlations were performed between each of these two measures and the three continuous DVs, *Frequency of global-similarity choices, Number of switches and Reaction time*. As it was not clear that any relationships between our measures of urbanisation and education and performance on the Navon task should be the same in men and women, analyses were carried out within males and females separately.

2.4.1.2.1.1 *Frequency of global-similarity choices*

Table 6 below shows the correlations between the measures of urbanisation and education and frequency of global-similarity choices for men and women separately. Neither *Number of visits to town* nor *Years of education* had any significant effect on *Frequency of global-similarity choices* for either men or women in the TN participants. Note that in addition to the overall non-significant correlations, the directions of correlation are reversed for men and women, and also for *Number of visits to town* and *Years of Education*.

Table 6. Table showing simple correlations between *Number of visits to town* and *Years of education* and the DV, *Frequency of global-similarity choices*, for TN participants. Fisher's Z tests compare the correlations for men and women; a significant Z score indicates a significant difference between the two correlations.

| | Number of Visits | Years of Education |
|---|---|---|
| **Men**<br>**(N=23)** | R=-.266<br>*p*=.221 | R=.117<br>*p*=.596 |
| **Women**<br>**(N=30)** | R=.227<br>*p*=.227 | R=-.207<br>*p*=.273 |
| **Fisher's Z test** | Z=1.42<br>*p*=.078 | Z=2.51<br>*p*=.006** |

Note: *** = *p*<.001, ** = *p* <.01, * = *p* <.05

### 2.4.1.2.1.2 *Number of Switches*

Table 7 below shows the correlations between the measures of urbanisation and education and *Number of switches* for men and women separately. The only significant correlation showed that men tended to make more switches with increased education. Note that as was the case for *Frequency of global-similarity choices*, the directions of correlation are reversed for men and women, and also for *Number of visits to town* and *Years of education*.

Table 7. Table to show simple correlations between *Number of visits to town* and *Years of education* and the DV, *Number of switches*, for TN participants. Fisher's Z tests compare the correlations for men and women; a significant Z score indicates a significant difference between the two correlations.

| | Number of Visits | Years of Education |
|---|---|---|
| **Men**<br>**(N=23)** | R=-.155<br>*p*=.481 | R=.597**<br>*p*=.003 |
| **Women**<br>**(N=30)** | R=.302<br>*p*=.104 | R=-.236<br>*p*=.210 |
| **Fisher's Z test** | Z=-1.71<br>*p*=.056 | Z=1.11<br>*p*=.001 |

Note: *** = *p*<.001, ** = *p* <.01, * = *p* <.05

### 2.4.1.2.1.3 *Reaction time*

Table 8 below shows the correlations between the measures of urbanisation and education and *Reaction time* for men and women separately. Neither *Number of visits to town* nor *Years of education* had any significant effect on *Reaction time* for either men or women in the TN participants.

Table 8. Table showing simple correlations between *Number of visits to town* and *Years of education* and the DV, *Reaction time*, for TN participants. Fisher's Z tests compare the correlations for men and women; a significant Z score indicates a significant difference between the two correlations.

| | Number of Visits | Years of Education |
|---|---|---|
| **Men**<br>**(N=23)** | R=-.221<br>*p*=.311 | R=-.040<br>*P*=.857 |
| **Women**<br>**(N=30)** | R=.124<br>*p*=.515 | R=.038<br>*p*=.842 |
| **Fisher's Z test** | Z=-1.18<br>*p*=.119 | Z=-0.26<br>*p*=.397 |

Note: *** = $p$<.001, ** = $p$ <.01, * = $p$ <.05

## 2.4.2 Between-group analyses

In order to compare performance on the Navon task across all groups of participants, participants who were considered to be non-stereotypical of their group were removed from the data set. For the TN sample, participants with any level of formal education were removed, and for the UN sample, participants without any formal education were also removed.

The UN participants were then broken down into a group of less urbanised (UN-) and another group of more urbanised (UN+) Namibians, to account for the fact that high and low urbanised participants may be best thought of as distinct categories of UN participants. This regrouping was achieved by performing a median-split on the variable *Extent of urbanisation*. As all unschooled UN participants had been removed from the data set, the two groups, UN+ and UN+, were approximately equal in terms of *Years of education*, and indeed neither group had received significantly more *Years of education* compared to the other ($t$(39)=-1.219, $p$=.230). Furthermore, the groups were approximately equal in their numbers of men and women.

The final set of four groups consisted of (1) a group of TN who had never been to school and who had received very little exposure to the urban environment (average 10 visits to town over the lifetime), (2) a group of UN- who had all been to school (for an average of 10 years) but who had only received a limited amount of urban exposure to a small town (with an average age of first exposure = 19 years; average cumulative years of exposure = 5 years; average proportion of time spent in urban environment = .70), (3) a group of UN+ who had all been to school (for an average of 11 years) and who had received a considerable amount of urban exposure to a small town (with an average age of first exposure = 4 years; average cumulative years of exposure = 17 years; average proportion of time spent in urban environment = .91), and (4) a group of UB participants who were all highly educated (current undergraduate students) and highly urbanised (currently living in London). Thus, because non-stereotypical group members had been removed, by and large the groups can be considered as proxies for different levels of urbanisation and education.

Groups were further broken down by *Gender*, and means were calculated for each subpopulation for each of the 3 continuous DVs, *Frequency of global-similarity choices*, *Number of switches* and *Reaction time*. Two-way between-subjects ANOVAs were performed for each DV across *Group* (TN, UN-, UN+, and UB) and *Gender*.

Preliminary skew, kurtosis and normality diagnostics indicated that all 3 DVs were to some extent non-normally distributed. To address the somewhat unsatisfactory nature of the DVs, following Conover and Iman (1981), a rank transformation procedure was applied to each of the DVs.

In addition to the ANOVA analyses, a categorical analysis was conducted in order to better understand participants' matching behaviours. The variable *Frequency of global-similarity choices* was used to create a categorical measure of similarity matching, *Preferred matching strategy*. Binary logistic regression was then used to assess the effects of *Group* and *Gender* on *Preferred matching strategy*. Similar categorical procedures were not applied to the other continuous DVs, *Number of switches* and *Reaction times*, as these variables did not easily lend themselves to derivation of any meaningful categorical measures.

**2.4.2.1 Analyses of continuous DV measures**

*2.4.2.1.1 Frequency of global-similarity choices*

Mean *Ranked frequency of global-similarity choices* were calculated for TN, UN-, UN+, and UB men and women and are shown in figure 4(a) below. Figure 4(b) additionally shows the raw (non-ranked) values for ease of interpretation. A two-way between-subjects ANOVA was conducted for *Group* and *Gender*. The main effects of *Group* and *Gender* were both significant (*Group*: $F(3,198)=24.175$, $p<.001$, $\eta^2= .369$; *Gender* $F(1,198)=12.151$, $p=.001$, $\eta^2$ .066), as was the *Group by Gender* interaction ($F(3,198)= 2.860$, $p=.038$, $\eta^2 = .055$).

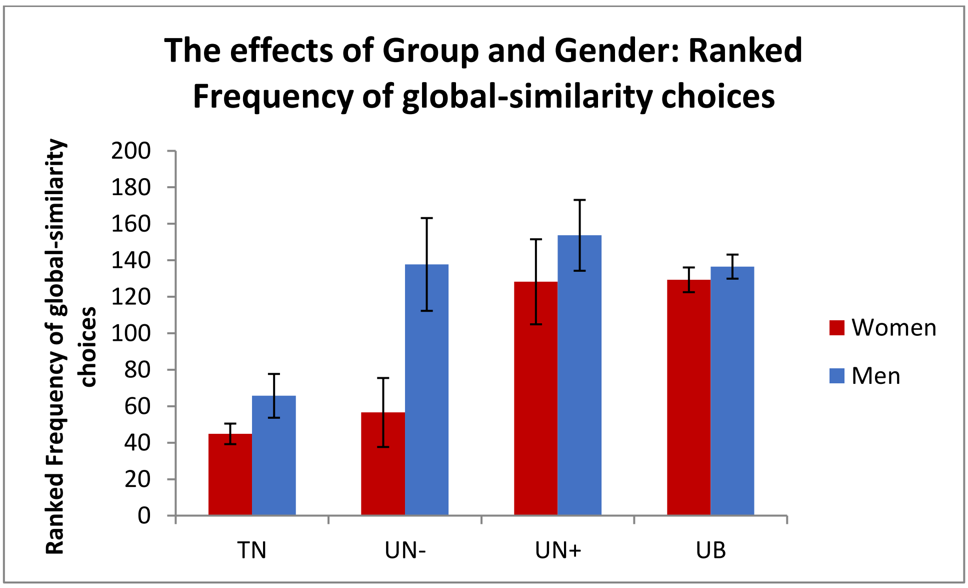
Post Hoc Bonferroni corrected analyses of the ranked data showed that TN participants made global-similarity choices less often that all other groups (compared to UN- $p=.045$, 95% CI of the mean difference = -.401, -.088; compared to UN+ $p<.001$, 95% CI of the mean difference = -.717, -.288; and compared to UB $p<.001$, 95% CI of the mean difference = -

.711, -.431), UN- participants made global-similarity choices less often than UN+ and UB (compared to UN+, *p*=.015, 95% CI of the mean difference = -.548, -.053; and compared to UB, *p*=.007, 95% CI of the mean difference = -.556, -.182), but UH+ participants did not make global-similarity choices less often than UB participants (*p*=1.000, CI of the mean difference = -.295, .122). Polynomial contrasts on the effect of group did not clearly discriminate between linear (contrast estimate = 61.896, *p*<.001) or quadratic (contrast estimate = -24.959, *p*=.011) trends. Nonetheless, the contrast estimate for the linear trend was clearly the larger of the two.

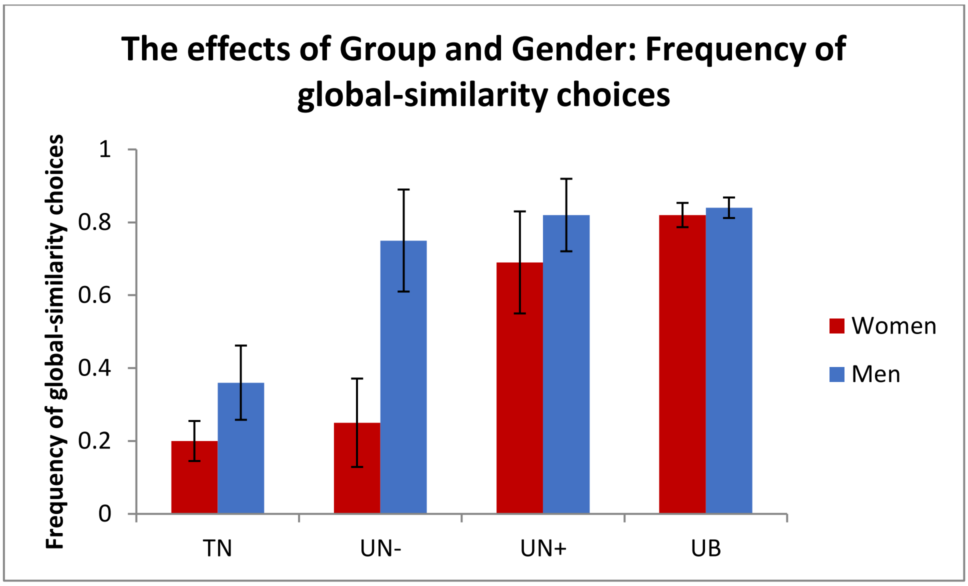
The effect of *Group* remained significant when compared separately for men ($F(3, 94)=8.554$, $p<.001$, $\eta^2 = .279$) and women ($F(3,104)=20.330$, $p<.001$, $\eta^2 = .485$), applying an adjusted alpha of .05/2=.025, to compensate for multiple comparisons.
Based on similar studies in Western populations, no gender difference was expected in our UB sample. In the remaining three groups, the effect of gender was only significant in the UN- group ($t(19)=2.624$, p=.017, $d$ = 1.178); it was not significant either in the TN group ($t(41)=1.571$, p=.130; equal variances not assumed) or in the UN+ group ($t(18)=0.846$, p=.408), applying an adjusted alpha of .05/3 = .017. However, it is noted that, in all groups, women made numerically fewer global-similarity choices.

Visual inspection of the graph in figure 4(a) below suggests that whilst UN- men appeared comparable to UN+ men but not TN men, UN- women, on the other hand appeared comparable to TN women but not UN+ women. The very large alpha correction required for individual comparisons makes it difficult to test these assumptions; however, the difference between UN- and TN men ($t(24)=-2.922$, $p=.007$) was near-significant, and the difference between UN- and UN+ women ($t(19)=-2.411$, $p=.026$) also tended towards significance, even at an adjusted alpha of .05/12=.004.

(a)



(b)



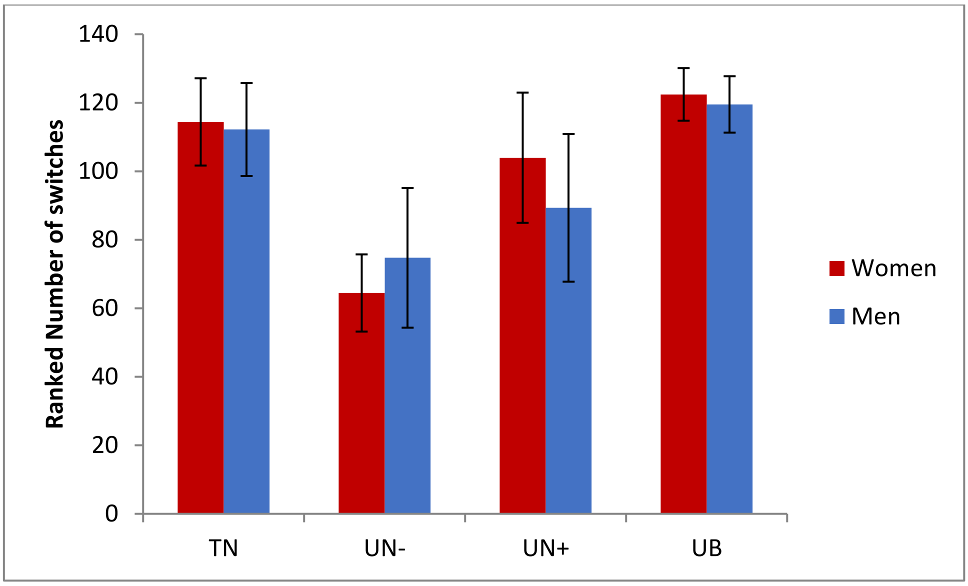

Figures 4(a) and 4(b). Graphs to show mean ranked (a) and unranked (b) *Frequency of global-similarity choices* for TN, UN-, UN+, and UB men and women. Error bars represent +/- 1 SEM.

### *2.4.2.1.2 Number of Switches*

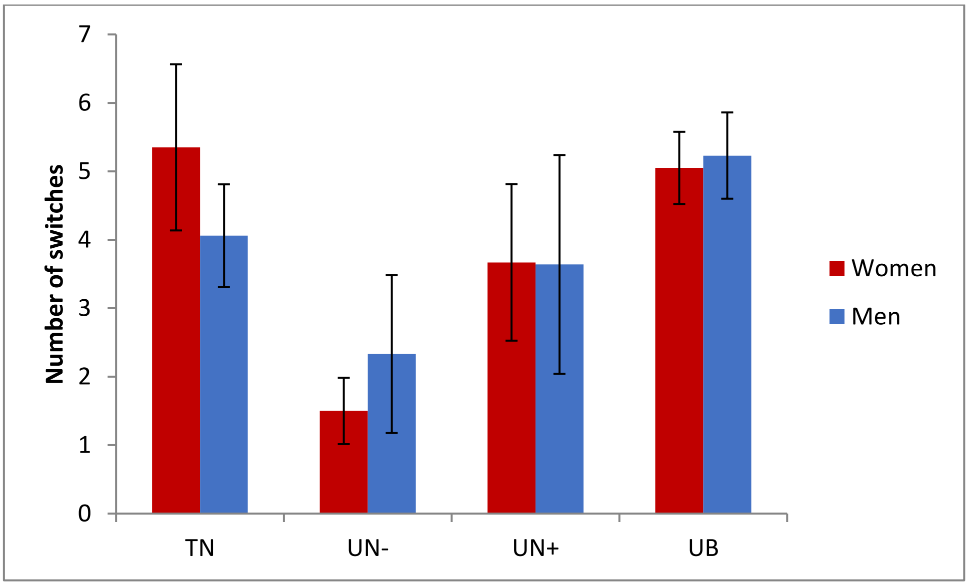
Mean *Ranked number of switches* was calculated for TN, UN-, UN+, and UB men and women and is shown in figure 5(a) below. Figure 5(b) additionally shows the raw (unranked) values for ease of interpretation. A two-way between-subjects ANOVA was conducted for *Group* and *Gender*. There was a significant main effect of group (F(3,198)=4.570, *p*=.004, $\eta^2$ = .051, but no main effect of *Gender* (F(1,198)=0.046, *p*=.831), and no *Group* by *Gender* interaction (F(3,198)=0.139, *p*=.936).

Post Hoc Bonferroni corrected analyses for the main effect of *Group* showed that UN- participants made significantly fewer switches than both TN (*p*=.041, 95% CI of the mean difference = 0.025, 6.223) and UB (*p*=.002, 95% CI of the mean difference = -6.235, -0.486) participants but not UN+ participants (*p*=.957). TN and UN+ participants (*p*=1.000), TN and UB (*p*=1.000) participants, and UN+ and UB participants (*p*=.551) all did not differ from each other. Polynomial contrasts on the effect of group signified a significant quadratic trend (contrast estimate = 34.014, p=.003).

(a)




(b)




Figures 5(a) and 5(b). Graphs to show mean ranked (a) and unranked (b) *Number of switches* for TN, UN-, UN+, and UB men and women. Error bars represent +/- 1 SEM.

### *2.4.2.1.3 Reaction time*

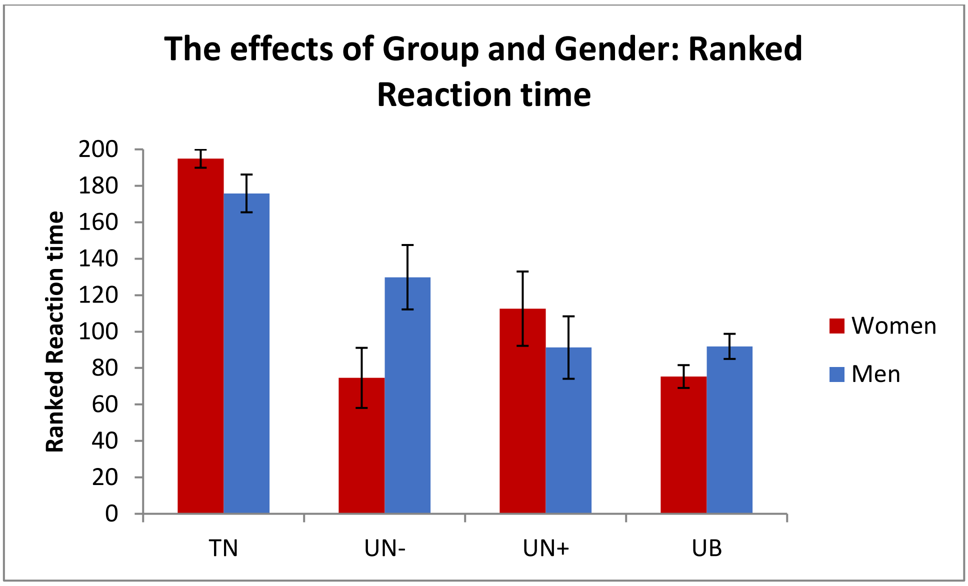
Mean *Ranked reaction time* was calculated for TN, UN-, UN+, and UB men and women and is shown in figure 6(a) below. Figure 6(b) additionally shows the raw values for ease of interpretation. A two-way between-subjects ANOVA was conducted for *Group* and *Gender*. There was a significant main effect of *Group* ($F(3,198)=43.724$, $p<.001$, $\eta^2=.489$). The main effect of *Gender* was non-significant (F(1,198)=0.767, *p*=.382), although there was a significant *Gender by Group* interaction (F(3,198)=3.465, *p*=.017, $\eta^2$ = .042).

Post Hoc Bonferroni corrected analyses for the effect of *Group* showed that TN made similarity-matches significantly more slowly than all other groups (compared to UN-, *p*<.001, 95% CI of the mean difference= 65.771, 139.143; compared to UN+, *p*<.001, 95% CI of the mean difference = 61.816, 136.490; and compared to UB, *p*<.001, 95% CI of the mean difference = 95.106, 141.801). UN- and UN+ (*p*=1.000), UN- and UB (*p*=1.000) and UN+ and UB (*p*=.899) participants, on the other hand, all made equally fast responses. Polynomial contrasts on the effect of *Group* did not clearly differentiate between linear (contrast estimate = -68.331, p<.001), quadratic (contrast estimate = 32.426, p<.001), or cubic (contrast estimate = -22.541, p=.035), trends, which were all significant. Nonetheless, the contrast estimate for the linear trend was clearly the largest of the three.

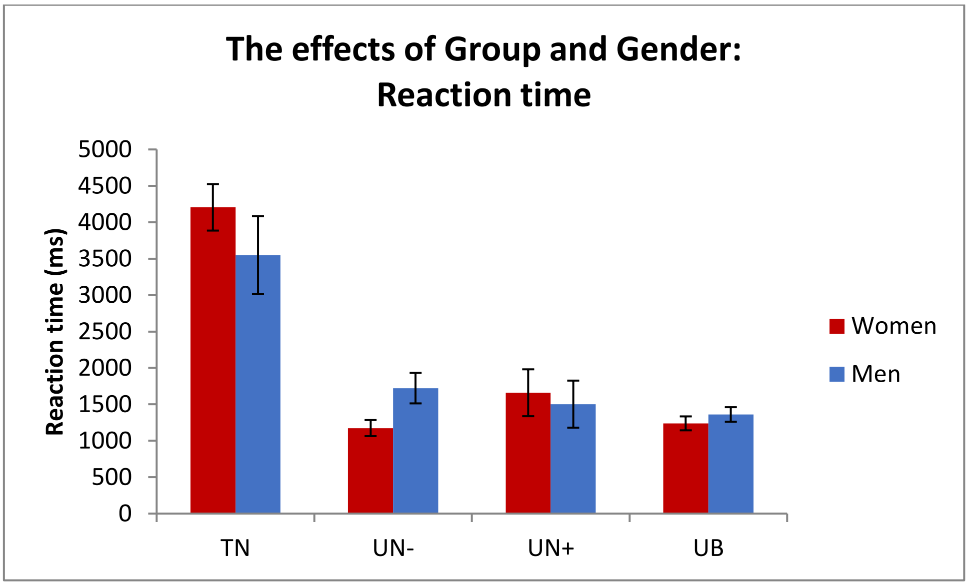
The effect of *Group* remained significant when compared separately in men (F(3,94)=12.306, p<.001, $\eta^2$ = .331) and in women (F(3,104)=42.226, p<.001, $\eta^2$ = .599), applying an adjusted alpha of .05/2 = .025 to account for multiple comparisons. However, from the values of the F statistic and the partial eta effect size, it is clear that the effect of *Group* was greater for women than for men.

The effect of *Gender* was not significant within any of the four groups (TN: *t*(41)=-1.659, *p*=.110, equal variances not assumed; UN-: *t*(19)=2.260, *p*=.036; UN+: *t*(18)=-0.807, *p*=.430; UB: *t*(120)=1.777, *p*=.078), applying an adjusted alpha of .05/4 = .013, although tended towards significance for the UN- group. This near significant effect of *Gender* in the UN- group, in the direction of faster *Reaction times* for women, along with the larger effect of *Group* for women, may go some way to explaining the significant interaction.

(a)




(b)




Figures 6(a) and 6(b). Graphs to show mean ranked (a) and unranked (b) *Reaction time* for TN, UN-, UN+, and UB men and women. Reaction times are given in milliseconds. Error bars represent +/- 1 SEM.

### 2.4.2.2 Analyses of the categorical DV measure

#### *2.4.2.2.1 Preferred matching strategy (local or global)*

ANOVA analysis showed that at the group level *Frequency of global-similarity choices* varied significantly between TN, UN-, UN+ and UB participants and gender (see section above). However, it is unclear from these average scores how individual participants in each subpopulation responded to the Navon task. For example, a small difference in *Frequency of* *global-similarity choices* across groups could result either from all or most participants in one group making global-similarity choices slightly more often than members of the other group, or alternatively could result from a few participants making many more global-similarity choices.

In order to differentiate between these possibilities, a categorical analysis was performed. Participants were classified as preferring either a local (*Frequency of global-similarity choices* <.5) or global (*Frequency of global-similarity choices* > .5) matching strategy. Figure 7 below shows the proportion of participants in each sample population preferring local and global matching strategies respectively.

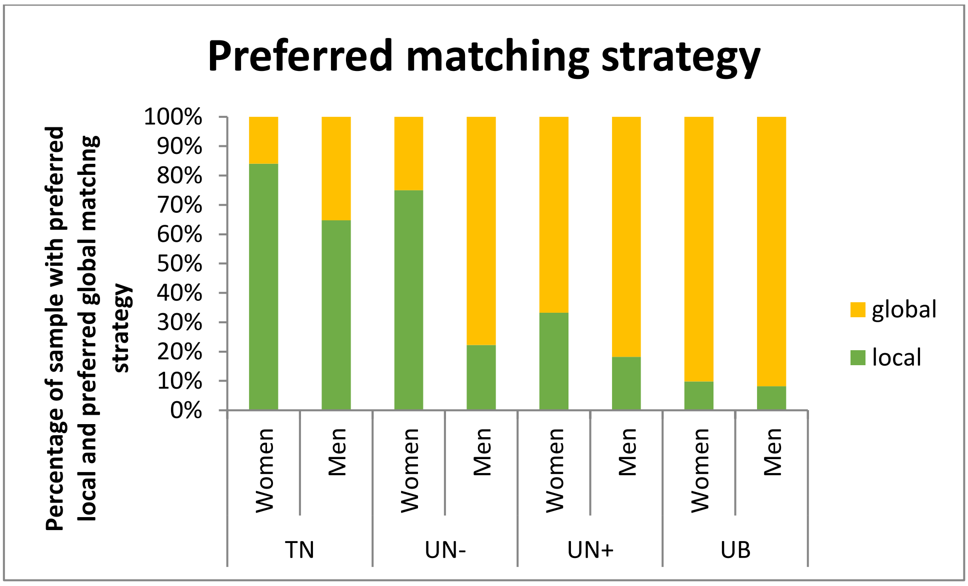



Figure 7. Graph to show percentage of each subpopulation of TN, UN-, UN+, and UB men and women with preferred local and preferred global matching strategies. Preferred local and preferred global matching strategy percentages add cumulatively to 100 for each subpopulation.

Binary logistic regression was used to test whether the likelihood of a participant preferring a specific matching strategy (local or global) was dependent on *Group* (TN, UN-, UN+ and UB) and *Gender*.

A preliminary hierarchical logistic regression was run to determine which variables should be included in the final model. In the first stage of the model, only the main effects of *Group* and *Gender* were entered into the model, and in the second stage the interaction term was also included. Both main effects were significant predictors in the model and were retained in the final model. Adding the interaction term did not significantly improve the model and the interaction term itself was not a significant predictor. On this basis, the *Group by Gender* interaction was not retained in the final model.

The final model overall was a significant predictor of *Preferred matching strategy* ($\chi^2(4)=79.880$, $p<.001$), with an 84.9% overall classification success rate (correct classification for 69.5% of participants with a preferred local matching strategy and 91.1% of participants with a preferred global-matching strategy). Both Group (Wald statistic (3) = 54.586, *p*<.001) and Gender (Wald statistic (1) = 5.156, *p*=.023) were significant contributors to the model. For Group, UB were chosen as the reference category, and for Gender, men were chosen as the reference category, and the model predicted a preferred global matching strategy. The odds of a UB participant presenting with a global preferred matching strategy were approximately 34 times higher than those of a TN participant, 11.5 times higher than those of a UN- participant and 3.5 times higher than those of a UN+ participant. Although all of these comparisons were statistically significant, note that the bootstrap confidence intervals around the log odds (*b*) for the 'UN+ vs. UB' comparison cross zero, and as such this effect cannot be considered reliable. The odds of a male participant presenting with a global preferred matching strategy were approximately 2.5 times higher than those of a female participant.

Table 9. Table to show coefficients of the model predicting whether participants preferred a global matching strategy. TN, UN- and UN+ participants are compared to UB participants. Women are compared to men. [95% BCa (bias-corrected and accelerated) bootstrap confidence intervals based on 1000 samples].

| | | Wald statistic | *b* | 95% CI for odds ratio | | |
|---|---|---|---|---|---|---|
| | | | | Lower | Odds | Upper |
| **Included** | | | | | | |
| **Constant** | | 17.423 (df=1) *p*<.001 | 2.858*** | | | |
| **Group** | | 54.586 (df = 3) *p*<.001 | | | | |
| | TN vs. UB | 50.800 (df=1) *p*<.001 | 3.526*** [2.464, 5.368] | 12.886 | 33.975 | 89.578 |
| | UN- vs. UB | 19.370 (df=1) *p*<.001 | 2.249*** [1.277, 5.368] | 3.848 | 11.351 | 33.487 |
| | UN+ vs. UB | 4.380 (df=1) *P*=.036 | 1.292* [-0.427, 2.725] | 1.085 | 3.641 | 12.212 |
| **Gender** | Women vs. Men | 5.156 (df=1) *p*=.023 | 0.921* [0.076, 1.956] | 1.134 | 2.513 | 5.567 |

Note: $R^2$= .323 (Cox & Snell) .462 (Nagelkerke). Model $\chi^2(4)$ = 79.880, *p*<.001. * *p*<.05, ***p*<.01, ****p*<.001

# 2.5 Discussion

## 2.5.1 Discussion of Results

### 2.5.1.1 Summary of the within-group analyses for UN participants

Both urbanisation and education impacted the Navon task performance of UN participants; however, their effects were felt differently by men and by women, and of the 3 DVs, *Frequency of global-similarity choices* was the most affected by both factors. Whereas variability in men's *Frequency of global-similarity choices* appeared to be better explained by education, conversely, women's *Frequency of global-similarity choices* appeared to be better explained by urbanisation.

For men, although none of the individual measures of urbanisation correlated significantly with *Frequency of global-similarity choices*, the composite measure *Extent of urbanisation did*. This relationship, however, was shown to be mediated by *Years of education*, whereas *Extent of urbanisation* did not explain any unique variance above and beyond that explained by *Years of education*. The effect of education, independent of any effect of urbanisation, was further supported by the comparison of schooled and unschooled males of equivalent levels of urbanisation. Neither *Number of switches* nor *Reaction time*s were shown to be affected by either education or urbanisation within the UN men.

For UN women, in stark contrast to men, education appeared to have almost no effect whatsoever on Navon task performance. The only significant finding relating to education was a decrease in *Number of switches* with increased *Years of education*. This effect however was only seen once the effect of urbanisation had been taken into account. Whereas the simple correlation between *Years of education* and *Number of switches* was non-significant, the effect did become significant when considered alongside *Extent of urbanisation* in the regression model. Thus, there may perhaps be some form of suppression effect whereby the effect of *Years of education* can only be seen after the effect of *Extent of urbanisation* has already been accounted for.

Whereas *Years of education* had little effect on the matching behaviour of UN women, *Extent of urbanisation* on the other hand was associated with both more global-similarity matching and more switching, suggesting that urbanisation considerably altered the matching behaviours of women. Simple correlations between the four individual measures of urbanisation and the DVs showed that whilst it was *Age of initial urbanisation* and *Proportion of time spent in the urban environment* that were significantly correlated with *Frequency of global-similarity choices*, it was *Age of initial urbanisation* and *Cumulative years of urban exposure* that were near-significantly correlated with *Number of switches*. This somewhat different pattern of association may possibly suggest that the overall effect of *Extent of urbanisation* on *Frequency of global-similarity choices* and on *Number of switches* may be driven by somewhat different underlying aspects of urbanisation.

Neither urbanisation nor education was able to directly explain any of the variance in *Reaction time* within either the UN men's or the women's data. However, the *Gender by Extent of urbanisation* interaction was able to explain a small but significant amount of variance. Whereas men who were more urbanised tended to make similarity-matches more quickly, women who were more urbanised on the other hand tended to make similarity matches more *slowly*.

There was also some suggestion in the data that, overall, men made more global-similarity choices than women, and that women made faster similarity choices than men. These conclusions were suggested respectively by the main effect of *Gender* on *Frequency of global-similarity choices* in the model aimed at testing the *Gender* by *Years of education* interaction, and by the main effect of *Gender* on *Reaction time* in the model aimed at testing the *Gender by Extent of urbanisation* interaction. The analyses presented in this section, however, are not adequate to address the overall effect of *Gender*, which will be addressed in the section dealing with cross-group comparisons.

Overall, the findings that men's and women's Navon task matching appears to be differentially affected by urbanisation and education is compatible with the suggestion that the environmental drivers of local-global bias may not affect men and women equally or in the same way.

#### 2.5.1.2 Summary of the within-group analyses for TN participants

The finding that *Number of visits to town* did not correlate with *Frequency of global-similarity choices* in the current TN sample was somewhat surprising given the previous finding of increased global-similarity matching with increased visits to town (Caparos et al., 2012). It is possible that this discrepancy could relate to the smaller sample size of the current study relative to the previous study, or to the fact that TN participants in the current study had on average made more visits to town than TN participants from the previous study.

Although the current sample did not allow for an extensive investigation into the possible effect of education on the matching behaviours of TN participants, nonetheless a significant correlation was seen between *Years of education* and *Number of switches* for men. Men with higher levels of education made significantly more switches than men with lower levels of education or with no formal education. Further research will be required to allow for any confident conclusions to be drawn. However, these data provide some suggestion that, at least for men, even relatively small levels of education may impact the matching behaviour of TN.

#### 2.5.1.3 Summary of between-group analyses

Within-group analyses (see sections 2.5.1.1 and 2.5.1.2), particularly for UN participants, suggested that education and urbanisation primarily affected *Frequency of global-similarity* *choices* above *Number of switches* and *Reaction times*. Comparing cross-culturally, however, all DVs were clearly affected by *Group*, which itself was largely defined by education and urbanisation. The pattern of change across groups, and across gender, however, differed considerably for each of the three DVs, and these different patterns of change are, perhaps, testament to the complex nature of the effects.

*Frequency of global-similarity choices*, as predicted, increased moving from unschooled and un-urbanised TN participants to highly urbanised and highly educated UB participants. Post hoc analyses showed that all groups were differentiable from each other, with the exception of UN+ and UB. The categorical analysis on *Preferred matching strategy* confirmed that group differences were related to what might be considered as qualitative differences in whether individuals were more likely to present with an overall local bias (preferred local matching strategy) or an overall global bias (preferred global matching strategy). On this categorical measure, there was some indication that UB participants in fact may be somewhat more likely than UN+ participants to prefer a global matching strategy. However, bootstrapped confidence intervals on the log odds suggested this finding may not be fully robust. The apparent lack of convergence between the results of the AVOVA and logistic regression, with regards to whether UN+ and UB can be said to resemble each other, is likely to relate to the fact that UN+ participants made numerically fewer switches. Thus, even though a lower proportion of the UN+ group presented with an overall global bias, those who did are likely to have had a higher *Frequency of global-similarity choices* than the UB participants who also presented with an overall global bias.

Comparing *Gender* across *Group* showed that overall women made fewer global-similarity choices than men, although the size of the effect was small in comparison to the effect of *Group*. Although women made numerically fewer global-similarity choices than men at each level of *Group*, this difference was, however, only significant in the UN- group. The significant *Group by Gender* interaction further confirmed that the gender difference was not consistent across *Group*, and demonstrates that environmental factors, at least in part, determine whether or not gender differences will emerge. Similarly, *Gender*, either biologically or socially defined, may play an important role in moderating environmental influences. Whereas UN- men already resembled UN+ men in terms of *Frequency of global-similarity choices,* UN- women did not resemble UN+ women and this difference was near-significant even after applying a very large alpha correction. Thus, the similarity matching behaviours of men and women do not appear to be equally impacted by similar levels of urban exposure and education.

Whereas *Frequency of global similarity choices* increased moving from unschooled and un-urbanised TN participants to highly urbanised and highly educated UB participants, in a pattern consistent with a linear trend, this was not the case for *Number of switches*. UN- participants stood out as being particularly consistent in their matching choices across experimental trials, making significantly fewer *Number of switches* than both TN an UB participants, creating a U-shaped pattern of results. Although environmental factors had a clear impact on switching behaviour, the drop in *Number of switches* from TN to UN- shows that it is not a simple case of greater education and greater urbanisation being associated with a higher rate of switching.

Whilst there was some suggestion in the UN within-group analyses that women's switching behaviour may be more influenced by environmental factors than men's, this was not supported by the cross-group analyses presented in the current section. The finding that UN- participants made fewer switches than TN and UB participants, regardless of gender, shows that this reduced switching behaviour was unlikely to be related to whether or not the individual UN- participants had or had not transitioned to a global bias, but rather was a unique quality of that group as a whole. Finally, the fact that UN- participants were distinguishable from UB participants but not from UN+ participants may tentatively suggest, albeit indirectly, that with a higher-powered analyses UN+ and UB participants may also be shown to be distinguishable groups.

For *Reaction times*, TN participants were considerably slower than all other groups, whilst the other groups did not differ. As the experimental paradigm allowed unlimited stimulus exposure, this slower reaction time of TN participants would have meant that TN participants were exposed to each of the stimuli for longer, and may possibly suggest that TN participants adopted a different viewing strategy compared to the other groups. As well as a main effect of *Group* in the reaction time data, explained by slower *Reaction time* for TN, there was also a *Group by Gender* interaction. Although this interaction is difficult to interpret, it may in part relate to the near-significant difference in *Reaction time* for UN- men and women, where the women responded faster than the men. The finding that UN- women made relatively fast responses, regardless of whether they were significantly faster than UN- men, is made all the more interesting by the fact that UN- women simultaneously made very few global similarity choices. Thus, whilst it is possible that to some extent the local bias of TN participants could relate to a unique viewing strategy, UN- women nonetheless presented with a local bias equal to that of TN women yet did not demonstrate this same viewing strategy.

## 2.5.2 Chapter discussion

### 2.5.2.1 The interrelated effects of urbanisation, education and gender

Previous research (Caparos et al., 2012) has suggested that exposure to the urban environment and urban living may provide the necessary environmental pressure to encourage a global bias in a population (the Himba) that, in the absence of this exposure, otherwise retains a local bias. The urban Namibian (Himba) group in the 2012 study overall still made similarity matches more often at the local rather than global level of structure.

That research, however, did not attempt to quantify urban exposure and treated all urbanised participants as a homogenous sample. This meant that it was unclear whether the size of the effect was dependent on the extent of the urban exposure and whether all members of the group were affected by urbanisation to the same extent (the generalisability of the effect) or whether other factors such as gender and education may have interacted with or contributed to the effect of urban exposure. In the current study we addressed some of the methodological shortfalls of the previous study, and will discuss the results in the context of trying to understand 1) the kinds of environmental pressures (physical and/or societal) that may be at play in shaping local-global bias (either by directly affecting the development of local-global bias, or by affecting the propensity for a change in bias in the face of new environmental demands) and 2) possible biological constraints that may facilitate or limit the effects of those environmental drivers.

Our results replicate the previous finding of a local bias in a remote Namibian population. In addition, we also show for the first time that urban Namibians who became urbanised early, have spent a long time in the urban environment, spend their time predominantly in the urban environment and who have received formal education, by contrast, demonstrate a global bias. Since our two populations will have come from very similar genetic backgrounds, it is suggested that phenotypic plasticity (which allows for flexible ontogenetic development to meet the demands of the environment) favours a local strategy under certain circumstances and a global strategy under others. It is as yet untested whether the remote environment itself may actively promote a local bias; however, here we present further evidence that environmental pressures associated with urban and modern living actively work to promote global bias.

The findings further showed that extent of urbanisation, years of education and gender all impact local-global bias, but that none of these factors works in isolation and that there are no simple blanket-effects. Education on the one hand appears to mediate the relationship between urban exposure and global-similarity matching in urban Namibian men, yet on the other hand has no observable relationship with global-similarity matching in urban Namibian women. Gender on the other hand appears to have a separate moderating effect on the relationship between urban exposure and global-similarity matching such that local-global bias in educated urban women was only affected by relatively large amounts of urban exposure whereas local-global bias was more readily affected in men of equivalent educational background.

The current study also expanded on previous work by including two additional dependent variables, *Number of switches* and *Reaction time* which are not routinely analysed in studies of similarity-matching. Both of these new variables were shown to vary according to experience-dependent factors. Although the effect of the environment was not readily evident in the within-group analyses, between-group analyses revealed considerable environment-dependent differences in both switching behaviours and reaction times. These findings suggest that *Number of switches* and *Reaction time* may be useful measures for future research into group differences in local-global bias (see also Pletzner et al., 2014, for an example of group differences in reaction time on a local-global similarity matching task).

#### 2.5.2.2 Understanding the role of gender

Men and women differed very little from each other in terms of *Number of switches* and *Reaction time*. However, several important gender differences were observed in regards to *Frequency of global-similarity choices*. These differences included differential responses to the environmental effects of urbanisation and education as well as to overall differences in the rate of global-similarity matching. The differential effects of education and urbanisation on men and women will primarily be addressed in the subsequent sections (2.5.2.3 and 2.5.2.4), and the focus of the current section will be on understanding the factors which contribute to the gender difference in local-global similarity matching which exists even when levels of urbanisation and education have been controlled for.

Across all groups (TN, UN-, UN+, UB) women overall tended to make fewer global similarity choices and less often adopt a global matching strategy. This finding is consistent with developmental reports which suggest a lower frequency of global-similarity matching in Western girls compared to boys of the same age (e.g., Kramer et al., 1996). The gender difference in our sample was, however, only reliable within UN-, the less urbanised group of educated urban Namibians. Furthermore, the significant group by gender interaction demonstrated that gender differences are culture- or context-dependent and not a fixed quantity. This is consistent with previous research which shows that any initial gender difference in childhood appears to disappear by adulthood, at least in populations where global-bias is the norm.

In our urban sample, mild urbanisation worked to broaden the gender difference whereas more intense urban exposure worked to close that gender gap; whereas there was no significant difference between non-urbanised TN men and women and the more highly urbanised UN+ men and women, a gender gap did emerge between UN- men and women. Whereas UN- women made very few global-similarity matches and resembled TN women (though, notably, differed in regards to reaction times), UN- men most often made global matches and resembled UN+ men.

It is unclear whether the gender difference in local-global similarity-matching observed in UN- participants reflects 1) different biological sensitivities to environmental drivers of local-global bias, or 2) different environmental experiences resulting from the differential cultural treatment of men and women.

One explanation for the gender difference might be that, whatever the environmental drivers are that promote a global bias, men may simply need less exposure to those drivers whereas only with larger doses of exposure do women begin to show a global bias. It has been suggested that sex hormones play a role in moderating local-global processing (see e.g., Pletzer, 2014) and it may, for example, be that male sex hormones amplify the effect of any environmental drivers whereas female sex hormones may inhibit or dampen those effects. In other words, male sex hormones may work to enhance men's overall sensitivity and receptiveness to those drivers relative to women's.

Additionally, the moderating effect of gender on the effects of urbanisation and/or education (as indexed by group membership; TN, UN-, UN+, or UB) may relate to gender-dependent social factors. For example, men and women may become urbanised and educated under different circumstances and for different motivations, and the experiences and consequences of urbanisation and education also may not be equivalent.

Traditional Namibian culture is based on strong gender divisions, with males and females going through different rites of passage and taking on different roles in their communities. Broadly speaking, men take responsibility for looking after the cattle, whilst women take on the childcare. With urbanisation, there will inevitably be a shift towards a money-based economy and an emphasis on material wealth, and it is likely that the pressure to make money will fall disproportionately on men. For the urban Namibian men (but not women), *Years of education* and *Extent of urbanisation* were highly correlated. This could reflect the fact that men may be more likely to move to urban areas and to stay in those areas for economic reasons, which may be closely tied to education.

The women in the urban Namibian sample were as educated as the men. However, in stark contrast to the men, not only was the correlation between *Years of education* and *Extent of urbanisation* non-significant but that correlation was in fact remarkably close to zero. Whilst urbanisation and education are certainly confounded in Namibian women (traditional women had rarely received any formal education whereas all but one of the urban sample had been to school), it may be that women are less likely to seek out an education specifically with the intention of attaining the financial gains that are necessary to sustain life in the urban environment. Such a possibility would be compatible with the fact that whilst Namibia has attained parity in terms of the numbers of boys and girls attending primary secondary and tertiary education (UNICEF, 2015), women remain underrepresented in the workforce (UNICEF, 2015).

The correlation between *Years of education* and *Frequency of global-similarity choices* (in addition to the above-mentioned correlation between *Years of education* and *Extent of urbanisation*) was also only evident in urban men and not urban women. Increases in education were linked to increases in global-similarity matching, but only in men. The discrepancy between the correlations for men and women cannot easily be accounted for by the fact that there were more uneducated men than uneducated women, as there was still a trend towards a correlation between education and global-similarity matching even after the uneducated males were removed ($r=.350$, $p=.092$; compared to $r=-.014$, $p=.951$ for educated women).

It seems likely that the increase in global-similarity matching that accompanied an increase in *Years of education* in men was not an inevitable result of the content of the educational training itself (though this training may well have been an enabling factor). For example, one would assume that education would facilitate literacy, capacity for abstract thought or a broadening of psychological distance roughly equally in men and women alike. Although we do not have any record of educational attainment or educational engagement, the fact that equal numbers of men and women in Namibia go on to tertiary education would indirectly suggest that educational attainment for men and women may be approximately equal.

If increases in global-similarity matching were an inevitable result of an increased capacity for abstract thought, a broadening of psychological distance, or the perceptual learning involved with the acquisition of literacy, then one would expect to find an effect of education in women as well as in men; although it is not beyond the realms of possibility that an effect of education could be hormone-modulated it seems unlikely that even with considerable levels of education there should be no effect at all for women.

Rather than an inevitable result of the educational content itself, one possibility is that educational background may shape experience in a gender-dependent way. For example, men and women may tend towards different kinds of activities, and men's activity may be more determined by educational status. One's activities within the urban environment may have consequences in terms of both the perceptual input to which one is exposed and also the types of cognitive tasks with which one is engaged. In general, differences in the (culturally-mediated) activities of men and women may be expected to contribute to gender differences in cognition and perceptual processing (e.g., see Newcombe et al., 1983). It is possible that the activities of educated UN men may more heavily promote global processing than those of educated UN women.

For example, educational status is perhaps particularly likely to affect employment status and the kinds of jobs that are engaged in for men. Men who are more educated may be more likely to be promoted to managerial and skilled roles while less educated males may be assigned to more menial jobs. Managerial and skilled positions are likely to require a broad overview of how local elements of a system work together and at a conceptual level may require a more global perspective, and this may activate global modes of processing. For women, pregnancy rates in teenagers remain very high, irrespective of education, and it is likely that many urbanised and educated women take on responsibilities for childcare and domestic duties from a young age (UNICEF, 2015). Although perhaps an overgeneralisation, in many ways the daily activities of many urban Namibian women may not differ greatly from those of women in traditional villages and may be largely focused around childcare and domestic duties. Namibian women who do enter formal employment are likely to face discrimination either directly or indirectly and, for example, are far less likely to be appointed to managerial roles.

The difference between UN- men and UN- women (note that both groups consisted of educated participants only), then, may relate in part to engagement in different activities, and exposure to different kinds of experiences. These differences in experience may have several implications for local-global processing. For example, educated men and women may be exposed to different visual environments (e.g., the workplace versus the home), may become skilled in different forms of perceptual processing (e.g., men may perhaps be more exposed to technology such as computers, machinery, etc.), and may have different environmental pressures placed on conceptual processing (e.g., formal employment versus domestic duties may encourage different forms of conceptualisation).

Gender, however, may not only affect the kinds of activities that urban Namibians take part in on a practical level but may also impact on the nature of the experiences encountered in the urban environment on psychological and emotional levels. Gender discrimination in Namibia, for example, goes far beyond fair access to work opportunities and equal wages, and women may often be seen as being of lower status compared to men (e.g., UNICEF, 2007). This is important because psychological state (e.g., power, affect, etc.) may play an important role in local-global processing (see chapter one, section 1.3.5).

Across the globe, gender-inequality is systematically larger in poorer countries and this is thought to be due both to the processes of development itself as well as to deeply entrenched cultural norms that exacerbate favouritism towards males (see e.g., Jayachandrun, 2015). In Namibia, gender-equality laws (e.g., Combating of Domestic Violence Act, the Combating of Rape Act, Married Persons Equality act) are broadly seen as progressive and provide legal protection to women across a spectrum of issues including marriage, work and inheritance. Yet attitudinal changes to gender-equality do not appear to have kept pace with the law. A 2007 UNICEF report (UNICEF, 2007) suggests that many Namibian men still view their partners as their property and the same report highlights that, specific to Namibia, gender-based violence stands out as the most serious manifestation of the attitudinal belief that women have a secondary role in society. A 2000 survey (cited in UNICEF, 2007) reports that 44% of men agreed that wife-beating is justified for one or more reasons, and a 2006-2007 study too reports that 35% of respondents agreed that it is justified for one or more of 5 specified reasons which included refusing sex or burning food (OECD, 2014). Similarly, as a further example of the lack of personal autonomy and lack of bargaining power afforded to women and girls, 24% of 15-24 years old and 42% of 10-14 years old females in one sample reported their first sexual experience to have been through forced sex (UNICEF, 2007).

The impact of differences in the cultural treatment of men and women may arguably be expected to be most salient for the UN- participants (who, perhaps not coincidentally are the only group where a significant gender effect is shown). For example, although traditional Namibian cultures are based primarily around patriarchal customs and values, women perhaps may be more vulnerable to the adverse effects of gender inequality within the urban setting (see, e.g., Tacoli, 2012).

Gender distinctions in the traditional environment are based on a system that has existed for generation upon generation and this system may well provide a secure environment for women where they themselves may not necessarily feel unjustly treated. Traditional women may also have their own separate measures of status. For example, in Himba tradition, women's puberty, marital and maternal statuses are all reflected in prescribed changes to hairstyle and adornment and such factors, in addition to the status of one's husband and one's family, may well afford women social status in the community. In some sectors of the urban population, in contrast, there is likely to be a conflict between traditional and modern gender values, and this conflict may leave women particularly open to vulnerability.

Urban women who are less well integrated into their urban communities may not have access to the extended support networks that may be available to women who remain in the traditional environment or who are more extensively integrated. Urban poverty in particular may exacerbate gender-based inequalities in power distribution in developing nations (Jayachandrum, 2015). Although we did not collect any measure of integration or wealth in the current urban sample, it is possible to assume that both these factors could be positively correlated with extent of urbanisation. As such, gender-based inequalities may perhaps be at their largest in the UN- sample. It may in part be these differential treatments that contribute to the observed gender differences in local-global bias, for example because of gender-based differences in power distribution (e.g., see Smith & Trope, 2006; Guinote, 2007) or because of high levels of negative affect (e.g., see Bauhmann & Kuhl, 2005), that may result from women being more vulnerable to the negative consequences of urban poverty (Tacoli, 2012). These effects of power, negative affect and other such variables may impact local-global processing either directly (e.g., Förster & Dannenberg, 2010) or via changes in attentional or behavioural patterns over more sustained periods of time (see general introduction).

Finally, one further possible contribution to the gender difference observed in UN- participants may relate to stress-response. Precisely because the UN- group as a whole (and, perhaps, especially women) may be particularly exposed to environmental stressors (e.g., if, as already alluded to, they have less access to support networks and are less financially secure), it is important to consider the impact that that environmental stress may have on the local-global processing of UN- men and women. This is important to the discussion of gender, because gender differences have been demonstrated in both physiological and psychological stress response (Olff et al., 2007) and these differences in response strategy may have consequences for local-global processing. For example, negative affective arousal (which one might expect to share some overlap with environmental stress) has been linked to gender differences in local-global processing, at least in respect to memory (Cahill, et al., 2003). Gender differences in stress-response strategies are thought to be contributed to by both biological and psychological factors including hormonal-modulation and cognitive appraisal (e.g., see Olff et al., 2007, for review.). It is possible then that the gender-difference in local-global perceptual processing in UN- participants may be contributed to by biologically and/or socio-culturally related differences in stress response which might encourage a greater focus on local processing under stress for women but not for men.

In sum, there is a strong case that both biological and socio-cultural aspects of gender may contribute to the observed differences in the similarity-matching behaviours of UN- men and women. Important factors may include 1) differences in the kinds of activities which men and women may engage in (e.g., paid employment versus domestic activities), 2) differences in psychological state (e.g., powerfulness, affect, etc.), 3) differences in stress-responses (due to biological and/or socio-cultural factors), and/or 4) differences in underlying biological sensitivities to environmental drivers of local-global bias.

The cross-cultural variation in men's and women's similarity-matching underlines the importance of considering contextual factors which may contribute to gender differences. The cross-cultural pattern of results suggests that exposure to environmental drivers of global bias (e.g., factors relating to urbanisation and education) may initially lead to gender disparities in local-global bias, which then become diminished and eradicated with further exposure to those drivers. It is unclear whether this pattern of local-global bias may result from differential sensitivities to environmental drivers of local-global bias which mean that men respond more readily to drivers of global bias but that women then 'catch up' with increased exposure, or whether alternatively/additionally socio-cultural differences in the treatment of men and women that are conflated with our measures of urbanisation and education may modify the effects of urban exposure and education in men and women.

#### 2.5.2.3 Understanding the role of education

The results presented in this chapter provide the first empirical evidence that education contributes to individual differences in local-global bias. *Years of education* was correlated with *Frequency of global-similarity choices* in UN men, and this relationship appeared to fully mediate the effect of *Extent of urbanisation*. Furthermore, controlling for level of urbanisation, uneducated UN men made fewer global-similarity matches than educated UN men with equivalent levels of exposure to the urban environment. There was also some limited evidence that education may impact the local-global matching behaviour of TN men, as even in a sample with limited variance in level of education nonetheless a significant correlation between *Number of switches* and *Years of education* could be observed; TN men with higher levels of education made more switches. In stark contrast to the men, however, there was no observable effect of education at all on any measures of task performance for UN or TN women.

It is important to note, however, that these findings do not imply either that education has no effect at all on the local-global bias of women or that urbanisation has no effect at all on the local-global bias of men because 1) there were no uneducated highly urbanised participants in the UN sample and 2) there were no highly educated participants in the TN sample. For example, had data from such participants been available it is possible that educated highly urbanised UN women may have made more global-similarity matches than uneducated highly urbanised women and/or highly educated TN women may have made more global-similarity matches than uneducated TN women. Equally it is possible that highly urbanised uneducated UN men may have made fewer global-similarity matches than highly urbanised educated UN men.

The finding that UN- women remain local in their bias, despite considerable levels of education, suggests that the effects of education on local-global bias are not an inevitable consequence of educational training. As discussed in the preceding section (2.5.2.2), if this were the case, one would expect to see at least some effect of education on women's local-global bias. It is quite possible, however, that education may *potentiate* a shift from local to global perceptual bias (e.g., because of the perceptual learning involved with literacy acquisition and the interpretation of pictorial information and/or because of its effect on abstract conceptual processing, etc.); but the effect of education does not appear to be deterministic. As already alluded to, education may play a greater role in shaping the lives of UN men as compared to UN women because men are more likely to be the main breadwinners and education is likely to be important for men's employability and social status. These indirect aspects of education may be at least as important in determining local-global bias as the direct educational training itself.

Many of the same factors which it was proposed (see section 2.5.2.2) may have contributed to the gender difference in UN- participants may also explain some of the variance that is observed as a function of *Years of education* in UN men. Possible important factors include 1) the effect that education may have on determining the kinds of experiences to which educated and uneducated men are exposed, and 2) the effect that education may have on the psychological state of educated and uneducated men.

Several surveys have indicated that a sense of male insecurity may be a wide-spread issue for Namibian men (see UNICEF, 2007), which suggests that Namibian men could have a heightened sensitivity towards issues of power and status. In traditional villages, a man's social standing and social status may be largely dependent on ancestry, whereas in urban areas is likely to be more linked to one's occupational and financial success. Namibia is not a wealthy nation and it is likely that there is high competition for access to money and resources. It may be this high level of competition and financial/material insecurity that, at least in part, contributes to male insecurity.

Education may have the effect of empowering men, both in practical terms of their access to resources and also in a more psychological sense. Uneducated and low educated males are likely to have less earning-power, less material wealth and lower social standing within the community. If providing for one's family is seen to be a part of a man's role in society, the inability to do so may lead to a sense of emasculation and powerlessness. Urban poverty, which is likely to be more prevalent in uneducated men than educated men, is also likely to be related to increased exposure to environmental stressors (note that aversive arousal has been associated with a narrowing of perceptual breadth; e.g., Derryberry & Tucker, 1994) and sources of negative affect. Power and affect are therefore potential factors that could help explain the mediating effect of education in UN men and why unschooled males made fewer global-similarity matches than schooled males with equivalent urban exposure.

Importantly, whereas the gender-differences in local-global bias that were observed in UN- men and women could be attributable to either biological or socio-cultural factors, the effect of education in UN men can only be attributable to socio-cultural factors. This strengthens the claim that at least some of the variance in UN- men and women's similarity-matching is likely to relate to socio-cultural factors, albeit perhaps in addition to innate biological differences.

#### 2.5.2.4 Understanding the role of urbanisation

The findings presented in this chapter provide further evidence that urbanisation is an important factor in driving global bias. However, the findings also make clear that mere exposure to the urban environment, even in considerable doses, is not sufficient in itself to produce a global bias. UN- (educated) women and uneducated UN men (with urban exposure levels approximately equivalent to the UN- group) made similarity-matches most often at the local level of structure. Indeed, UN- women were indistinguishable from TN women in terms of *Frequency of global-similarity choices*. Additionally, for UN men, urban exposure did not explain any additional variance in *Frequency of global-similarity choices* over and above that which could be explained by education. Therefore, although the findings presented here reiterate the importance of urban exposure, they also highlight the limitations of urbanisation as the sole explanatory factor for cross-cultural differences in local-global bias. Despite these limitations, however, several new observations could be made. In particular, breaking down urbanisation into separate measures proved a fruitful tool and highlighted the multifaceted nature of urban exposure.

Of the four individual measures of urban exposure, *Age of initial urban*isation emerged as the one most strongly linked to local-global similarity-matching (after controlling for gender). On face value this may suggest a sensitive period during childhood during which environmental factors (i.e., urban exposure and factors relating to urban living) may impart a greater effect on the development of global bias than when experienced later in life. *Age of initial urbanisation*, however, was only significantly correlated with local-global similarity matching within women; whereas women who became urbanised later in life were less likely to make global-similarity choices, this was not the case for men.

One interpretation may be that for women there is a sensitive period whereby experience-dependent factors during childhood play a bigger role than experience-dependent factors later in life, but that this is not the case for men. Since increases in levels of progesterone in women have been shown to be associated with increased local processing (see, e.g., Pletzer, 2014), it may be that urban exposure before puberty-related increases in progesterone may be more likely to support a global bias than exposure after progesterone levels have already risen. For men, on the other hand, since increased levels of testosterone have, conversely, been associated with increased global processing (see, e.g., Pletzer, 2014), testosterone increases after puberty may provide a biological boost towards more global processing, and the age of exposure may be of less importance.

There are, however, several complicating factors that make it impossible to say for sure whether any plasticity may be retained in adulthood or whether some kind of sensitive period may exist (albeit with possible differences across gender). As with previous research, it is not possible to determine whether urban participants who possess a global bias but who moved to town later in life may have already possessed that global bias prior to moving to town or whether urban exposure itself may have prompted a transformation from an initial local bias to a global one.

The fact that most of our urbanised sample had received some kind of formal education may indicate that the majority had not originally come from the most remote parts of the region, where it is rare to go to school. It is therefore possible that some participants who had been raised traditionally and relocated to town later in life, but who nonetheless presented with a global bias – that is, UN- (educated) men, but not uneducated men with equivalent urban exposure or UN- women - may already have had a global bias upon first moving to town. Since the participants who best match these criteria were the educated UN men, it is possible that their global bias may relate to education that occurred early in life (in the villages) rather than urbanisation that occurred later in life. Therefore, the concept of adult plasticity need not be evoked to explain the high rate of global-similarity matching of UN- men.

Additionally, the argument that there may be a hormonally-driven sensitive period in women (as alluded to above) presupposes that women urbanised later in life *cannot* develop a global bias, or that their ability to do so may be somehow impaired. A perhaps equally valid interpretation of the results may be that, rather, these women do not develop a global bias because it is not the most functionally adaptive strategy for their particular needs. For example, lack of power has been linked to *superior* processing of local features (Weick, Guinote, & Wilkinson, 2011). Though it is not intended to suggest that a reduced dependence on a global strategy should relate only to psychological factors such as power, this finding has led to the suggestion that the decreased efficiency in global processing which accompanies lack of power represents an *adaptive* change in processing strategy rather than some kind of perceptual processing deficiency. The possibility of adult plasticity, even for women, then also need not be dismissed to account for the local bias of UN-women.

A further possibility is that, childhood may be a particularly important time for the development of one's self-identity and the development of culture-dependent cognitive patterns and/or psychological characteristics which may have a moderating effect on visual processing (either directly or indirectly). Participants who moved to town later in life may be more likely to maintain strong aspects of their traditional identities, or to hold two separate cultural identities, and this tendency may be particularly strong in women. Gender differences in the extent to which traditional identities are maintained may be particularly likely in instances where there are gender-based power inequalities, as research suggests that factors such as power play an important role in regulating self-identity (e.g., Cast, 2003). If there is some pressure (e.g., from relatives, etc.) to maintain certain aspects of one's traditional culture, people in lower power positions (i.e., perhaps especially women) may be more likely to adhere to those pressures.

Finally, it is possible that a significant effect of *Age of initial urbanisation* could be explained, in principle, by the increased exposure to the non-urban environment that would accompany late exposure to the urban environment (i.e., age of urban exposure = number of years of non-urban exposure prior to first urban exposure). Just as the urban environment and/or education may encourage a global bias, the traditional environment may, equally, actively encourage a local bias, as already alluded to in chapter one (see general introduction).

That is, just because traditional Namibians do not acquire the global bias that is associated with typical development in Western children, it cannot be assumed that this is due to some kind of a lack of development, but equally could be explained by *active* development in the opposing direction. Physical properties of the traditional environment such as the lack of visual clutter and its less dynamic nature, as well as cultural aspects of the non-physical environment, may encourage a focus on details. For example, small seasonal changes to plants and foliage may provide vital information for survival, and a less abstracted more concrete view of the world may actively encourage attention to local rather than global information. The non-urban environment may exert its own effect on local-global processing and those who have spent longer in the traditional environment before coming to town may require additional urban exposure to overcome the effects of previous experience. This may particularly be the case for women if men may be biologically more sensitive to drivers of global bias and/or if women may be biologically more sensitive to drivers of local bias.

The finding that *proportion of time spent in the urban environment since initial urbanisation* was also significantly correlated with frequency of global-similarity choices (at least for women) could also be compatible with the idea that the remote environment may assert its own effect on local-global bias. For example, it could be either that sustained urban exposure is necessary for a global bias to develop, or that global bias may be reversed by time spent in the traditional environment.

However, although the correlation between *Proportion of time spent in the urban environment* and *Frequency of global-similarity choices* was significant for all participants after controlling for gender, the correlation appears to be driven almost exclusively by the women's data, with no evidence of any trend towards correlation in the men's data. It is important to note that because even men with relatively little urban exposure already demonstrated a high rate of global-similarity matching, there is less chance of observing any significant urbanisation-related correlations in this group. However, nonetheless, of all four measures of urbanisation, *Proportion of time spent in the urban environment* was in fact the least well correlated with *Frequency of global-similarity choices* for men.

As with the finding relating to *Age of initial urbanisation*, this effect of *Proportion of time spent in the urban environment* could be compatible with similar explanations at either the biological or the societal level. At the biological level, whilst male sex hormones could perhaps raise sensitivity to environmental drivers that encourage a global bias, female sex hormones could perhaps raise sensitivity to environmental drivers that encourage a local bias (as opposed to simply not providing as much sensitivity to environmental drivers of global bias). In this case, more sustained levels of urban exposure may be required to overturn a local bias for women than for men. Alternatively, however, urban women who spend more time back in the villages may retain more of their traditional identity and/or may be less well integrated into urban communities compared to men, and it may be these cultural ties which continue to promote a local bias even in the urban environment.

Interestingly, *Proportion of time spent in the urban environment* was not significantly correlated with any of the other 3 individual measures of urbanisation, either for men or for women. For women, the effect of *Proportion of time in the urban environment*, then, appears to be quite separate to the effect of *Age of initial urbanisation*. This may suggest that, for women, the 'immersiveness' of the urban experience may be an important factor.

Indeed, for women, whilst *Age of initial urban exposure* and *Proportion of time spent in the urban environment* were significantly correlated with *Frequency of global-similarity choices*, the overall amount of time spent in the urban environment did not appear to be as important. Neither *Years since initial urbanisation* nor *Cumulative years of urban exposure* were significantly correlated with *Frequency of global-similarity choices* for UN women, despite UN women's local-global bias in general being strongly linked to urban exposure. Both of these factors (*Age of initial urban exposure* and *Proportion of time spent in the urban environment*) are inherently linked to how much time the women spent outside of the urban environment (either prior to becoming urbanised as in the case of *Age of initial urbanisation*, or after becoming urbanised as in *Proportion of time spent in the urban environment after initial urbanisation*). Consistent with the previous discussions of gender differences, these findings may indicate either that socio-cultural factors relating to extent of urban integration and/or immersion are important for determining the local-global bias of women and/or that women may be either biologically less sensitive than men to environmental drivers of global bias and/or more sensitive to environmental drivers of local bias.

For men, on the other hand, overall amount of time spent in the urban environment, which did not appear to be important for women, by contrast, emerged as a possible important aspect of urban exposure. Of all four measures of urbanisation, although the correlation did not quite reach significance, *Cumulative years of urban exposure* was the most strongly correlated with *Frequency of global-similarity choices* for men. This difference adds to the overall body of evidence that there are marked differences in men's and women's responses to environmental drivers of local-global bias, either due to innate biological differences or because of socio-cultural factors.

In addition to the (gender-dependent) effects of urban exposure on *Frequency of global-similarity choices*, urbanisation (or its associated factors) also seems to have a profound effect on the other two measures of matching behaviour, *Number of Switches* and *Reaction time*. Although within-group analyses did not reveal strong evidence for any environmental influence on *Number of switches* and *Reaction time*, the between-group analyses did. These between-group effects may not relate exclusively to urbanisation. Nevertheless, the fact that neither *Number of switches* nor *Reaction time* differed between UN educated and uneducated men would appear to implicate urbanisation, rather than education, as the primary driving factor.

*Number of switches* and *Reaction time*, however, were not impacted in the same way as each other by urbanisation (and/or its associated factors). For *Reaction time*, TN participants were vastly slower than all other participants, whereas, by contrast, *Number of switches* followed a 'U-shaped' trajectory in relation to urban exposure, with UN- participants making switches significantly less often than both TN and UB participants.

With regards to the slower reaction times of TN participants, it is possible that the longer exposure durations for TN, could have influenced their perceptual experience of the stimuli. Research suggests that long exposure times in Western participants leads to higher rates of local-similarity matching (Hoar & Linnell, 2013) and so there is some possibility then that the longer stimulus exposures experienced by TN participants could lead to more local-similarity matches and an overestimate of the local bias in TN participants. This explanation however becomes problematic when one considers the fact that UN- women made local similarity matches as often as TN women yet were much faster. Furthermore, although these analyses are not included here in the thesis (i.e., in section 2.4), TN participants who presented with a global bias (i.e., participants whose *Preferred matching strategy* was global) were in fact, numerically, *slower* than those who presented with a local bias. Therefore, it is clearly not a simple case that slower reaction times equate to less frequent local-similarity matching.

There are at least two (not mutually-exclusive) likely explanations for the slow reaction times of TN participants. TN participants appeared to need to be trained (albeit very briefly) to understand that the two buttons on the response box corresponded to the two options shown on the computer screen, whereas for UN and UB participants this relationship needed little or no explanation. This unfamiliarity with using the button boxes, and general unfamiliarity with the experimental set up, is likely to have contributed at least somewhat to the extended reaction times of TN participants.

In addition, however, it is also possible that these between-group differences in *Reaction time* may be linked to some more fundamental difference between TN and other participants. For example, TN participants have been shown to demonstrate lower levels of behavioural measures of arousal (as compared to UB participants; Linnell et al., 2014) and it may be this lesser state of arousal, and/or a general slowness in the pace of life, that is expressed in these slow reaction times of TN participants.

The relationship between *Number of switches* and urbanisation, however, is perhaps less easy to explain. *Number of switches* was included as a dependent variable in the analyses under the assumption that some aspect of cognitive flexibility may be reflected in the measure. There are, however, at least two other reasons why participants may make switches. Firstly, it could suggest that the participant simply made a mistake and that their response did not necessarily match their perceptual experience. Secondly, it could suggest that the participant did not have a strong perceptual bias or may have been in a transitional state between biases.

There is perhaps some room for speculation that, given the initial difficulty that TN displayed with using the button boxes, the high rate of switching for TN participants (that is, relative to UN- participants) may indeed reflect some degree of error. The very low *Number of switches* made by UN- participants, however, does not fit easily with the interpretation that a high rate of switching may reflect an ongoing transition from local bias to global bias, as UN- participants were precisely the group who were most evenly split between participants who presented with local and global bias. This finding would also suggest that a higher rate of switching does not reflect a weaker bias *per se* as UN- are also perhaps the group where one might reasonably expect biases to be less firmly established. Therefore, these findings leave open the possibility that the lower rate of switching of UN- participants may reflect a decrease in cognitive flexibility. This interpretation is consistent with recent findings that cognitive flexibility is linked to increased rates of similarity-matching at the non-dominant level (i.e., Western participants with higher levels of cognitive flexibility, who, overall, still showed a strong preference for the global-similarity match, made more local-similarity choices than Western participants with higher levels of cognitive rigidity; Caparos, et al., 2015).

Three relevant factors that are known to reduce cognitive flexibility are negative affect (e.g., Baumann & Kuhl, 2005), stress (e.g., Alexander, Hillier, Smith, Tivarus & Beversdorf, 2007;

Plessow, Fisher, Kirschbaum & Goschke, 2011) and poverty (e.g., Clearfield & Niman, 2012). Levels of all three of these factors are perhaps likely to be higher for UN- participants as compared to participants from other groups.

As already outlined elsewhere in this discussion, wealth is likely to be positively correlated with urban exposure for UN participants, and exposure to environmental stressors is likely to be negatively correlated. Furthermore, research suggests that life satisfaction in the Himba is lower in urban Himba than Himba who live traditionally (Martin & Cooper, 2017). These (i.e., Martin & Cooper, 2017) findings were not discussed in relation to extent of urbanisation in the urban Himba group, though it seems not unlikely that had extent of urbanisation been accounted for, less urbanised urban Himba may have shown lower life-satisfaction scores than more urbanised urban Himba. Although by no means conclusive, it is possible, therefore, that the lower rate of switching of UN- participants may relate to factors such as negative affect and exposure to high levels of stress, which broadly speaking may stem from the negative aspects of urban poverty and may work to reduce cognitive flexibility.

It was speculated (see introduction) that cognitive flexibility may play an important role in facilitating a shift from a local to a global bias in line with the changes to demands on local-global processing which may accompany relocation to the urban environment. The finding of very low rates of switching, possibly indexing lower cognitive flexibility, for UN- men *despite* their overall global bias does not easily fit this interpretation. If reduced cognitive flexibility indeed hinders the ability to flexibly adapt one's perceptual strategy then, intuitively, this would suggest that UN- men should present with a local bias similar to that of TN men.

It is possible, however, as outlined previously, that UN- men may have possessed a global bias even *prior* to relocation to town. For example, since men appear to be especially sensitive to the effects of education, education received prior to relocation may have been sufficient to promote a global bias. Reduced cognitive flexibility, therefore still remains a possible explanatory factor for the finding of unexpectedly high levels of local-similarity matching in UN- women and uneducated UN men (of equivalent urban exposure to the UN-group), and to some degree is supported by the finding of the reduced switching behaviour of these participants.

#### 2.5.2.5 Conclusions

The results presented in this chapter provide evidence that urbanisation, education and gender all exert an influence on local-global bias. The effects of these three variables appear to be highly inter-related and may well be underpinned by a number of mediating factors. One possibility, broadly compatible with the schema presented in figure 2 (see general introduction) is that urbanisation and education may provide a catalyst for the development of a global bias, but that that development may be impeded or facilitated depending on certain other conditions.

Aspects of urbanisation and education that may catalyse the development of a global bias could include exposure to visual clutter, literacy acquisition, increased capacity for abstract processing, increased use of a psychologically distant perspective, and/or increased levels of arousal (see general introduction). Factors which may impede or facilitate the development of a global bias, on the other hand, may relate to psychological state (e.g., power-deprivation, negative affect, chronic stress, etc.), cognitive flexibility, and/or hormonal modulation (see general introduction).

The results also showed that, with sufficient levels of urbanisation and education urban Namibians do indeed (broadly speaking) resemble urban British participants in their similarity-matching behaviours. Educated UN-, UN+ and UB men were indistinguishable from each other in terms of frequency of global-similarity choices, as were UN+ and UB women. This would suggest that urban exposure and/or education provides the necessary environmental stimulus to bring about the full expression of a global bias in a population so vastly different to the Western populations which have more frequently been studied.

This suggestion, however, must be qualified by the acknowledgement that the paradigm may suffer from ceiling effects and may not always be sensitive enough to detect group differences. Indeed, there was some, albeit limited, indication that some small difference may remain between UN+ and UB participants. Although bootstrapping showed the result to be unreliable, there was some indication that UB participants were more likely than UN+ participants to present with a global bias (*Preferred matching strategy* was more likely to be global for UB participants than it was for UN+ participants).

For the most part, however, UN+ were indistinguishable from UB participants, demonstrating that the effects of urbanisation and education on local-global bias are even more profound than previous work (e.g., Caparos et al., 2012) may initially have suggested.

# Chapter three: The effects of education, literacy, and gender on perceptual bias in a semi-traditional Western population

## 3.1 Introduction

### 3.1.1 Background

In the preceding chapter (chapter two), we built upon previous research to show that the local-global perceptual bias of a remote Namibian population is impacted by a combination of several interrelated factors. Previous research (Caparos et al., 2012) had already demonstrated a link between urban exposure and global similarity-matching choices on a local-global similarity-matching task in the same population. The findings presented in chapter two were consistent with this observation, showing that, on average, increased exposure to the urban environment was related to a higher frequency of global-similarity matches on the same similarity-matching task.

However, our results also showed that the relationship between urbanisation and local-global bias is in no way straightforward, and that urbanisation is not the only environmental factor that exerts an effect. We showed evidence that, for urban Namibian men only, the relationship between urban exposure and similarity-matching was mediated by education and that educated men with only moderate levels of urban exposure (UN- men) already presented with a strong global bias. By contrast, urban Namibian women with the same level of education only presented with a global bias if they had become urbanised early in life, had lived many years in the urban environment, and rarely spent any time away from the urban environment (UN+ women). Less urbanised women (UN- women), in contrast, showed a firm preference for the local similarity-match and presented with a local bias as strong as the women in the traditional villages (TN women). In sum, numerous key differences emerged between how men and women responded to the environmental influences exerted by urbanisation and education.

Cross-cultural analyses comparing traditional Namibians (TN), moderately urbanised Namibians (UN-), urbanised Namibians (UN+) and urbanised British (UB) participants showed that populations with higher levels of urbanisation and/or education made considerably more global-similarity choices than populations with lower levels of urbanisation and/or education, and were more likely to present with a global bias. There was also a smaller main effect of gender, which showed that across all populations women made slightly fewer global-similarity choices than men. This effect, however, was only reliable for the UN- group, for whom the gender difference was substantial. A significant *Group* by *Gender* interaction confirmed that gender differences in local-global bias are not a stable quantity but are dependent on environmental context, and further confirmed the observation that men and women were not impacted equally by urbanisation and education.

These results were, to our knowledge, the first to demonstrate an effect of education on local-global bias and the first to demonstrate a gender difference in local-global similarity-matching in an adult population. In this chapter, we seek to further clarify the role of education and gender in shaping local-global bias. To this end we measure local-global bias in a semi-traditional Eastern-European community where it is common to find adults who have never been to school or learnt to read and write, and where traditional gender roles are likely to be maintained to a greater extent than in most other Western populations.

### 3.1.2 Education

For the research presented in chapter two, education in the urban Namibian sample was confounded with both urbanisation and gender. Years of education was more variable in the male sample, for whom 9 out of 32 participants had never been to school and could not read or write, compared to just 1 out of 22 for the urban Namibian women. Furthermore, for the urban men (but not women), extent of urbanisation and years of education were highly correlated. These confounds made it difficult to draw conclusions about the specific contribution of each variable to local-global bias, not least because the effects of all three variables (education, urbanisation and gender) also appear to interact with each other. However, despite these limitations we were able to present substantial evidence that, overall, education works to promote a global bias.

From a theoretical perspective, there are at least two aspects of educational training that might be expected to have a direct influence on local-global perceptual and conceptual processing (see also chapter one, for discussion). Educational training may promote a global bias through fostering greater dependence on abstract conceptualisations (e.g., Greenfield & Bruner, 1966) and/or through the perceptual learning which accompanies literacy acquisition (e.g., Szwed et al., 2012).

According to construal level theory (CLT; Trope & Liberman, 2003; Trope & Liberman, 2011), any event or object may be construed at differing levels of abstraction (along a continuum) and level of abstraction is positively associated with increased psychological distance; abstract representations encourage a psychologically distal perspective and, likewise, psychological distancing encourages abstract representation. Proximal-distal psychological distancing, in turn, has been suggested to have bidirectional carry-over effects to local-global perceptual processing (see Trope & Liberman, 2011, for review. However, see also, e.g., Firestone & Scholl, 2016, for important caveats. See also general introduction.), a finding which is consistent with several theories which suggest that conceptual scope of processing may be intimately related to perceptual scope of processing (e.g., Derryberry & Tucker, 1994).

Formal education has been shown to increase abstract thinking (Greenfield & Bruner, 1966) and the use of abstract language (Klein, Ventura, Licata & Semin, 2010). We suggest that formal education may routinely require abstract mental representation and greater psychological distancing (e.g. when learning about the solar system, how plants photosynthesise, or algebra, etc.). This dependence on abstract representation, because abstract thought has been linked to conceptual, and possibly perceptual, processing, may encourage a bias towards more global processing. Particularly in cultural settings where education is not the norm, experiences outside of formal education may entail comparatively little need for such a high degree of abstraction or psychological distancing.

A second aspect of education relevant to the discussion of local-global processing is literacy acquisition. In young children, there is some evidence that literacy acquisition may correspond to changes in local-global processing of hierarchical (Navon) stimuli. In a drawing study, pre-literate 4-5-year-old children had difficulty replicating the global level of hierarchical figures made either of geometrical shapes or letters. 6-8 year olds, on the other hand, had difficulty replicating the global level of structure only for the figures comprised of geometrical shape but resembled adults in their ability to process the global level when the figure was comprised of letters (Dukette & Stilles, 2001). Similarly, on a similarity-matching Navon paradigm, 6-year-olds were more likely to make global similarity matches when the stimuli were comprised of letters than when they were comprised of geometrical shapes (Dukette & Stiles, 1996).

More generally, it has been noted (see Szwed et al., 2011) that it may be no mere coincidence that age of learning to read in childhood coincides with behavioural measures of increased integration of spatial and contextual information, which may be important skills for global processing (e.g. rapid improvement of contour integration, Kovacs, Kozma, Feher & Benedek, 1999; Kovacs, 2000, and increased sensitivity to the Ebbinghaus illusion, Doherty, Campbell, Tsuji & Phillips, 2010). Indeed, even literacy acquisition in adulthood has been shown to have similar effects on skills of spatial integration (Szwed, Ventura, Querido, Cohen, & Dehaene 2012). In a perceptual task requiring the ability to perceive global structure (a contour integration task) ex-illiterate participants who had learnt to read in adulthood, but not illiterate participants, were able to reach normal adult levels of visual function on the task (Szwed et al, 2012).

It has been suggested that becoming literate requires a form of perceptual learning that requires fast, parallel information processing, under pressure, more often than other forms of visual cognition, and that this intensive perceptual training can improve the functioning of relatively early visual processes (Szwed et al., 2012). This perceptual training may support or enhance global processing; for example, the contour integration task is thought to provide an index of the long-range horizontal connections in V1 which have been implicated as being functionally important for global processing (e.g., Kovacs, 2000. Note, however, that *writing* acquisition has sometimes been linked to enhanced *local* processing; Tso & Hsiao, 2014). Furthermore, literacy acquisition has also been shown to affect hemispheric specialisation (e. g., Dehaene et al., 2015). This structural reorganisation may be expected to impact local-global bias because local-global processing shows some degree of lateralisation of function (e.g., Robertson & Lamb, 1991). Those who never learn to read, however, may have little environmental pressure to develop the equivalent processing skills.

From the Namibian sample (see chapter two), indeed no group of unschooled and illiterate participants (i.e., TN men and women, UN uneducated men) presented with a global bias at the group level. Although by no means conclusive, this finding is consistent with the idea that education may play an important role in potentiating a global bias.

However, clear evidence also shows that even if education may perhaps potentiate the development of a global bias, the precise influence of education is not deterministic. UN-women, despite being as highly educated as UN- men and UN+ men and women, remained firmly local in their perceptual bias and years of education did not correlate with local-global similarity matching across the female UN sample.

We suggest that the mediatory effect of education on the relationship between urbanisation and local-global bias that was observed for Namibian males only may be best explained by possible differences in the utility of educational attainment for men and women respectively. We suppose that, in certain cultural contexts, educational attainment may have stronger consequences for men than for women, and that these social consequences of education may be an important factor in determining local-global bias.

In traditional Namibian culture, social roles are strongly divided along gender lines; whereas the women tend to the children and the homestead, the men look after the cattle. This way of life remains common in many rural areas, and it is likely that traditional gender roles will be maintained to a considerable extent in urban areas, and perhaps particularly amongst less urbanised and/or less integrated sectors of urban society. For example, for traditionally-raised Namibians who relocate to town later in life, there may be a greater expectation that the man should be the main or sole breadwinner whilst the woman looks after the children.

Educational attainment, therefore, is likely to be an important factor in determining a man's ability to earn money and, consequently, in determining their social status and social power. Loss of earnings that may be associated with lower levels of education may also expose men to greater levels of environmental stressors and other negative aspects of urban poverty. It may be these aspects of education which, through their effects on psychological state and/or cognitive flexibility, drives the relationship between education and local-global processing rather than solely any direct effect of the educational content itself.

### 3.1.3 Gender

To our knowledge, prior to the gender difference we report in chapter two, no gender differences in local-global similarity-match choices have ever previously been shown in an adult population, even in experiments specifically aimed at testing for them (Basso & Lowery, 2004; Scheringer & Pletzer, 2016). However, at least two studies have shown that in childhood boys are prone to make more global similarity-matches than girls of the same age (Kramer, Ellenberg, Leonard & Share, 1996, for children aged 4-12; Tzuriel & Egozi, 2010, for children aged 6-7 years).

As already discussed in the general introduction, these gender differences in childhood have typically been attributed to biological level explanations. It has been proposed that boys and girls differ in both the rate and extent of hemispheric lateralisation, with boys developing greater overall hemispheric specialisation and at a younger age than girls (Best, 1988; Witelson, 1976). Prenatal testosterone (which is typically higher for boys) has been linked to cerebral lateralisation, both anatomically and functionally (e.g. Geschwind & Galaburda, 1987; Witelson & Nowakowski, 1991; Grimshaw, Bryden and Finegan, 1995; see also Toga &

Thompson, 2003, for review). Thus, it is suggested that exposure to prenatal testosterone may slow down the development of the left hemisphere (associated with local processing) relative to the dominant right, and the observed gender differences in local-global bias in childhood may relate to this early testosterone-mediated difference in hemispheric rates of maturity.

In adulthood, whilst there have been no reports of differences in local-global similarity-matching, there have, however, been reports of gender differences in the speeded processing of local-global hierarchical stimuli. Several results have shown that men respond faster to global targets and show greater global advantage compared to women (Razumnikova & Vol'f, 2011; Müller-Oehring, Schulte, Raassi, Pfefferbaum & Sullivan, 2007; Pletzer, Petasis & Cahill, 2014; Roalf, Lowery & Turetsky, 2006; see, however, Kimchi, Amishav & Sulitzeanu-Kenan, 2009). In one study, it was shown that global advantage (faster reaction times for global targets) was positively related to testosterone levels in men and women and negatively related to progesterone levels in women (Pletzer et al., 2014). The authors suggested that the results were consistent with a testosterone-mediated enhancement of right hemisphere functioning in addition to a progesterone-mediated inter-hemispheric decoupling, leading to less inter-hemispheric inhibition with greater levels of progesterone. Specific to the local-global similarity-matching paradigm, testosterone levels have also been linked to increased rates of global-similarity choices, for both men and women (Schenringer & Pletzer, 2016), even though men did not overall make significantly more matches and both genders made matches most often at the level of global similarity.

Findings linking sex hormones to local-global processing provide compelling evidence for some role of biological factors in individual development and between-gender differences in local-global processing. Hormonal regulation has also been proposed to be a key factor in explaining gender differences in stress-response (e.g., Goldstein et al., 2010) and related gender differences in memory for local-global details of stories following negative arousal at the time of encoding (Cahill et al., 2003). This is particularly important to the current discussion because the populations reported on here in the current chapter (especially the Romanian participants) and in the previous chapter (especially the urban Namibians) are likely to be exposed to high levels of environmental stressors and it is possible that the effects of gender-specific stress-responses may extend beyond differences in memory for local-global details to differences in local-global processing more generally.

However, the role of socio-cultural aspects of gender as an explanatory factor can by no means be discounted. Indeed, the highly gender-specific pattern of effects relating to the various measures of urbanisation and education (e.g., the correlation between *Frequency of global-similarity choices* and *Years of education* for UN men that was entirely absent for UN women, and the correlation between *Frequency of global-similarity choices* and *Proportion of time spent in the urban environment* for UN women that was entirely absent for UN men) reported in the previous chapter, although not entirely incompatible with a purely biological explanation, intuitively seems more compatible with an account that allows for some influence from sociocultural factors also.

Particularly given the wealth of evidence to suggest that psychological factors may perhaps play a key role in mediating local-global processing (e.g., Smith and Trope, 2006; Gasper & Clore, 2002, etc.), it seems pertinent to ask whether certain socio-cultural conditions may foster different psychological states in men and women, and whether in turn these differences may contribute to the observed gender differences (see chapter two) in local-global bias. As discussed in the previous chapter, and in the general introduction, perceived power may be one such psychological dimension (of which there may be many) along which culturally fuelled gender differences are likely to emerge. The extent of any gender differences in power (and other sociocultural variables), and the consequences of those differences, however, is likely to vary considerably between cultural settings.

Generally speaking, across cultures men possess higher levels of interpersonal power (e.g., see Carli, 1999), and command more social influence than women (e.g., see Carli, 2001). Although men in general hold more power, this of course does not mean that women will be entirely devoid of power or opportunities to experience and exert their powerfulness. In certain situations, however, some women (and indeed some men) may find themselves in a position of chronic powerlessness. One might suppose that women from disadvantaged backgrounds in particular may struggle to find opportunities to hold power, and that this may be exacerbated in cultures where women are generally regarded as subordinate to men. In such scenarios, one might expect to find more pronounced gender differences in local-global processing. The question of the cultural treatment of men and women, then, alongside any pre-existing innate biological differences which may exist, is of central importance to the current study. Power provides one example of a sociocultural dimension which is likely to be confounded with gender and which may be important for local-global processing.

Traditionally, Roma men are afforded higher status than the women, and even in less traditional Roma communities such attitudes remain prevalent (Kelly et al, 2010; Kyuchukov, 2011; Voicu & Popescu, 2009). Unequal distribution of power, in favour of Roma males, is particularly evident in interpersonal relationships where men are afforded much greater relationship-power and relationship-control (Kelly et al, 2010; Voicu & Popescu, 2009). A great deal of emphasis is placed on the importance of female virginity and 'cleanliness' as a requirement for marriage. As a result, girls are often married at a very young age, sometimes even as young as around 13 (Kyuchukov, 2011; Voicu & Popescu, 2009) and often to men who are substantially older. The status of women is generally elevated in less traditional Roma communities, though patriarchal structures continue to characterise Roma societies in general (Voicu & Popescu, 2009). Thus, there are likely to be considerable differences between the life experiences of the men and women in the current sample, which may have bearing on psychological dimensions (power, affect, stress etc.) which may be important for local-global bias.

### 3.1.4 Examining the effects of education and gender in two Roma populations

In order to examine the effects of education and literacy, it was necessary to find a population for whom, for historical reasons, attending school was not necessarily the norm. This was so as to ensure that any effects relating to our measure of education (and/or literacy) could more confidently be attributed to differences in level of education, with minimal contamination from other covarying factors such as socioeconomic status or other social variables. It was also important to find a population where there was access to both men and women of varying levels of education, and where level of education was unlikely to be linked to levels of urbanisation. This was important so as to discounfound education from both urbanisation and gender to address the shortcomings of the research conducted on the populations reported on in the previous chapter.

One such population was a Roma community living at Pata-Rât, Romania. Approximately half of the Pata-Rât participants interviewed had never been to school and could not read or write. Participants were selected on the basis of availability rather than by any specific selection criteria, and so we assume the ratio of schooled to unschooled participants to be approximately representative of the overall population there.

Pata-Rât consists of four small settlements of predominantly Roma ethnicity formed around a landfill on the outskirts of Cluj-Napoca, the capital of Transylvania. From Pata-Rât we worked with two of these settlements, at Dallas and directly at the landfill (see United Nations Development Programme report, 2012). Pata-Rât in general is an area of extreme poverty and this is particularly evident at the landfill settlement, where there is no electricity and no running water. Families live in small improvised barracks directly next to (and occasionally actually on) the landfill itself, and are continuously exposed to risks to health and safety. Conditions in Dallas, a 10-minute walk from the landfill, are somewhat improved but still extremely impoverished. Housing in Dallas is a mixture of improvised barracks and small wooden homes provided mainly by NGO's. Clean water is accessible by a public tap, and most households have access to shared or private outside toilet facilities and private indoor cooking facilities, but not usually to electricity (United Nations Development Programme report, 2012).

We also collected data from Roma communities where schooling was the norm and where standards of living were generally higher. This allowed us to examine whether the effect of schooling was comparable across both populations or whether factors other than education, such as socioeconomic status, may also impact on group differences, whilst as best as possible controlling for other cultural confounds that would exist between Roma and non-Roma populations. Conclusions drawn from the comparison of the effect of education between these two populations must, however, be qualified by the acknowledgement that the education available to the two populations cannot be guaranteed to have been of equivalent quality.

This second group of Roma participants was recruited from two small rural towns in Hungary, Borsodnádasd in Northern Hungary and Sáp in Eastern Hungary near the Romanian border. In these populations, it was rare to find adults who had not received at least some formal education (and most had completed their compulsory primary education, up to 8th grade, or, until around age 14), or who could not read and write. Although poverty was still an issue, living standards were far higher than those of the Pata-Rât communities.

In Borsodnádasd we were able to obtain some basic background measures of standard of living. Around 60% of participants reported that their house was big enough for their family's needs, 70% had a private bathroom, 80% had piped water and 50% had their own access to the internet. From what could be gathered, conditions in Sáp were broadly similar. Rural populations were chosen because of the difficulty in quantifying the urbanicity of the Pata-Rât participants. Although Pata-Rât itself is not well developed and more resembles a rural settlement, it is within easy access to the city centre. Choosing a rural comparison sample alleviated the risk of any group differences (in the direction of increased global bias in our Hungarian sample) being attributable to greater urban exposure.

It was also important to choose Roma communities for both populations so as to avoid any possible effects that may have resulted from choosing two culturally distinct populations. Although different Roma communities do vary considerably in the extent to which traditional values are observed, Roma communities in general follow their own specific traditional values which are often autonomous of the majority population (e.g., see Kelly, et al., 2010). The Pata-Rât settlements are in general somewhat less traditional than more rural Romanian Roma communities (Voicu & Popescu, 2009), although, the landfill settlement may be somewhat more traditional than Dallas (United Nations Development Programme report, 2012). It is likely that our Hungarian sample is even less traditional than our Romanian sample, as strength of tradition amongst Roma typically diminishes as a function of access to education (Voicu & Popescu, 2009), and in particular female access to education (Kyuchukov, 2011). Nonetheless, the two Roma populations reported here are likely to share considerable cultural overlap.

### 3.1.5 Predictions

We predict that, if anything, the Romanian sample may show reduced global bias relative to the Hungarian sample that, in turn, may show reduced global bias relative to the British control group. These predictions are based on the assumptions that higher levels of education and socioeconomic status may be associated with higher rates of global bias.

We further predict that any gender differences will be in the direction of stronger global bias in men, and that gender differences will be most likely to occur in our Romanian sample. This is based on the assumption that the status of women is likely to be lowest in our Romanian sample and in addition that particularly in marginalised and stigmatised populations of low socioeconomic status women are less likely to experience power in wider social contexts outside of their immediate relationships. The Romanian sample are also most likely to be exposed to high levels of environmental stressors and gender differences in stress-response may have implications for local-global processing.

Finally, we predict that higher levels of education may be associated with higher rates of global bias, though perhaps dependant on the utility value of that education in terms of elevated status and/or access to wealth. Based on this reasoning we also predict that there may be a gender by education interaction because of possible differences in the utility values of education for men and for women.

## 3.2 Methodology

### 3.2.1 Participants

Participants were recruited from three populations, Romanian Roma, Hungarian Roma, and British. All participants were aged 16-45. Participants were recruited by word of mouth and through the assistance of local charities, local workplaces and local authorities. Participants were given the equivalent of approximately £2.50 in compensation for their time, except where there was an explicit request (e.g., from a local authority) not to do so. All participants took part voluntarily.

#### ***3.2.1.1 Romanian Roma***

Testing took place in shady spots or in people's homes. Participants were recruited by word of mouth and opportunistic sampling through the assistance of a local charity.

23 males with an average age of 28, (range = 18- 44, SD = 7.6), average years of formal schooling of 3.0 (Range 0-10, SD = 3.3). 39% were literate. 2 further males were not included in the final data set because their performance on the task did not fulfil the inclusion criteria (see Stimuli and Procedure section below).

27 females with an average age of 26, (range = 16-40, SD = 7.1), average years of formal schooling of 3.0 (Range = 0-10, SD = 3.6). 48% were literate. 2 further females were not included in the final data set because their performance on the task did not fulfil the inclusion criteria.

#### ***3.2.1.2 Hungarian Roma***

Testing took place in shady spots, in people's homes, or in people's workplace. Participants were recruited by word of mouth and opportunistic sampling, sometimes through the assistance of local authorities or local workplaces.

17 males with an average age of 26, (range = 18- 40, SD = 6.8), average years of formal schooling of 7.0 (Range 0-12, SD = 3.1). 88% were literate.

27 females with an average age of 30, (range = 17-44, SD = 8.4), average years of formal schooling of 8.3 (Range = 3-11, SD = 1.8). 96% were literate. 2 further females were not included in the final data set because their performance on the task did not fulfil the inclusion criteria.

#### *3.2.1.3 Urban British*

All participants were living in London at the time of testing, and had been living there for at least 6 months. Participants were recruited through word of mouth and opportunistic sampling in public spaces. Participants took part voluntarily and without reward.

16 males, average age 27 (Range= 17-40, SD=7.8). 17 females, average age 31 (Range=17-38, SD= 5.9). 1 further male was not included in the final data set because their performance on the task did not fulfil the inclusion criteria.

### 3.2.2 Stimuli and procedure

The task consisted of 5 cards, of which one was a practice trial, three were test trials and one was a control trial. The practice trial consisted of three coloured circles of the same size arranged with one on top and two below in a triangular arrangement, at equal distance from each other. The reference figure (the top figure) was a red circle and the two comparison figures were comprised of one blue circle and one pinkish-red circle. The practice was included for the purpose of familiarising participants with the concept of matching by similarity (given that the task is designed for use with young children).

Each of the remaining 4 trials consisted of three hierarchical Navon figures (Navon, 1977) arranged with one on top and two below in a triangular arrangement, at equal distance from each other (see figure 1). Figures were made from geometrical shapes (circles, crosses and squares) at both the local and global level of structure. At a viewing distance of 50cm each global structure subtended 4.3° and each local element 0.7°. Stimuli were presented on A4 card.

The figure at the top of the display was always the reference figure, and the two at the bottom were the comparison figures. Participants indicated which of the two comparison figures "looks most like" the reference figure by pointing with their finger to indicate the comparison figure on either the left or the right side of the card.

Of these 4 experimental trials, there were 3 test trials in which one comparison figure matched the reference figure at the global level of structure but not at the local level, and the other comparison figure matched at the local level but not the global level. The other trial was a control trial in which one comparison figure matched the reference at both the local and global level of structure (it was identical to the reference figure, and therefore was the correct response) and the other comparison figure shared no similarity with the reference figure at either the global or the local level.

Participants who did not get the control trial correct were not included in the study. The control trial always came at the end, the other 3 trials were randomised. Choices were made by pointing with a finger.

Instructions were given in the participants own language, through a translator for the Romanian and Hungarian participants.

## 3.2.3 Analyses

### 3.2.3.1 Overview of analyses

Results are based on the 3 experimental trials for which there was no identical match between the reference figure and either of the two comparison figures. For each of these trials, one comparison figure matched the reference figure on the local but not the global level of structure, and the other comparison figure matched on the global but not the local level. Participants were required to make 2-AFC responses based on perceived similarity at either the local or the global level of structure. Data from the 1 trial for which there was an identical match to the reference figure are not included in the analyses. One continuous DV, *Frequency of global-similarity choices*, and one categorical DV, *Preferred matching strategy*, were extracted from participants' matching behaviours. *Number of switches* and *Reaction times*, which were analysed in the previous chapter, could not be extracted from the card version of the task.

### 3.2.3.2 Measures

#### *3.2.3.2.1 Continuous measure: Frequency of Global-Similarity choices*

Frequency with which a participant made similarity matches at the global rather than local level of structure over the 3 experimental trials. A *Frequency of global-similarity choice* score of 0 indicates that the participant always made matches at the local level of structure, and a score of 1 indicates that the participant always made matches at the global level of structure. As *Frequency of global-similarity choices* was based on only 3 experimental trials, participants' scores could only be one of four possible outcomes: 0, .33, .67, or 1.

Preliminary skew, kurtosis and normality diagnostics indicated that *Frequency of global-similarity choices* was to some extent non-normally distributed. To address the somewhat unsatisfactory nature of the DV, following Conovan and Iman (1981), a rank transformation procedure was applied for all comparisons involving *Frequency of global-similarity choices*.

*3.2.3.2.2 Categorical measure: Preferred matching strategy (local, global, or mixed matching strategy)*

Participants were categorised as having a preferred local matching strategy if *Frequency of global-similarity choices* was 0, a preferred global matching strategy if *Frequency of global similarity choices* was 1, and a mixed matching strategy if *Frequency of global-similarity choices* was .33 or .67.

**3.2.3.3 Analyses**

3.2.3.3.1 *Within-group assessment of the role of Education and Literacy*

The initial stages of analyses aimed to first examine the roles of education and literacy within-group separately for Romanian (education and literacy) and Hungarian (education only) participants. Within-group analyses were chosen in order to avoid any additional confounds relating to the different group identities. Men and women were also treated separately within each group as there were theoretical reasons to suspect that men and women may respond differently to environmental drivers of local-global bias, either due to innate biological differences and/or to socially constructed differences between the sexes.

For both Romanian and Hungarian participants, the role of education was examined through simple correlations between *Highest grade of education* and *Frequency of global-similarity choices,* separately for men and women. Where the correlations between men's and women's *Highest grade of education* and *Frequency of global-similarity choices* were comparable both in terms of the direction of, and the overall strength of, the relationship, correlations for the combined data were also conducted so as to increase statistical power.

For the Romanian group only, participants were divided into groups of literate and illiterate participants. A two-way between-subjects ANOVA was performed across *Literacy level* and *Gender*, in order to assess this specific aspect of education. The same analysis could not be performed on the Hungarian data as there were too few illiterate participants.

*3.2.3.3.2 Comparisons across Group and Gender*

In the previous chapter, in order to compare across groups, first, participants who did not match the group stereotypes were deselected from the analyses. For TN participants, this involved removing educated participants and for UN participants this involved removing uneducated participants. For the current analyses, however, it was not possible to take this approach because of the highly diverse nature of the Romanian sample. For this reason, the first set of cross-cultural comparisons compared all Romanian, Hungarian, and British men and women, regardless of *Highest grade of education* and *Literacy level*.

Differences in mean *Frequency of global-similarity choices* were compared in a two-way between-subjects ANOVA for the effects of *Group* (Romanian, Hungarian, and British) and *Gender.* Differences in classification of *Preferred matching strategy* were assessed through multinomial logistic regression. Due to the sample size being relatively small for logistic regression, independent variables (*Group*, *Gender*, *Group by Gender* interaction) were added to the model based on their statistical relevance, in order to conserve power. To the extent that the final model was based on statistical relevance, rather than specific theory, these analyses should be considered as somewhat exploratory rather than entirely confirmatory.

*3.2.3.3.3 Comparisons across Group, Gender, and Level of education*

For Romanian and Hungarian participants only, the roles of *Group*, *Gender* and education were further assessed in a three-way between-subjects ANOVA examining the effects of *Group*, *Gender* and *Level of education* on *Frequency of global-similarity choices.*

In order to include *Level of education*, participants in each *Group* were classified as either *High educated* or *Low educated* participants. In both Romania and Hungary, education is compulsory until the end of primary school, which consists of 8 grades. It had been hoped to be able to classify participants as having either completed primary education or not completed primary education, as this would seem to be a meaningful distinction. Unfortunately, however, too few Romanian participants had completed primary education and so this distinction could not be used. Owing to the differing overall levels of education between the Romanian and Hungarian samples, indeed it was not possible to use exactly the same criteria for the Romanian and Hungarian groups to classify High educated and Low educated participants.

Romanian participants who had completed at least 7 grades were classified as High educated participants and participants who had completed less than 7 grades were classified as Low educated participants. For Hungarian participants, participants who had completed *greater than* 7 grades were classified as High educated participants whereas participants who had completed 7 grades or less were classified as Low educated participants. For the Hungarian group, this distinction was equivalent to the distinction between having completed and not having completed primary education.

It was acknowledged from the outset that the uneven classification criteria for High and Low educated participants for the Romanian and Hungarian groups was problematic. However, adopting the same classification criteria for both groups would inevitably have resulted in either too few High educated Romanian participants or too few Low educated Hungarian participants. Owing to the inbuilt confound between *Level of education* and highest grade of education for the two groups, results must be interpreted with caution.

British participants were not included in the analysis as there were no *Low educated* participants in the British sample.

# 3.3 Results

### 3.3.1 Assessment of the role of Education and Literacy in Romanian and Hungarian participants

#### *3.3.1.1 Education*

Simple correlations were performed between *Highest grade of education* and *Frequency of global-similarity choices*, for Hungarian and Romanian participants. As it was not clear that any relationships between our measures of urbanisation and education and performance on the Navon task should be the same in men and women, analyses were initially carried out for men and women separately. Where appropriate, men and women's data were then combined in order to increase statistical power.

Table 10 below shows the correlations between *Highest grade of education* and *Frequency of global-similarity choices*, for Hungarian and Romanian men and women separately. No correlations in either population were significant when analysed separately for men and women. For the Hungarian sample, the direction of the correlation was the same for men and women, and the overall strength of the correlation was very similar. On this basis, the data were combined and reanalysed. The men and women's combined data for the Hungarian group showed a significant positive correlation between *Highest grade of education* and *Frequency of global-similarity choices*. For the Romanian data, however, there was no evidence for a relationship between *Highest grade of education* and *Frequency of global-similarity choices*. This was particularly true for the Romanian women's data, where the correlation coefficient was remarkably close to zero.

Table 10. Table to show simple correlations between Highest grade of education and Frequency of global-similarity choices for Romanian and Hungarian participants. Fisher's Z tests compare the correlations for men and women; a significant Z score indicates a significant difference between the two correlations.

| | Romanian | Hungarian |
|---|---|---|
| **Men** | r=.214<br>*p*=.328<br>N=23 | r=.349<br>*p*=.094<br>N=24 |
| **Women** | r=-.027<br>*p*=.894<br>N=27 | r=.385<br>*p*=.127<br>N=17 |
| **Combined** | - | r=.369*<br>*p*=.018<br>N=44 |
| **Fisher's Z test** | Z= 0.209<br>*p*=.418 | Z= -0.12<br>*P*= .452 |

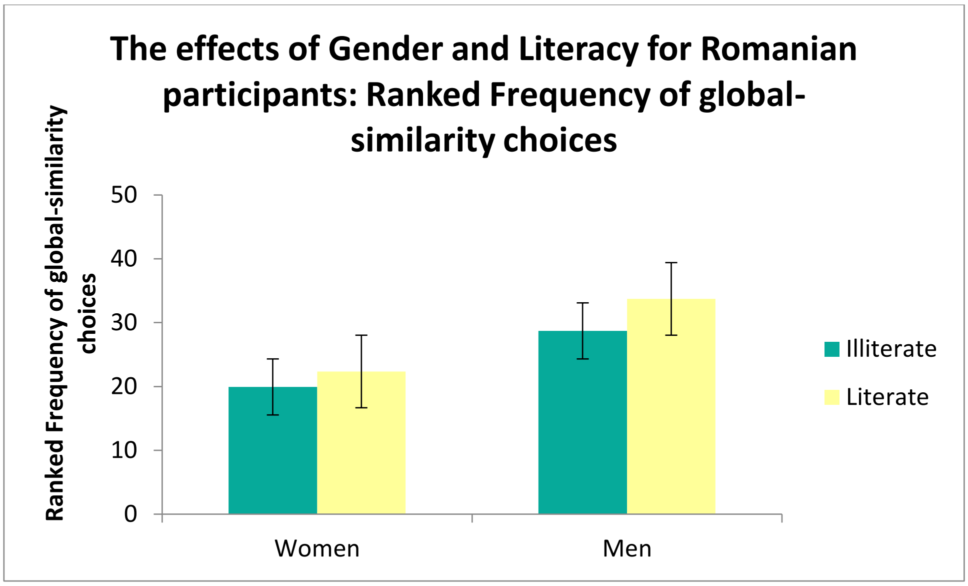
Note: *** = $p$<.001, ** = $p$ <.01, * = $p$ <.05

### *3.3.1.2 Literacy*

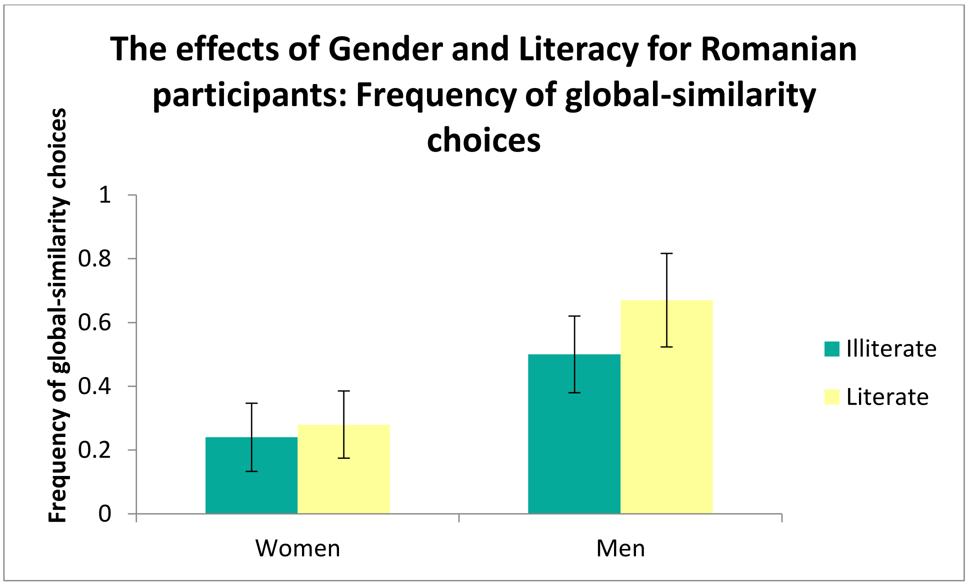
For the Romanian data only, it was possible to compare *Frequency of global-similarity choices* for literate and illiterate participants. As it was unclear whether any effects would be the same for men and women, *Literacy level* was compared across *Gender*.

Mean *Ranked Frequency of global-similarity choices* was calculated for literate and illiterate men and women and is shown in figure 8(a) below. Figure 8(b) additionally shows the raw values for ease of interpretation. A two-way between-subjects ANOVA was conducted for *Literacy level* and *Gender*. The main effect of *Gender* was significant ($F(1,46)=7.355$, $p$=.009, $\eta^2$=0.138), in the direction that women made fewer global-similarity choices. Partial Eta Squared effect size value ($\eta^2$=0.138) suggested a high practical significance. However, there was no main effect of *Literacy level* ($F(1,46)=0.998$, $p$=.323, $\eta^2$=.021), or any *Literacy level by Gender* interaction ($F(1,46)$= 0.121, $p$=.729, $\eta^2$=.003).

(a)




(b)




Figures 8(a) and 8(b). Graphs to show mean ranked (a) and unranked (b) Frequency of global-similarity choices for Literate and illiterate Romanian men and women. Error bars represent +/- 1 SEM.

### 3.3.2 Cross-cultural comparisons across gender

#### *3.3.2.1 Frequency of global-similarity choices*

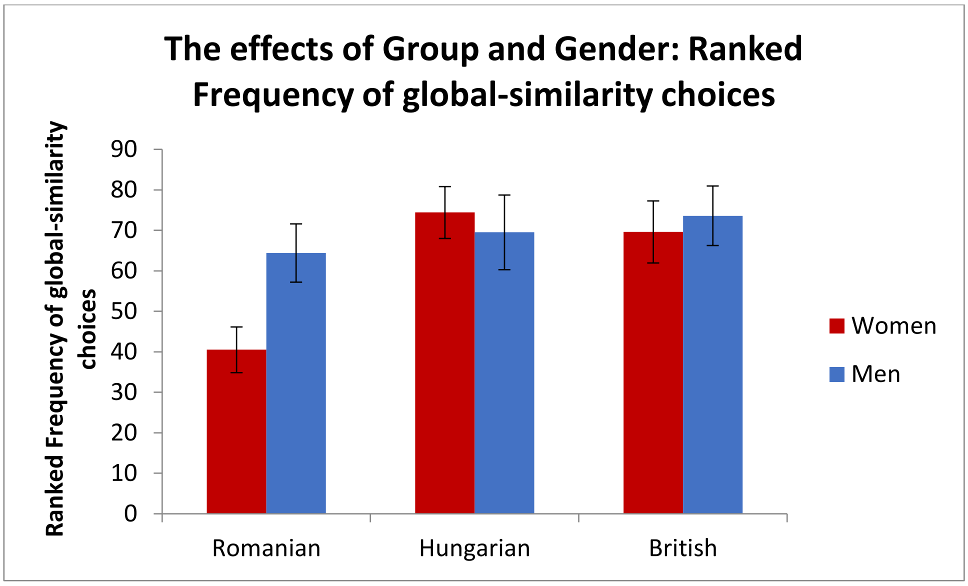
Mean *Ranked Frequency of global-similarity choices* was calculated for Romanian, Hungarian, and British men and women and is shown in figure 9(a) below. Figure 9(b) additionally shows the raw values for ease of interpretation. A two-way between-subjects ANOVA was conducted for *Group* (Romanian, Hungarian, and British) and *Gender*. The main effect of *Group* was significant (F(2,121)=5.240, *p*=.007) and the Partial Eta Squared effect size value ($\eta^2$=.080) suggested a moderate to high practical significance; however, there was no main effect of *Gender* (F(1,121)=1.688, *p*=.196, $\eta^2$=0.037), or any *Group by Gender* interaction (F(1,121)= 2.292, *p*=.105, $\eta^2$=0.014).

Post hoc Bonferroni corrected comparisons for the effect of *Group* showed that Romanian participants made fewer global-similarity matches than both Hungarian (p=.007, 95% CI of the difference = -37.479, -4.657) and British (p=.022, 95% CI of the difference = -37.822, -2.208) participants, whereas Hungarian and British participants' *Frequency of global-similarity choices* did not differ from each other (p=1.000, 95% CI of the difference = -19.337, 17.231).

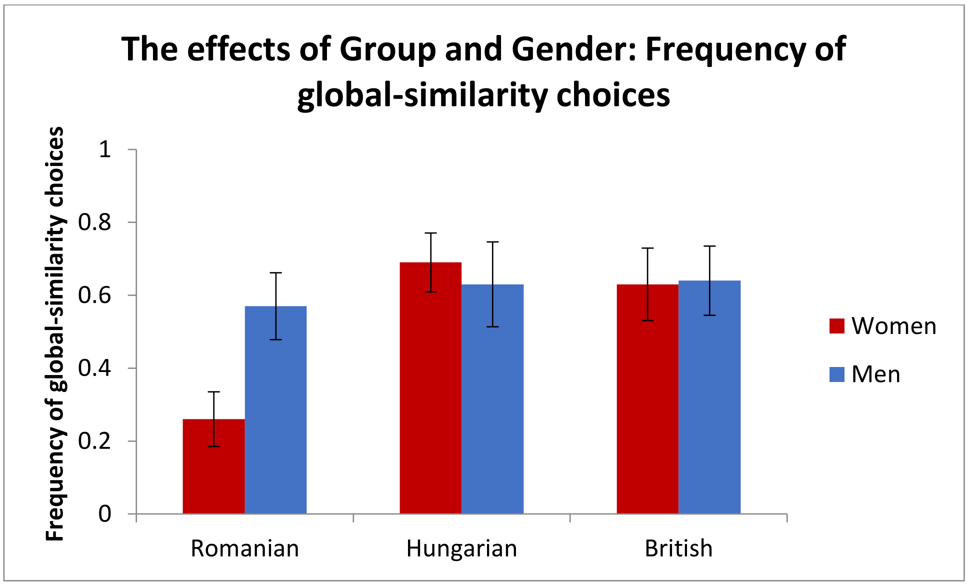
Although neither the main effect of *Gender* nor the *Gender by Group* interaction were significant, results from the within-group ANOVA in the previous section examining the effects of *Gender* and *Level of literacy* can be interpreted to suggest that the main effect of *Group* in the current between-group analysis may be driven primarily by the particularly low *Frequency of global-similarity choices* made by the Romanian women. We therefore tested whether the effect of Group may be better explained by the women's rather than the men's data, and in particular whether Romanian women, but not Romanian men, may differ from their Hungarian and British counterparts.

Applying an alpha correction of .05/2 =.025, the effect of *Group* on *Ranked Frequency of global-similarity choices* was significant for the women's data (F(2,68)=8.810, *p*<.001, $\eta^2$=0.206) but not the men's (F(2,53)=0.349, *p*=.707, $\eta^2$=0.013). Romanian women made fewer global-similarity matches than Hungarian (*t*(52), *p*<.001, 95% CI of the difference = -50.966, -16.757, *d*=1.080) and British women (*t*(42)=-3.111, *p* =.003, 95% CI of the difference = -47.928, -10.211, *d*=.0954), and these differences were significant even after applying an alpha correction of .05/6 = .008, to compensate for multiple comparisons. Hungarian and British women, by contrast, did not differ on their *Ranked Frequency of global-similarity choices* (*t*(42)=0.473, *p*=.639, 95% CI of the difference = -15.625, 25.189, *d*=.0147).

(a)




(b)




Figures 9(a) and 9(b). Graphs to show mean ranked (a) and unranked (b) Frequency of global-similarity choices for Romanian, Hungarian, and British men and women. Error bars represent +/- 1 SEM.

#### *3.3.2.2 Preferred matching strategy*

ANOVA analysis showed that at the group level *Frequency of global-similarity choices* varied significantly between Romanian, Hungarian, and British participants (see section above). However, it is unclear from these average group scores how individual participants in each subpopulation responded to the Navon task. For example, a small difference in *Frequency of global-similarity choices* across groups could result either from all or most participants in one group making global-similarity choices slightly more often than members of the other group, or alternatively could result from a few participants making many more global-similarity choices.

In order to differentiate between these possibilities, a categorical analysis was performed. Participants were classified as preferring a matching strategy that was either local (*Frequency of global-similarity choices* =0), global (*Frequency of global-similarity choices* =1), or mixed (*Frequency of global-similarity choices* = .33 or .67). Figure 10 below shows the proportion of participants in each sample population preferring local, global and mixed matching strategies respectively.

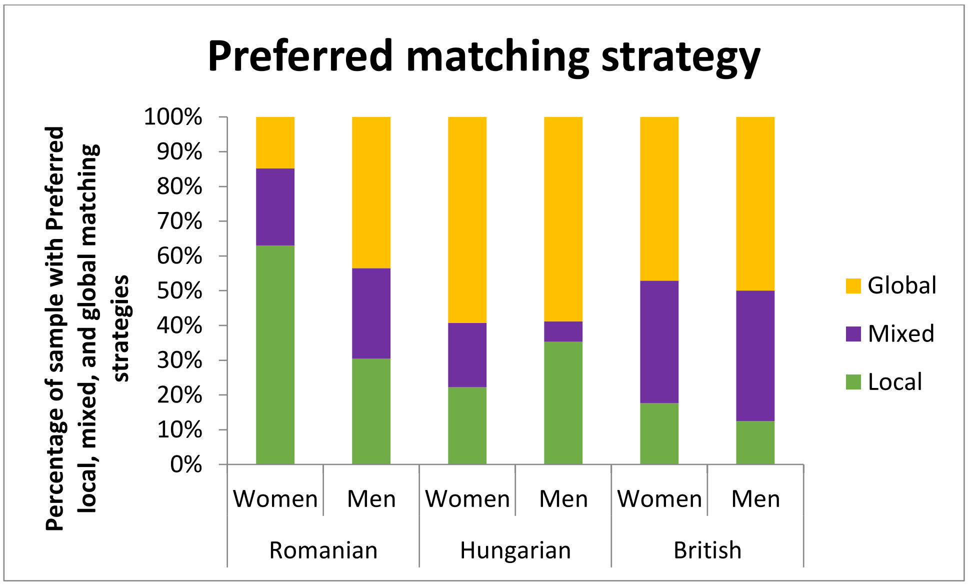



Figure 10. Graph to show percentage of each sample of Romanian, Hungarian, and British men and women with Preferred local, Preferred mixed, and Preferred global matching strategies. Preferred local, Preferred mixed, and Preferred global matching strategy percentages add cumulatively to 100 for each subpopulation.

Multinomial logistic regression was used to test whether the likelihood of a participant preferring a specific matching strategy (local, global, or mixed) was dependent on either *Group* or *Gender*.

A preliminary hierarchical logistic regression was run to determine which variables should be included in the final model. In the first stage of the model, only the main effects of *Group* and *Gender* were entered into the model, and in the second stage the interaction term was also included. Only the main effect of *Group* was a significant predictor in the model and was retained in the final model; the main effect of Gender was non-significant and Gender was not retained in the final model. Adding the interaction term did not significantly improve the model and the interaction term itself was not a significant predictor. On this basis, the *Group by Gender* interaction was also not retained in the final model. Results are shown in table 11 below.

The final model, with only *Group* as a predictor, was overall a significant predictor of *Preferred matching strategy* ($\chi^2(4)=17.112$, $p=.002$), albeit with only a 52.0% overall classification success rate (correct classification for 58.5% of participants with a preferred local matching strategy, 75.0% of participants with a preferred global-matching strategy, but 0% of participants who preferred a mixed matching strategy).

The British group were chosen as the reference category, and the model predicted a Preferred global strategy. The odds of a British participant presenting with a Preferred global as compared to a Preferred local matching strategy were approximately 5.5 times higher than those of a Romanian participant; however, the two groups did not differ in their odds for presenting with a Preferred global as compared to a Preferred mixed matching strategy. Hungarian participants, on the other hand, did not differ from British participants in their odds for presenting with a Preferred global as compared to a Preferred local matching strategy; however, the odds of a Hungarian participant presenting with a Preferred global as compared to a Preferred mixed matching strategy, on the other hand, were approximately 0.3 times lower than those of a British participant. In summary, British participants were more likely to present with a Preferred global matching strategy than a preferred local matching strategy as compared to Romanians, but were more likely than Hungarians to present with a Preferred mixed strategy as compared to a Preferred global strategy (although both groups more often presented with a Preferred global strategy than a Preferred mixed strategy, as can be seen in Figure 10).

Table 11. Table to show coefficients of the model predicting whether participants preferred a global matching strategy over a local or a mixed matching strategy. Romanian and Hungarian participants are compared to UB participants.

| | | | b(SE) | 95% CI for Odds Ratio | | |
|---|---|---|---|---|---|---|
| | | | | Lower | Odds Ratio | Upper |
| **Local vs. Global** | | | | | | |
| | Intercept | | -1.163 (0.512)* | | | |
| | Group | R vs. B | 1.702 (0.613)** | 1.650 | 5.486 | 18.235 |
| | | H vs. B | 0.390 (0.620) | .438 | 1.477 | 4.978 |
| **Mixed vs. Global** | | | | | | |
| | Intercept | | -0.288 (0.382) | | | |
| | Group | R vs. B | 0.134 (0.548) | 0.390 | 1.143 | 3.347 |
| | | H vs. B | -1.179 (0.592)* | 0.096 | 0.308 | 0.983 |

Note. $R^2$= .126 (Cox & Snell), .123 (Nagelkerke). Model $\chi^2(4) = 17.112$, $p$=.002. * $p < .05$, ** $p < .01$, *** $p < .001$

### 3.3.3 Cross-cultural comparisons across gender and Level of education

For Romanian and Hungarian participants only, the roles of *Group*, *Gender* and education were further assessed in a three-way between-subjects ANOVA for the effects of *Group*, *Gender* and *Level of education* on *Frequency of global-similarity choices.*

Although *Level of education* could not be defined equally for the Romanian and Hungarian groups, it was hoped that including some measure of education would provide some insight into the question of whether the group difference between Romanian and Hungarian participants was in part related to education.

Romanian participants who had completed at least 7 grades were classified as *High educated* participants and participants who had completed less than 7 grades were classified as Low educated participants. For Hungarian participants, participants who had completed *greater than* 7 grades were classified as High educated participants whereas participants who at completed 7 grades or less were classified as Low educated participants. Mean *Highest grade of education* and percentage of participants with basic literacy skills are provided in table 12 below as a function of *Group*, *Gender, and Level of Education*.

Table 12. Table to show education and literacy demographics for Romanian and Hungarian High and Low educated men and women.

| | | Mean highest grade of education (SD) | Percentage of participants with basic literacy skills |
|---|---|---|---|
| **Low educated Romanian** | **Men (N=17)** | 1.35 (1.80) | 17.6 |
| | **Women (N=19)** | 0.95 (1.65) | 31.6 |
| **High educated Romanian** | **Men (N=6)** | 7.75 (1.17) | 100 |
| | **Women (N=8)** | 8.00 (1.1) | 87.5 |
| **Low educated Hungarian** | **Men (N=9)** | 5.00 (2.69) | 77.8 |
| | **Women (N=4)** | 5.75 (1.89) | 75 |
| **High educated Hungarian** | **Men (N=8)** | 9.25 (1.75) | 100 |
| | **Women (N=20)** | 8.75 (1.25) | 100 |

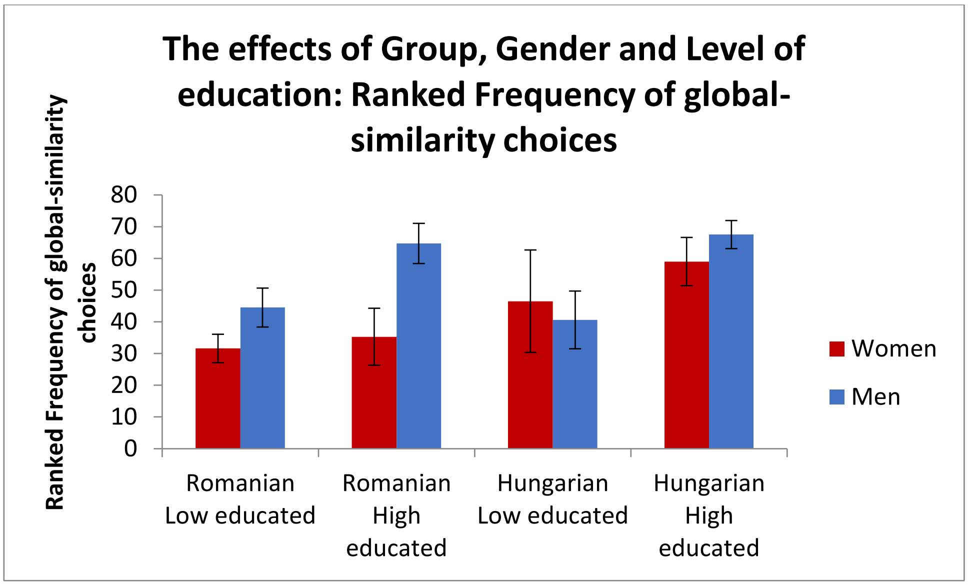
A three-way between-subjects ANOVA was performed across *Group* (Romanian and Hungarian), *Gender* and *Level of education* (high or low). Mean *Ranked Frequency of global-similarity choices* were calculated for each subpopulation and are shown in figure 11(a) below. Figure 11(b) additionally shows the raw values for ease of interpretation. Both the main effect of *Gender* ($F(1,83)=4.119$, $p=.046$, $\eta^2=0.047$) and of *Level of education* ($F(1,83)=8.121$, $p=.006$, $\eta^2=0.089$) were significant, in the direction of fewer global-similarity choices for women and for *Low educated* participants. The main effect of *Group* was non-significant ($F(1,83)=2.870$, $p=.094$, $\eta^2=0.033$) though did tend towards significance, as did the *Group by Gender* interaction ($F(1,83)=3.202$, $p=.077$, $\eta^2=0.037$). All other interactions were also non-significant (*Gender* by *Level of education*: $F(2,1,83)=1.952$, $p=.166$, $\eta^2=0.023$; *Group* by *Level of education*: $F(1,83)=0.491$, $p=.485$, $\eta^2=0.006$; *Group* by *Gender* by *Level of education*: $F(1,83)= 0.009$, $p=.925$, $\eta^2<0.001$).

Although no interactions involving gender were significant, the findings of the previous chapters, along with visual inspection of the graphs in figure 11, gave reason to suspect that the environmental drivers of local-global bias may have different effects on men and women. To test this theory, ANOVAs for *Group* and *Level of education* were repeated separately for men and for women.

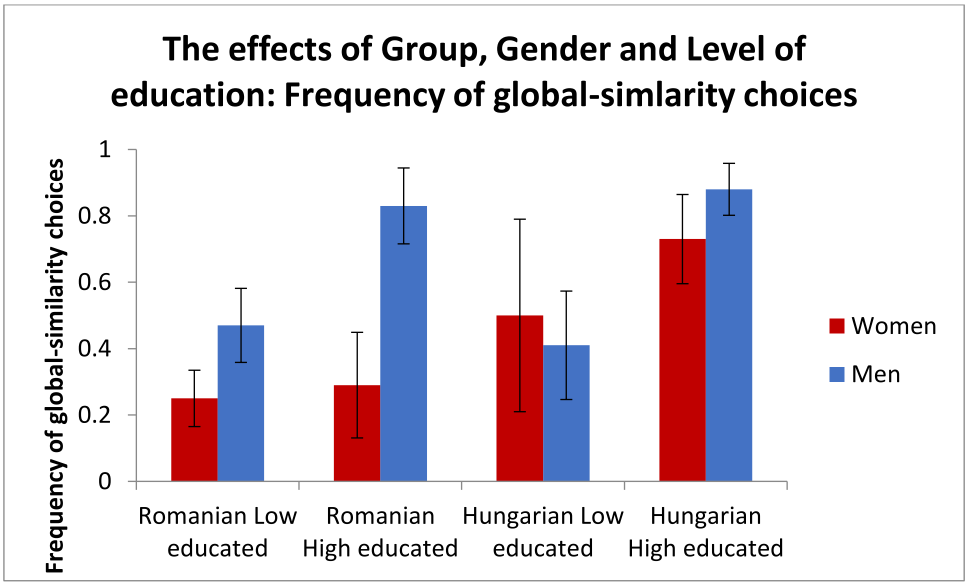
For the male-only data, there was a significant effect of *Level of education* ($F(1,36)=8.580$, $p=.006$, $\eta^2=0.192$), applying an adjusted alpha of .05/2=.025, but not *Group* ($F(1,36)=0.004$, $p=.948$, $\eta^2<0.001$) on *Ranked Frequency of global-similarity choices*. For the female-only data, conversely, there was a significant effect of *Group* ($F(1,47)=6.300$, $p=.016$, $\eta^2=0.118$), applying an adjusted alpha of .05/2=.025, but not *Level of education* ($F(1,47)=1.096$, $p=.301$, $\eta^2=0.023$). The *Group* b*y Level of education* interaction was non-significant in both the men's ($F(1,36)=0.175$, $p=.678$, $\eta^2=0.005$) and the women's models ($F(1,47)=0.328$, $p=.570$, $\eta^2=0.007$).

Consistent with the Post hoc comparisons presented in the above section (on cross-cultural comparisons across gender), t-tests confirmed that the effect of *Gender* was only significant for the Romanian sample ($t(48)=2.655$, $p=.011$, 95% CI of the difference = 4.143, 30.008, d=0.748), even after applying an alpha correction of .05/2 =.025, and not for the Hungarian sample ($t(42)=-0.451$, $p=.654$, 95% CI of the difference = -19.124, 12.135, d=0.137).

(a)




(b)




Figures 11(a) and 11(b). Graphs to show mean ranked (a) and unranked (b) Frequency of global-similarity choices for Romanian and Hungarian High and Low educated men and women. Error bars represent +/- 1 SEM.

## 3.4 Discussion

### 3.4.1 Discussion of results

#### 3.4.1.1 Summary of within-group assessments of education and literacy

*Highest grade of education* was shown to significantly correlate with *Frequency of global-similarity choices* for the Hungarian sample only. This correlation was significant only for the combined men and women's data. However, correlation coefficients from the separate analyses suggest that the effect may be equally strong for Hungarian men and women.

For the Romanian data, no correlation between *Highest grade of education and Frequency of global-similarity choices* was observed. Approximately half of the Romanian sample had received no formal education and only a handful had completed the full 8 years of primary education (which finishes at around age 14). Whereas the Romanian sample, then, was skewed towards having received less education, the Hungarian sample, conversely, was skewed towards a relatively more educated sample. It is possible that some of the discrepancy between the two groups may be explained by these different compositions of *Highest grade of education*. For the Romanian women's data, however, the correlation was close to zero, and indeed was even, marginally, in the opposite direction to what would be expected. The women's data, then, shows fairly conclusively that education did not impact the local-global bias of the Romanian women.

For the Romanian sample, *Level of literacy* was singled out as a further possible differentiating factor. For both men and women, however, no evidence for an effect of literacy could be seen, and the only defining factor for the Romanian group was *Gender*. Romanian women made fewer global-similarity choices than Romanian men, regardless of *Level of literacy* or *Highest grade of education.*

#### 3.4.1.2 *Summary of cross-cultural comparisons*

Comparing the effect of *Level of education* across both *Group* and *Gender*, for the Romanian and Hungarian samples, confirmed education as an important environmental factor. Comparing the effect of *Group* (i.e., Romanian and Hungarian only) and *Level of education* separately for men and women, however, demonstrated that the effect of education was not equivalent for all participants. Men were affected by *Level of education* regardless of *Group*, but did not differ across *Group* whereas women, on the other hand, differed across *Group* regardless of *Level of education*, but did not demonstrate any overall effect of *Level of education*.

Taken together with the findings from the within-group analyses, these findings suggest that Romanian and Hungarian men may be impacted by *Level of education* in similar ways, although the evidence for an effect of education on local-global bias in the Romanian men is less conclusive. For women, on the other hand, the data suggest that Hungarian women most likely were impacted by education, but that no effect at all could be observed for Romanian women.

Cross-cultural comparisons across all three groups (Romanian, Hungarian, British) also showed that, for the most part, the Hungarian sample and the British sample were indistinguishable from each other, with both groups demonstrating comparable *Frequency of global-similarity choices* and being equally as likely as each other to favour a global over a local matching strategy. The only comparison to show any difference between these two groups was the likelihood of favouring a global over a mixed matching strategy. Although both groups were more likely to favour the global matching strategy over the mixed matching strategy, Hungarian participants were significantly more likely to do so.

Whereas the Hungarian and British groups showed broadly consistent results, the Romanian sample, on the other hand, was shown to be clearly distinguishable from both the Hungarian and the British ones. The categorical analyses showed that Romanians were especially more likely to favour a local matching strategy over a global matching strategy. Post hoc analyses on *Frequency of global-similarity choices* showed, however, that this group difference was attributable to the particularly low *Frequency of global-similarity choices* of the Romanian women as compared to all other subpopulations. Indeed, the main effect of *Group* on *Frequency of global-similarity choices* disappeared entirely when comparing only the male data.

### 3.4.2 Chapter discussion

Here we show further evidence that both gender and education are important factors in determining local-global bias, but that their effects may be interrelated and dependent on cultural setting. We also show for the first time that a local bias, under certain circumstances (at least for women), can be the dominant perceptual style of even an educated (albeit not to a very high level), literate, Western population who are in regular contact with the urban environment.

In some regards, the findings relating to education show considerable similarity with findings presented in the previous chapter which demonstrated an effect of education for UN men but not UN women. Here, across *Group* (Hungarian and Romanian) *Level of education* was shown to impact local-global similarity matching only reliably for men. This suggests that, overall, men may be more sensitive to the influence of education, perhaps because education has higher utility for men than for women in certain social contexts.

For the Hungarian sample, however, the effect of education seemed to be equally strong for both men and women. This was surprising given the previous finding (see chapter two) that for UN women education exerted no effect on local-global bias and the current finding, presented here, that education also exerted no effect on the Romanian women. It is unclear why education should impact the Hungarian women but not the women from the other populations.

One key difference that sets the Hungarian population apart from the Romanian population is that very few Hungarian participants had never been to school or could not read and write. It may be the case that, in a population where education is the norm, lower levels of education may be more strongly associated with factors such as lower sociocultural status or social standing and poverty. However, for UN women education was also the norm, and yet had no impact at all on local-global processing. One possibility is that for UN women the effect of education may have been ‘counteracted’ in some way by other factors which created a drive towards local perceptual processing (or somehow ‘blocked’ the development of a global bias); however, this remains speculation. The best that can be said is that the effects of education may be culturally mediated in some way.

The current findings, also suggested that, in general, the effect of education was stronger for the Hungarian participants. There was some suggestion in the data that Romanian men may also be impacted by level of education; however, the data were not sufficient to allow direct claims to be made. What is clear, however was that at least for Romanian women, education did not impact local-global bias. Regardless of educational and literacy level, Romanian women remained local in their bias. These findings replicate the finding presented in chapter two which showed that, at least for moderate levels of education and basic levels of literacy, neither educational training nor literacy acquisition is sufficient in its own right to bring about a global bias.

Romanian women, regardless of education or literacy levels, made significantly fewer global-similarity choices compared to Romanian men, and were the only subpopulation to present with a local bias. No such gender difference was observed in the Hungarian sample, replicating the finding from chapter two that gender differences in local-global bias are mediated by environmental factors (which may also interact with biological factors). There are a number of different factors which might explain why the Romanian but not Hungarian women presented with a local bias.

The Romanian and Hungarian groups were both comprised of Roma participants, and the two groups will have had many shared values and customs. The most immediate differences between the two groups, however, were their relative levels of poverty, living standards and access to education. Although poverty was not measured directly in our study, the difference in living standards was immediately obvious and the Pata-rât community in Romania has been highlighted as being particularly disadvantaged (see introduction to this chapter). Whilst discrimination is still a major issue for Roma people in general, there are additional issues of stigmatisation unique to the Pata-rât (and other similar) communities because of their association with the landfill (United Nations Development Program, 2012). The Romanian sample, therefore, above and beyond the Hungarian sample, can be considered as being of particularly low socioeconomic status and particularly marginalised.

Although also not directly measured in our study, it is likely that traditional attitudes towards gender roles would be stronger in the Romanian group than the Hungarian group, because access to education has been linked to a more egalitarian perspective on gender within Roma communities across Eastern Europe (Kyuchukov, 2011). As such, women in the Romanian sample may be afforded less interpersonal power compared not only to the British women, but also to the Hungarian women (see Voicu & Popescu, 2009, for a summary of gender attitudes in various Roma populations, including specifically the Pata-rât community).

One possibility is that these differences in the cultural treatment of men and women may have contributed to the observed gender difference in the Romanian sample. Both the Romanian men and women in our sample are at the extreme low end of the socioeconomic spectrum. However, whereas men are likely to possess and experience power within their own community, women on the other hand may lack power not only in a wider social framework, but also within their immediate social environment. Clearly, more research is needed to determine whether a chronic lack of power (or the negative affect, or other factors, which may be associated with power deprivation) may indeed bring about a local processing bias in real life situations. Nonetheless this account of the findings is consistent with laboratory based studies suggesting a link between power priming and local-global processing (e.g., Smith & Trope, 2006).

A second possibility is that gender-based differences in stress-response may have important consequences for local-global bias. Gender-based differences in stress-response are likely to reflect both biologically (e.g., hormonal regulation) and socio-culturally (e.g., psychological appraisal) derived differences between men and women (see e.g., Ollf et al., 2007) for review). It is possible that exposure to environmental stressors may encourage a more local processing style in women than in men in the face of equivalent levels of stress (see e.g., Cahill, 2003 for evidence that negative arousal may lead to enhanced local processing for women but not men). Since the Romanian Roma in particular are likely to live in circumstances of very high levels of stress, this may explain why gender differences are observed only in this population.

In general, the findings presented here are consistent with the proposal put forward in chapter two, and consistent with the schema presented in chapter one (see Figure 2), that psychological state (e.g., power, affect, stress-related negative arousal, etc.) may have a mediatory effect on local-global bias, and may contribute to gender differences in local-global bias in certain cultural contexts. This may be due either to underlying biological (e.g., hormonal-modulation of stress response) or sociocultural (e.g., unequal power distribution) factors. Whether biological or sociocultural factors underpin the gender difference observed in the Romanian sample, the findings nonetheless implicate socioeconomic status and factors associated with poverty (e.g., power-deprivation, high exposure to environmental stressors, etc.) as a possible environmental driver of local-global bias, at least for women.

Although factors relating to socioeconomic status seem a likely explanatory factor, it is, however, not possible to fully discount the possibility that the gender difference in the Romanian sample could relate entirely to differences in underlying biological sensitivities to environmental drivers of local-global bias such as education. This is because education and socioeconomic status were confounded between the Hungarian and Romanian samples. It is possible that had the Romanian women been as highly educated as the Hungarian women they may have presented with a global bias, and, had the Hungarian women been as little educated as the Romanian women they may have presented with a local bias. Our preliminary findings comparing *Level of education* (high or low) across *Group* suggests that these outcomes are unlikely; however, the data were not adequately suited to testing this hypothesis.

Finally, our results also showed that Hungarian participants (but not Romanian participants) were less likely than British participants to adopt a mixed matching strategy as compared to a global matching strategy. The fact that Romanian participants were not any less likely than the British to adopt a mixed matching strategy as compared to a global matching strategy is less surprising given that the Romanians participants were the least likely to adopt a global matching strategy. Although not entirely equivalent, the finding that Hungarian participants were less likely than British participants to use a mixed matching strategy as compared to a global strategy (despite the two groups overall making matches at the global level of structure equally often) is comparable to the previously presented finding (see chapter two) that UN- participants made fewer switches (i.e., the number of times they switched between local and global matching strategies) than the British participants.

Although these findings do not provide any direct evidence to support the theory that cognitive flexibility may contribute to cross-cultural differences in local-global bias, the findings may perhaps indicate that highly urbanised, highly educated British participants may have higher levels of cognitive flexibility as compared to less urbanised, less educated and less wealthy participants from more traditional backgrounds, at least in regards to their tendency to not always interpret ambiguous local-global visual material in the same way. This account is consistent with findings that socioeconomic status has been shown to influence behavioural measures of cognitive flexibility (Clearfield, & Niman, 2012).

# Chapter 4: The effects of urbanisation, education and gender on the development of local-global bias in a remote African population

## 4.1 Introduction

### 4.1.1 Background

Through the use of comparative studies across genetically similar populations, it has now been clearly demonstrated that environmental factors (either relating to socio-cultural and/or physical aspects of the environment) can lead to both group differences (see chapters two and three; see also Caparos et al., 2012) as well as gender differences (see chapters two and three) in adult local-global perceptual bias. Focusing solely on adult populations, however, provides only a snapshot of the gene-environment interactions which dynamically shape perceptual bias across the course of development.

Here we extend our research into local-global bias and the environment by comparing the developmental trajectories of traditional Namibian (TN) and urban Namibian (UN) children between the ages of 4 and 15, as well as a control group of urbanised British (UB) children of the same age. The examination of local-global bias across both age and culture allows for a more fine-grained understanding of both the process by which cross-cultural differences emerge as well as the extent to which (if at all) developmental processes should be considered universal and immutable to mechanisms of phenotypic plasticity.

Remote Namibian adults living in traditional villages have been shown to possess a strong local bias. This local bias is diminished with exposure to the urban environment (Caparos et al., 2012; see also chapter two) and given extensive urban exposure and formal education urbanised Namibians are indistinguishable from British adults in terms of their similarity-matching of hierarchical (Navon) figures (chapter two). Both urbanisation (chapter two) and education (chapters two and three) appear to be important factors in determining perceptual bias. Although neither factor, either on its own or in combination with the other, is sufficient to fully explain the variance between different subpopulations, both factors have clearly been shown to be strongly associated with a global bias.

In the study reported in this chapter, the three populations (TN, UN, and UB) differ from each other in important ways along both the dimensions of urbanisation and also education (as well as along other lines of cultural norms and values). Traditional Namibians have very little contact with the urban, modern environment and rarely attend school or acquire any basic literacy or numeracy, though some may attend a mobile school if it is accessible from their village. Indeed, the current TN sample includes some such children who remain in the remote villages but attend these mobile schools. The urbanised Namibian group were sampled from the small town of Opuwo where it is standard for children to begin school at around age 6 or 7 years. All but a handful of urban Namibian children who were of school age were attending school. UN children and TN children of the same age who were attending school, however, were not educated to the same degree, and so, as was also the case in chapter two, it was not possible to fully disconfound education and urbanisation in the Namibian samples. Finally, the urbanised British group were sampled from London, one of the most urban cities in the world, and where it is typical to start school at age 4 or 5.

Although in adulthood the most urbanised and educated Namibians resemble urbanised and educated British adults (see chapter two), it is unclear whether this would be the case in childhood. It is possible, for example, that the intensely urban environment of London and/or the earlier starting age of formal education of British children relative to urban Namibian children may lead to early cross-cultural differences between the two groups which are not seen later in life (either because they no longer exist, or because the paradigm is not sufficiently sensitive to detect them). If differences in local-global bias between UN and UB exist during childhood, this may be demonstrated in a number of ways. Developmental trajectories between the two groups could be characterised by differences in the age at which periods of maturation and stability occur or, alternatively, by differences in the magnitude of the maturational growth at each stage even if the overall trajectories follow similar time courses.

For the traditional Namibian group, it is unclear whether any kind of developmental trends would be observed or not. Adult TN data presented in chapter one from the computerised version of the task, suggest that adult TN levels of global-similarity matching may not be completely at floor level even though overall a local matching-strategy is clearly preferred. It seems reasonable to suppose that even in the traditional environment there would be situations where the need for an integrated perception of global configuration would drive the development of the mechanisms which support global perception. Indeed, when specifically instructed to do so traditional Namibian adults actually performed better than British adults at tasks requiring responses to the global as well as the local level of structure for hierarchical figures (Caparos, Linnell, Bremner, de Fockert & Davidoff, 2012). Thus, it could be that even within a population which retains a local bias in adulthood, there may be a small developmental movement towards a more global processing style with age. Alternatively, it is possible that, if a local perceptual strategy is more adaptive for traditional Namibians, it may be that environmental pressures select for more specialised *local* perception with age. In which case, it may even be that young traditional Namibian children could perhaps be more global than traditional Namibian adults.

A further source of potential variance between the three populations is the extent to which gender differences may or may not be present. Western studies have suggested that during childhood global bias may be more pronounced for boys than for girls (e.g., Kramer et al, 1996). The research presented in chapters two and three, however, also shows that, at least in adults, gender differences in local-global bias are to a large extent dependent on environmental context. The mediating factors which underlie the interaction between gender and environment remain unknown but may relate either to biological differences between the sexes and/or to the differential cultural treatment of males and females.

As with the previous chapters, it will be important to control for gender in the current study because group averages for boys and girls combined may well be misrepresentative (if boys and girls differ in their similarity matching) and, additionally, because differences between boys' and girls' responses to environmental influences (i.e., urbanisation and education) might be informative with regards to the underlying variables which mediate experience-dependent differences in local-global bias.

The following sections provide an overview of the empirical findings upon which the hypotheses for the current research are based. The sections will review the development of local-global bias in the West, gender-specific effects on the development of local-global bias, and the effects of urbanisation and education on the development of visual processing more broadly (because little is known about the effect of these variables on local-global bias specifically).

### 4.1.2 The development of local-global bias

As already outlined in the general introduction, within the West, developmental studies utilising similarity-matching tasks typically report a developmental shift from local preference to global preference at around 6 years of age (Kramer Ellenberg, Leonard & Share, 1996, at 7 years of age; Vinter Puspitawati & Witt, 2010; and Oishi et al.,2015 at 5 years of age; Poirel, Mellet, Houdé & Pineau, 2008, at 6 years of age). Some variation in the exact age at which a transition is observed using behavioural measures is to be expected because even small changes in stimulus or display properties can impact the relative saliencies of the local and global levels of structure (see, e.g., Kimchi, 1992). Nonetheless, results converge to suggest a transition at around 5-7 years of age, an age which roughly coincides with the transition period from childhood to middle childhood (e.g., Bogin, 1997) and with marked changes in the processing of visual contextual information (Doherty, Campbell, Tsuji & Phillips, 2010; Kovacs, Kozma, Feher & Benedek, 1999; Kovacs, 2000). It is suggested that the period at around 6 years of age may represent a particularly important window for the development of global bias (e.g., Poirel, Leroux, Pineau, Houdé & Simon, 2014).

A number of neural correlates of this behavioural transition from local to global bias have been identified. At age 6, children who showed a preference for a global similarity-matching strategy showed evidence of grey matter loss (a decrease in cortical thickness) in localised areas of primary visual cortex (Poirel, Simon, Cassotti, 2011; Poirel, et al., 2014) as well as increased cortical thickness in left hemisphere parietal, frontal and cingulate regions (Poirel et al., 2014) that was not evident in children of the same age who still showed a preference for a local similarity-matching strategy.

Grey matter loss, or synaptic pruning, is considered to be a fundamental mechanism of neural plasticity, by which neural networks become fine tuned to the statistics of the sampled environment (i.e., dependent on visual input) and to the interaction between behaviour and environment (e.g., through perceptual learning), and it is this fine tuning which brings about selective behavioural specialisation (e.g., Edelman, 1993). The grey matter loss observed in visual cortex of the 6-year-old children who preferred a global matching strategy was more pronounced in the right hemisphere, leading the authors to suggest that the effect may reflect the need for greater specialisation of right occipital networks in order to support a global bias. The same regions are known to be involved in global processing in adults (Han, et al., 2002).

At the same time, those 6-year-olds who preferred a global matching-strategy also showed *increased* cortical thickness in left hemisphere parietal, frontal and cingulate regions relative to 6-year-olds who still preferred a local matching-strategy (Poirel et al., 2014). Since these regions have been linked to visual attentional control in adults (Corbetta, Kincade, McAvoy & Shulman, 2000; Weissman, Giesbrecht, Song, Magnum & Woldorff, 2003; Weissman, Gopalakrishnan, Hazlett & Woldorff, 2005), it is suggested that initial expansion mechanisms (increases in neural density) in these regions may allow the child to disengage from an autonomic attentional focus on local information and begin to shift attention to global information (Poirel et al., 2014).

Yet despite the relative consistency in Western studies with regards to the age at which a transition occurs, there is perhaps some suggestion in the literature that the developmental onset of the transition from local to global bias may not be entirely biologically determined. In a study comparing local-global similarity matching in 4-6-year-old Japanese and American children, American children made global matches more often than local matches (frequency of global-similarity matches >.5) from age 5, whilst Japanese children continued to make matches more often at the local level (frequency of global-similarity matches <.5) even at age 6, the highest age included in the developmental part of the study (Oishi et al., 2015). Overall group differences, however, between Japanese and American children were small, with neither group showing a strong overall preference for either the local or the global level of structure. The results, therefore, cannot be said to be conclusive with regards to any differences in developmental timings, and indeed the authors do not attempt to invoke such a line of argument.

The current study will aim to test the extent to which the developmental trajectories of our three populations are in accordance with each other, in terms of both the developmental timings of periods of maturation and stability and in terms of the overall magnitude of any age-related effect, with the intention that this may shed light on the generalisability of current models of perceptual development. To an extent, however, the interpretation of the findings for the UN group may be somewhat complicated by the fact that chronological age is expected to be negatively related to urban exposure in this group. This is because many of the older children will have moved to town later in life (often because secondary education is difficult to access in rural areas, even in areas where there are mobile primary schools) than the younger children, many of whom will have lived there since birth. As there was little variability in levels of urban exposure within each age group, it was not possible to split participants into more urbanised and less urbanised groups of participants (as was the procedure for the urban adults in chapter two).

#### 4.1.3 Gender differences in the development of local-global bias

Although results have not been entirely unequivocal, at least two studies have suggested that in childhood boys are prone to make more global similarity-matches than girls of the same age (Kramer, Ellenberg, Leonard & Share, 1996, for children aged 4-12; Tzuriel & Egozi, 2010, for children aged 6-7. *However*, see Oishi et al., 2015, for findings of no gender differences in the similarity-matching strategies of children aged 4-6). The suggestion of gender differences in local-global processing in childhood - though not yet shown to be fully robust - has been supported by biological explanations consistent with the hypothesis, which have already been discussed in earlier chapters and are briefly reviewed again here.

Specifically, it has been proposed that boys and girls differ in both the rate and extent of hemispheric lateralisation, with boys developing greater overall hemispheric specialisation and at a younger age than girls (Best, 1988; Witelson, 1976). Prenatal testosterone (which is typically higher for boys) has been linked to cerebral lateralisation, both anatomically and functionally (e.g., Geschwind & Galaburda, 1987; Witelson & Nowakowski, 1991; Grimshaw, Bryden & Finegan, 1995; see also Toga & Thompson, 2003, for a review). Thus, it is suggested that exposure to prenatal testosterone may slow down the development of the left hemisphere (associated with local processing) relative to the dominant right, and that the observed gender differences in local-global bias in childhood may relate to this early testosterone-mediated difference in hemispheric rates of maturation (see Kramer et al., 1996; Toga & Thompson, 2003).

At the same time, however, it must be acknowledged that even if there may be a biological component to any observed gender differences in the development of local-global processing, biological influence need not be deterministic and may be amplified or dampened according to experience-dependent factors. A similar argument has been put forward with regards to gender differences in spatial ability (see Newcombe, 2007). Robust gender differences in tasks of spatial ability, present even as early as 3-5 months (Moore & Johnson, 2008; Quinn & Liben, 2008) and proposed to be mediated by gender differences in local-global processing strategies (e.g., Tzuriel & Egozi, 2010), have been shown to be sensitive to a number of environmental (Levine, Vasilyeva, Lourenco, Newcombe & Huttenlocher, 2005; Lippa, Collaera & Peters, 2008) and psychological (Estes & Felker, 2012) factors. Furthermore, appropriate intervention strategies can eliminate these gender differences altogether (e.g., Tzuriel & Egozi, 2010).

Such findings have led to the growing recognition that there is a need to study gender differences in cognitive development within the context of environmental setting and experience (Halpern, 2004; Linn & Petersen, 1985; Levine et al., 2005; Tzuriel & Egozi, 2010). This is particularly important because gender itself plays such a large role in determining one's experiences throughout the lifespan.

Thus, gender and experience are often heavily confounded and furthermore certain environmental factors may have different consequential weightings for males and for females.  In chapter two, for example, it was shown that for urbanised Namibian men but not women, education was highly correlated with *Frequency of global-similarity choices* and indeed even mediated the relationship between urban exposure and global-similarity matching. For women, on the other hand, both *Proportion of time spent in the urban environment* and *Age of initial urbanisation* appeared to be important factors, whereas for men these same variables were not significantly correlated with similarity-matching.

In this chapter, we examine whether patterns of gender differences in the development of local-global bias are consistent across cultures, and for UN and TN children (note that some TN children had attended school) additionally we will observe whether, as per the suggestion from the adult data, boys and girls are sensitive to different kinds of environmental influence.

### 4.1.4 The effects of urbanisation and education on the development of perceptual processing

Most studies into the development of perceptual processing to date have been conducted on Western children, most likely from urban communities, and in societies where education is the norm. As a consequence of this tendency for research to be conducted primarily on Western populations, little is known about how urbanisation and education may affect the development of local-global processing, or indeed other aspects of visual perception. The exception to this is a handful of studies conducted on remote populations.

Perhaps the most extensively documented aspect of the visual perception of remote peoples is their tendency to show considerably less susceptibility to visual illusions which depend on contextual information (e.g., the Ebbinghaus illusion: de Fockert et al., 2007; Caparos et al., 2012; the Müller-Lyer illusion: Rivers, 1905; Segall, Cambell & Herskovits, 1963; Ahluwalia, 1978) as compared to their urbanised and educated counterparts. Not surprisingly then, developmental studies of remote populations too have focused on this aspect of visual processing. Developmental studies have confirmed that, like adults from remote environments, children from remote environments also show a reduced susceptibility to visual illusions which rely on contextual information (e.g., the Ebbinghaus illusion: Bremner et al., 2016; the Müller-Lyer illusion: Stewart, 1973; the Ponzo illusion: Wagner, 1977). These findings are of particular interest to the current study because it has been suggested that cross-cultural variations in visual context effects may be driven (at least in part) by variations in perceptual bias (Bremner et al., 2016. Note, however, that at the individual – rather than group – level, contextual illusions do not typically correlate well with measures of local-global bias).

The individual contributions of urbanisation and education to the development of perceptual processing are particularly difficult to separate because they are often fundamentally confounded. One early study, however, used a fully factorial design to examine the separable effects of urbanisation and schooling on the development of two context-rich versions of the Ponzo illusion in urban and rural, schooled and unschooled Moroccan children from around aged 7 through to adulthood (Wagner, 1977). Rural (for both versions of the illusion) and urban (for one version of the illusion) unschooled children did not show the expected age-related increase in illusion susceptibility that was seen in the schooled children from both environments. In addition, there was also a main effect of urbanisation, both overall and when schooled and unschooled children were examined separately. The findings, then, strongly suggest that both education and urbanisation exert their own effects on the development of contextual processing.

Both urbanisation and education have also been suggested to contribute to developmental differences in sensitivity to contextual illusions between children from the exact same populations which we report on here. In one study susceptibility to the Ebbinghaus illusion was compared across traditional (Himba) and urban Namibian and urban British children (Bremner et al., 2016). Whereas British and urbanised Namibian children began to show susceptibility to the illusion from at least 7-8 years of age, traditional Namibian children did not begin to show the illusion until 9-10 years of age, suggesting that the developmental onset of the maturational processes involved in visual contextual processing are to some extent experience-dependent. Overall, the British children showed considerably greater illusion susceptibility compared to both the urban and traditional Namibians, and urban Namibian children showed greater susceptibility compared to traditional Namibians. Thus, urban exposure has been implicated in contributing to developmental differences in both the overall sensitivities to contextual illusions between the different populations of the current study as well as to the developmental onset of the maturational processes.

At the same time, however, overall extent of time spent in the urban environment (years of urban exposure) did not significantly correlate with illusion strength within the urban Namibian sample (Bremner et al., 2016). In contrast, within this group there was a small but significant correlation between level of education and illusion strength, even after controlling for chronological age and years of urban exposure. Thus, as in the study by Wagner (1977), both urbanisation and education were implicated as causal factors for the cross-cultural differences.

### 4.1.5 Hypotheses, predictions and aims

Here we extend our research into the effects of urbanisation, education and gender on perceptual bias by following the developmental trajectories of three populations. It is predicted that there will be a main effect of group (TN, UN, UB), in line with the findings presented in chapter one. TN children are expected to make fewer global-similarity matches than UN and UB children. It is unclear whether there will be any differences between UN and UB children, although if present these are expected to be in the direction of fewer global-similarity matches for UN children, especially given that susceptibility to contextual illusions is stronger for UB children (Bremner et al, 2016). The finding that susceptibility to contextual illusions started from the same age for UB and UN children in the same study may suggest that the maturational onset for the development of a global bias may also begin at around the same age for UB and UN children; however, it is also possible that developmental onset may be brought forward in UB children due to the stronger intensity of the urban environment and/or the earlier age of starting school.

Based on previous research, at least for UN and UB participants, younger children are expected to make fewer global-similarity choices than older children, and at the youngest age group (aged 4) it is expected that all three groups will present with a local bias. UN and UB participants, are expected to shift to a global bias at around the age of our second age group (aged 5-7), though this process may perhaps be delayed in UN children.

A main effect of gender is expected in the direction of fewer global-similarity choices by girls, although the extent of any gender differences may perhaps differ between groups. It is possible that gender differences in local-global bias during childhood (as well as in adulthood) might be even more prominent in populations that may be less likely to reach ceiling levels of global bias, or may reach those levels later in development, and/or where cultural norms may be more highly genderised. Therefore, it might perhaps be expected that gender differences may be greater in TN and UN children as compared to UB children.

In one study of the developmental trajectory of local-global bias, for 4-12-year-old children, boys made more global similarity-matches than girls at all ages (Kramer et al., 1996), and the gender difference was substantial. Based on this research it is predicted that there is likely to be a gender difference for the three youngest age groups (4, 5-7, 9-11). To our knowledge, no previous research has examined gender differences in adolescents, and so no predictions are made as to whether gender differences will be seen in the eldest group (aged 13-15). Finally, in addition to any age-related effects and based on the findings of chapter two, we will explore the possibility that TN and UN girls' local-global matching may relate more strongly to measures of urbanisation than education, whereas TN and UN boys' local-global matching may relate more strongly to measures of education than urbanisation.

# 4.2 Methodology

## 4.2.1 Participants

Participants were recruited from three populations, Traditional Namibian, Urban Namibian, and Urban British. All British and urban Namibian participants were aged 4-15. All traditional Namibian participants were estimated aged 4-15.

### *4.2.1.1 Traditional Namibian*

Testing took place in a testing tent in traditional villages in the Kunene region of Namibia. All participants were Himba and were monolingual in Otjiherero. Consent was obtained from parents or close relatives (typically the mother), who remained close by during testing. Verbal assent was obtained from the children themselves. Consent was also obtained from the village chief prior to testing. Children were thanked for their time and given small gifts (e.g., biscuits).

33 males with an average age of 8.3, (range = 4-15, SD = 3.97), average years of formal schooling of 0.4 (range 0-4, SD = 0.85). None were literate. Participants had made on

average 0.7 visits to town (range = 0-3, SD =.90). A further three males aged 4, and two males aged 6, were not included in the final data set because their performance on the task did not meet the inclusion criteria (see Stimuli and Procedure section below).

35 females with an average age of 8.8, (range = 16-40, SD = 4.1), average years of formal schooling of .3 (range = 0-2, SD = 0.68). None were literate. Participants had made on average 0.7 visits to town (range = 0-3, SD =.90). A further two females aged 4, two females aged 5, one female age 7 and one female aged 13 were not included in the final data set because their performance on the task did not meet the inclusion criteria.

#### *4.2.1.2 Urban Namibian*

Testing took place in a testing tent in town, and in schools and nurseries. Participants were recruited by word of mouth and opportunistic sampling or through schools and nurseries. Most participants were Himba, but other denominations were also included. Consent was obtained from parents, close relatives, or teachers and a familiar adult remained close by during testing. Verbal assent was obtained from the children themselves. Consent was also obtained from head teachers prior to testing. Children were thanked for their time and given small gifts (e.g., biscuits, pens, etc.). Schools and nurseries were given small gifts to thank them for their co-operation (e.g., stationary).

29 males with an average age of 7.3, (range = 4-15, SD = 3.4), average years of formal schooling of 1.6 (Range 0-9, SD = 2.7). 24% were literate. Participants had been living in town for on average 3.8 years (range = 0.67-9.0, SD = 2.0). Participants had moved to town at an average age of 3.9 (range = 0-14, SD=2.0). A further three males aged 4, one male aged 5, two males aged 6 and one male aged 7 were not included in the final data set because their performance on the task did not meet the inclusion criteria.

48 females with an average age of 9.10, (range = 4-15, SD = 4.2), average years of formal schooling of 3.1 (Range = 0-8, SD = 3.5). 44% were literate. Participants had been living in town for on average 4.3 years (range = 1.0-11.0, SD = 3.1). Participants had moved to town at an average age of 5.6 (range = 0-14, SD=5.4).

#### *4.2.1.3 Urban British*

All participants were living in London at the time of testing, and had been living there for at least 6 months. Participants were recruited through word of mouth, opportunistic sampling in public spaces, and testing at schools, nurseries, and youth centres. Written consent was obtained from parents and/or guardians and verbal assent was obtained from the children themselves. A familiar adult remained nearby during testing. Consent was also obtained from head teachers. Children were thanked for their participation and given small gifts (e.g., stickers, chocolate, etc.).

50 males, average age 8.1 (Range= 4-14, SD=3.9). 48 females, average age 8.1 (Range=4-15, SD= 4.2). A further four males aged 4, one male aged 5, one male aged 6, three females aged 4, and two females aged 5 were not included in the final data set because their performance on the task did not meet the inclusion criteria.

## 4.2.2 Stimuli and procedure

The task consisted of 5 cards, of which one was a practice trial, three were test trials and one was a control trial. The practice trial consisted of three coloured circles of the same size arranged with one on top and two below in a triangular arrangement, at equal distance from each other. The reference figure (the top figure) was a red circle and the two comparison figures were comprised of one blue circle and one pinkish-red circle which resembled the reference figure. The practice was included for the purpose of familiarising participants with the concept of matching by similarity.

Each of the remaining 4 trials consisted of three hierarchical Navon figures (Navon, 1977) arranged with one on top and two below in a triangular arrangement, at equal distance from each other (see figure 1). Figures were made from geometrical shapes (circles, crosses and squares) at both the local and global level of structure. At a viewing distance of 50cm each global structure subtended 4.3° and each local element 0.7°. The centre of each figure was 4.2° form the display centre. Stimuli were presented on A4 card.

The figure at the top of the display was always the reference figure, and the two at the bottom were the comparison figures. Participants indicated which of the two comparison figures "looks most like" the reference figure by pointing with their finger to indicate the figure on either the left or the right side of the card.

Of these 4 experimental trials, there were 3 test trials in which one comparison figure matched the reference figure at the global level of structure but not at the local level, and the other comparison figure matched at the local level but not the global level. The other trial was a control trial in which one comparison figure matched the reference at both the local and global level of structure (it was identical to the reference figure, and therefore was the correct response) and the other comparison figure shared no similarity with the reference figure at either the global or the local level.

Participants who did not get the control trial correct were not included in the study. The control trial always came at the end; the other 3 trials were randomised. Choices were made by pointing with a finger.

## 4.2.3 Analyses

#### 4.2.3.1 Overview of analyses

Results are based on the 3 experimental trials for which there was no identical match between the reference figure and either of the two comparison figures. For each of these trials, one comparison figure matched the reference figure on the local but not the global level of structure, and the other comparison figure matched on the global but not the local level. Participants were required to make 2-AFC responses based on perceived similarity at either the local or the global level of structure. Data from the 1 trial for which there was an identical match to the reference figure are not included in the analyses. One continuous DV, *Frequency of global-similarity choices*, and one categorical DV, *Preferred matching strategy*, were extracted from participants' matching behaviours. *Number of switches* and *Reaction times*, which were analysed in the first empirical chapter, could not be extracted from the card version of the task.

#### 4.2.3.2 Measures

##### *4.2.3.2.1 Continuous measure: Frequency of Global-Similarity choices*

Frequency with which a participant made similarity matches at the global rather than local level of structure over the 3 experimental trials. A *Frequency of global-similarity choice* score of 0 indicates that the participant always made matches at the local level of structure, and a score of 1 indicates that the participant always made matches at the global level of structure. As *Frequency of global-similarity choices* was based on only 3 experimental trials, participants' scores could be only one of four possible outcomes: 0, .33, .67, or 1.

Preliminary skew, kurtosis and normality diagnostics indicated that *Frequency of global-similarity choices* was to some extent non-normally distributed. To address the somewhat unsatisfactory nature of the DV, following Conovan and Iman (1981), a rank transformation procedure was applied for all comparisons involving *Frequency of global-similarity choices*.

##### *4.2.3.2.1 Categorical measure: Preferred matching strategy (local or global)*

Participants were categorised as having a preferred *global* matching strategy if *Frequency of global-similarity choices* was 1 or .67 and a preferred *local* matching strategy if *Frequency of global similarity choices* was 0 or .33.

Had a larger sample been available, it may have been possible to (do as we did in the previous empirical chapter on the Roma and) include a third category of participants who chose a mixed matching strategy, matching sometimes at the local and sometimes at the global level of structure. However, on the whole participants were fairly consistent in their matching strategies, and there were too few participants who used a mixed matching strategy (*Frequency of global-similarity choices* = .33 or .67) to warrant the inclusion of this additional category, and its addition would have led to a destabilising effect on the statistical modelling.

**4.2.3.3 Within-group analyses: The relative contributions of Urbanisation and Education and Age**

The initial stages of analyses aimed to first examine the roles of urbanisation, education and age within-group, separately for UN and TN participants. Within-group analyses were chosen so as to avoid any additional confounds relating to the different group identities. Boys and girls were also treated separately within each group as there were theoretical reasons to suspect that boys and girls may respond differently to environmental drivers of local-global bias, either due to innate biological differences and/or to socially constructed differences between the sexes.

For UN participants, following the protocol laid out in the first empirical chapter, four individual measures of urbanisation were obtained for each UN participant: *Age of initial urbanisation*, *Years since initial urbanisation*, *Cumulative years of urbanisation*, *Proportion of time spent in the urban environment since initial urbanisation*. In addition, *Years of formal education* was also obtained. However, all participants reported to have spent all or very nearly all of their time in the urban environment since their initial exposure, and so there was not enough variation in this last variable to warrant further investigation. Similarly, the lack of any variance in *Proportion of time spent in urban environment* meant that the two variables *Years since initial urbanisation* and *Cumulated years of urbanisation* were extremely highly correlated to the point of redundancy; given this, *Cumulative years of urbanisation* is taken to be synonymous with *Years since initial urbanisation*, and the latter was dropped from analyses.

For UN participants only, within-group, the roles of urbanisation, education and age were initially assessed though simple correlations between *Frequency of global-similarity choices* and each of the 4 IVs, *Age of initial urbanisation*, *Cumulative years of urban exposure (as just redefined)*, *Years of education,* and *Age*.

Based on the simple correlations, IVs which were significantly correlated with *Frequency of similarity-choices* were entered into a regression model to examine their relative contributions. Regressions of the main effects were performed separately for boys and girls, for the aforementioned reason that the two groups may be best conceptualised as separate subpopulations. Where appropriate, possible mediation effects were assessed through hierarchical regression models and confirmed by a Sobel test of mediation.

Potential interactions involving *Gender* were assessed in separate stand-alone regression models including *Gender* with each of the other IVs. This was necessary because regression models are known to be underpowered to detect interaction effects in field studies (McClelland & Judd, 1993, cited in Howell, 2010, p.561), particularly when sample sizes are small.

Similar analyses were then repeated for TN participants. For TN participants, following the protocol laid out in the first empirical chapter, urbanisation was measured by *Number of* *visits to town*, and education as per UN participants, was measured by *Years of education*. As many TN do not know their exact age, *Age* was estimated; in most cases, information was gathered from multiple sources so as to cross-reference the ages of children from the same villages.

For TN participants only, within-group, the roles of urbanisation, education and age were initially assessed though simple correlations between *Frequency of global-similarity choices* and each of the 3 IVs, *Number of visits to town*, *Years of education,* and *Age*.

Based on the simple correlations, IVs which were significantly correlated with *Frequency of similarity-choices* were entered into a regression model to examine their relative contributions. Regressions of the main effects were performed only for boys, as no IVs correlated with *Frequency of global-similarity choices* for the girls' data. Where appropriate, possible mediation effects were assessed through hierarchical regression models and confirmed by a Sobel test of mediation. Potential interactions involving *Gender* were assessed in separate stand-alone regression models with *Gender* and each of the other IVs.

To further assess the role of education in the TN sample, participants were divided into those who had never been to school and those who had received at least some formal education. In the TN sample, whilst very few of the younger children had ever been to school, around 40% of older participants (9-15 year olds) had received some amount of formal education. The overall levels of education for this 40%, however, were generally very low. For this reason, it was thought that education may be better represented as a categorical measure, distinguishing between participants with no formal education and with some formal education. For older children only, in order not to confound age with education, participants were categorised as schooled or unschooled depending on whether they had received any degree of formal education. An ANOVA analysis was used to compare the effects of schooling across the genders. Equivalent analyses for the UN data were not possible because all but two of the school-aged participants (from 7 years and upwards) were already attending school.

#### 4.2.3.4 Between-group analyses

For the cross-group analyses on TN, UN and UB adults presented in the first empirical chapter focused on adults, participants who were considered unrepresentative of the group stereotype (educated TN participants and uneducated UN participants) were removed from analyses before comparing across *Groups*.

For the current TN sample, however, removing the participants with any level of schooling would have created very small sample sizes for the older *Age* groups, and so these participants were retained in the cross-group analyses. Note that although this meant that the TN group was not a homogenous sample, education at least was not confounded with *Gender*, as approximately equal proportions of TN boys and girls had received some level of education. For the current UN sample, almost all children who were of school age (from age

7 years and upwards) were currently attending school, with the exception of only two children (one aged 7 and one aged 10 years) and so for the older age groups the UN group can be considered a good representative of schooled children. It is unclear, however, how representative the youngest age groups are of children who would be expected to go on to further education, as no measure of future intention to go to school was taken.

Had a larger and more diverse sample of participants been available, an ideal analysis would have also included separate educated and uneducated TN samples, as well as an uneducated UN sample.

Children were divided into four separate *Age* groups: 4 (4-year-olds), 6 (5-7-year-olds), 10 (9-11-year-olds) and 14 (13-15-year-olds). A three-way between-subjects ANOVA was performed across *Group* (TN, UN-, UN+, and UB), *Age* (4, 6, 10, 14), and *Gender* for all participants in order to compare the full developmental trajectories of *Frequency of global-similarity choices* across *Group* and *Gender*.

The final analysis was based on a categorical measure of similarity-matching, *Preferred matching strategy*, which was intended to compliment the cross-cultural comparison based on *Frequency of global-similarity choices*. Particularly for groups where averages of *Frequency of global-similarity choices* are intermediate, the mean value may be a poor representative of the group at large. An intermediate value could be accounted for either by the majority of participants adopting a mixed matching strategy, or, by some participants adopting a local matching strategy and others adopting a global matching strategy. In the case of the latter, average *Frequency of global-similarity choices* is likely to offer a poor representation of the majority of participants in the group and a categorical measure may offer additional insight into participants' matching-behaviours.

Binary logistic regression was employed to compare category membership on the DV *Preferred matching strategy* (local versus global) across *Group, Age* and *Gender*. Due to the sample size being relatively small for logistic regression, independent variables and interaction terms were added to the model based on their statistical relevance, so as to conserve power. To the extent that the final model was based on statistical relevance, rather than specific theory, these analyses should be considered as somewhat exploratory rather than entirely confirmatory.

## 4.3 Results

### 4.3.1 Initial assessment of the roles of Age, Urbanisation and Education in UN participants

Two measures of urbanisation and one measure of education were obtained for each UN participant: *Age of initial urbanisation*, *Cumulative years of urban exposure* and *Years of formal education*, and additionally *Age* group was also recorded for each participant. Simple correlations presented in tables 13(a) and 13(b) below show the interrelations of each of these IVs, separately for boys and for girls.

For both boys and girls, *Age of initial urbanisation* was highly correlated with all other variables (*Age*, *Years of education* and *Cumulative years of urban exposure*), and additionally *Age* was highly correlated with *Years of education*. The only difference between the patterns of correlations seen for boys and girls was with regards to *Cumulative years of urban exposure*. For boys, *Cumulative years of urban exposure* was near-significantly correlated with *Age*, and significantly correlated with *Years of education*, whereas for girls the equivalent correlations were non-significant.

Tables 13(a) 13(b) and 13(c): Tables to show the correlations between Age, Years of education, Age of initial urbanisation and Cumulative years of urban exposure for UN boys (a) and girls (b). All participants were aged 4-15 years, and residing in the town of Opuwo, at the time of testing. Table 13(c) shows Fisher's Z scores comparing the correlations between boys and girls. A significant p value indicates a significant difference in correlations.

(a)

| **BOYS** | **Chronological age** | **Years of education** | **Age of initial urbanisation** | **Cumulative years of urban exposure** |
|---|---|---|---|---|
| Chronological age (29) | - | | | |
| Years of education (29) | r=.937 *p*<.001*** | - | | |
| Age of initial urbanisation (23) | r=.922 *p*<.001*** | r=.910 *p*<.001*** | - | |
| Cumulative years of urban exposure (23) | r=-.406 *p*=.055 | r=-.433 *p*=.034** | r=-.726 *p*<.001*** | - |

(b)

| GIRLS | Chronological age | Years of education | Age of initial urbanisation | Cumulative years of urban exposure |
|---|---|---|---|---|
| Chronological age (48) | - | | | |
| Years of education (48) | r=.964 *p*<.001*** | - | | |
| Age of initial urbanisation (44) | r=.819 *p*<.001*** | r=.824 *p*<.001*** | - | |
| Cumulative years of urban exposure (44) | r=-.068 *p*=.662 | r=-.125 *p*=.418 | r=-.627 *p*<.001*** | - |

(c)

| FISHER'S Z TEST | Chronological age | Years of education | Age of initial urbanisation | Cumulative years of urban exposure |
|---|---|---|---|---|
| Chronological age | - | | | |
| Years of education | Z= -1.16 *p*= .123 | - | | |
| Age of initial urbanisation | Z= 1.65 *p*= .051 | Z= 1.31 *p*= .095 | - | |
| Cumulative years of urban exposure | Z= -1.33 *p*= .092 | Z= -1.24 *p*= .108 | Z= 0.67 *p*= .503 | - |

* *p*<.05, ***p*<.01, ****p*<.001

In order to assess the relationship between each of the IVs and *Frequency of global-similarity choices*, simple correlations were performed between *Age of initial urbanisation*, *Accumulated years of urbanisation*, *Years of education*, and *Age*, and the DV, *Frequency of global-similarity choices*. As it was not clear that any relationships between our measures of urbanisation and education and performance on the Navon task should be the same for boys and girls, analyses were conducted for boys and girls separately. Results are shown in table 14 below.

*Age*, *Age of urbanisation* and *Years of education* were all moderately-highly correlated with *Frequency of global-similarity choices*, for both boys and girls, although correlations for the boys' data were somewhat high than those for the girls' data. *Cumulative years of urban exposure* was not correlated with *Frequency of global-similarity choices.* Note that, counter-intuitively, the correlation between *Age of urbanisation* and *Frequency of global-similarity choices* was positive, meaning that participants who came to town later in life were *more* likely to make global-similarity choices. This is likely to relate to the fact that older and more educated children, who made more global-similarity choices, tended to come to town later in life than younger and less educated children (see table 13).

Table 14: Table to show the correlations between Age, Years of education, Age of initial urbanisation and Cumulative years of urban exposure and the DV, Frequency of global-similarity choices, for UN boys and girls. All participants were aged 4-15 years and residing in the town of Opuwo, at the time of testing. Fisher's Z tests compare the correlations for boys and girls; a significant Z score indicates a significant difference between the two correlations.

| | Chronological age | Years of education | Age of initial urbanisation | Cumulative years of urban exposure |
|---|---|---|---|---|
| **Boys** | r=.789<br>*p*<.001***<br>N=29 | r=.778<br>*p* <.001***<br>N=29 | r=.680<br>*p* <.001***<br>N=23 | r=-.125<br>*p* =.569<br>N=23 |
| **Girls** | r=.542<br>*p* <.001***<br>N=48 | r=.554<br>*p* <.001***<br>N=48 | r=.421<br>*p* =.004**<br>N=44 | r=.071<br>*p* =.647<br>N=44 |
| **Fisher's Z test** | Z= 1.87<br>*p*= .031* | Z= 1.69<br>*p*= .046* | Z= 1.39<br>*p*= .082 | Z= -0.72<br>*p*= .472 |

*p*<.05, ***p*<.01, ****p*<.001

### 4.3.2 Assessing the relative contributions of Age, Urbanisation and Education in UN participants

The effects of *Age, Years of education, Age of initial urbanisation and Cumulative years of urban exposure* were examined alongside each other in regression modelling to assess their unique contribution to explaining the variance in *Frequency of global-similarity choices*. Simple correlations showed that *Age*, *Years of education*, and *Age of initial urbanisation* were all significantly correlated with *Frequency of global similarity choices*, but that *Cumulative years of exposure* was not. For this reason, only *Age, Years of education,* and *Age of initial urbanisation* were entered into the model.

As it was not clear that similar effects would be seen for boys and for girls, separate regressions were performed for each gender. *Gender* interactions with the other IVs were then examined in separate stand-alone regression models for each of these IVs in turn.

The overall numbers of participants, as well as the ratio of cases to variables, were relatively small for regression modelling. As such, the following procedures are best thought of as exploratory, and results interpreted with some degree of caution.

#### ***4.3.2.1 Regression modelling***

##### *4.3.2.1.1 Boys' data*

###### *4.3.2.1.1.1 Main effects*

The overall regression model for the main effects of *Ranked Age, Ranked Years of education,* and *Ranked Age of initial urbanisation* was a significant predictor of *Ranked Frequency of global-similarity choices* ($F(3,19)=19.178$; $p<.001$), and accounted for approximately 70% of the variance ($R^2 = .752$; adjusted $R^2 = .713$). The only variable to significantly account for unique variance in the regression model was *Years of education* ($t=3.991$; $p=.001$. Standardised $\beta = 1.122$, 95% CI for B = .009, .113). Neither *Age* ($t=-.0640$; $p=.530$. Standardised $\beta = -.189$, 95% CI interval for B = -.008, .032), nor *Age of initial urbanisation* ($t=-.807$; $p=.429$. Standardised $\beta = -.135$, 95% CI interval for B = -.010, .039), accounted for unique variance in the model.

###### *4.3.2.1.1.2 Mediation*

The regression model with *Ranked Age*, *Ranked Years of education* and *Ranked Age of initial urbanisation* showed that with these three variables entered together only *Years of education* was a significant predictor of *Frequency of global-similarity choices.* This was despite the previous finding (see table 2) that both *Age* and *Age of initial urbanisation* were highly correlated with *Frequency of global-similarity choices* when their relationships were considered in isolation.

The disappearance of the significant relationships between *Age* and *Frequency of global-similarity choices* and between *Age of initial urbanisation* and *Frequency of global-similarity choices* in the presence of *Years of education*, was consistent with a possible mediatory effect of *Years of education*. Two separate mediation analyses were performed, one for the possible mediatory effect of *Years of education* on the relationship between *Age* and *Frequency of global-similarity choices*, and one for the possible mediatory effect of *Years of education* on the relationship between *Age of initial urbanisation* and *Frequency of global-similarity choices*.

4.3.2.1.1.2.1 *Education and Age*

A mediation analyses was performed to examine the possible mediatory effect of *Years of education* on the relationship between *Age* and *Frequency of global-similarity choices*. The initial criteria for a mediatory effect were met by confirming that the pathways between each of the two Ranked IVs and the Ranked DV, and between each of the two ranked IVs themselves, were all significant. Simple correlations confirmed that *Ranked Age* and *Ranked Frequency of global-similarity choices* were significantly correlated (r=.734, $p$<.001) as were *Ranked Years of education* and *Ranked Frequency of global-similarity choices* (r=.799, $p$<.001) and *Ranked Age* and *Ranked Years of education* (r=.914, $p$<.001).

To formally test the mediatory effect, the regression model was rerun as a hierarchical regression with *Ranked Age* entered first and both *Ranked Age* and *Ranked Years of education* entered together in the second stage. Based on these outcomes, the unstandardised regression coefficients of *Age* (the IV, with *Years of education* not present in the model) and *Years of education* (the mediator, with *Age* also present in the model) and their associated standard errors were entered into an online Sobel calculator (www.quantpsy.org). The Sobel test of mediation confirmed the mediatory effect of *Years of education* on *Age* (z=2.45, p=.014).

*4.3.1.1.2.2 Education and Age of initial urbanisation*

A mediation analyses was performed for the mediatory effect of *Years of education* on the relationship between *Age of initial urbanisation* and *Frequency of global-similarity choices*. The initial criteria for a mediatory effect were met by confirming that the pathways between each of the two Ranked IVs and the Ranked DV, and between each of the two ranked IVs themselves, were all significant. Simple correlations confirmed that *Ranked Age of initial urbanisation* and *Ranked Frequency of global-similarity choices* were significantly correlated (r=.505, $p$=.014) as were *Ranked Years of education* and *Ranked Frequency of global-similarity choices* (r=.799, $p$<.001) and *Ranked Age of initial urbanisation* and *Ranked Years of education* (r=.694, $p$<.001). Note that the simple correlation between *Ranked Age of initial urbanisation* and *Ranked Frequency of global-similarity choices* was in the opposite direction to what would normally be expected. A mediation analysis was performed to confirm the assumption that the positive relationship between *Age of initial urbanisation* and *Frequency of global-similarity matches* was related to the fact that more educated children, who made more global-similarity-choices, had come to town later in life.

To formally test the mediatory effect, the regression model was rerun as a hierarchical regression with *Ranked Age of initial urbanisation* entered first and both *Ranked Age of* *initial urbanisation* and *Ranked Years of education* entered together in the second stage. Based on these outcomes, the unstandardised regression coefficients of *Extent of urbanisation* (the IV, with *Years of education* not present in the model) and *Years of education* (the mediator, with *Age of initial urbanisation* also present in the model) and their associated standard errors were entered into an online Sobel calculator (www.quantpsy.org). The Sobel test of mediation confirmed the mediatory effect of *Years of education* on *Age of initial urbanisation* (z=2.50, p=.012).

##### *4.3.2.1.2 Girls' data*

###### *4.3.2.1.2.1 Main effects*

The overall regression model for the main effects of *Ranked Age, Ranked Years of education,* and *Ranked Age of initial urbanisation* was a significant predictor of *Ranked Frequency of global-similarity choices* (F(3,43)=7.052; *p*=.001), and accounted for approximately 30% of the variance ($R^2$ = .346; adjusted $R^2$ = .297). Although the model as a whole was a significant predictor of *Frequency of global-similarity choices*, none of the individual variables significantly accounted for unique variance in the regression model (*Years of education*: *t*=1.164, *p*=.251. Standardised β = .352, 95% CI for B = -.004, .025; *Age: t*=.854, *p*=.398. Standardised β = .287, 95% CI for B =-.025, .015; *Age of initial urbanisation: t*=-.276; *p*=.784. Standardised β = -.052, 95% CI for B = -.002, .042). No mediatory analyses were performed, because no one variable emerged as having more explanatory power than the others.

### 4.3.3 Initial assessment of the roles of Age, Urbanisation and Education in TN participants

One measure of urbanisation, and one measure of education were obtained for each TN participant: *Number of visits to town* and *Years of formal education*. Estimated *Age* was also recorded. Simple correlations presented in tables 15(a) and 15(b) below show the interrelations between each of these IVs, separately for boys and for girls. For both boys and girls, *Age* and *Years of education* were positively correlated. *Number of visits to town* was correlated with *Age* for boys but not girls, and *Years of education* and *Number of visits* were not correlated for either gender.

Tables 15(a), 15(b) and 15 (c): Tables to show the correlations between Age, Years of education, and Number of visits to town for TN boys (a) and girls (b). All participants are estimated to be aged 4-15 years. Table 15(c) shows Fisher's Z scores comparing the correlations between boys and girls. A significant p value indicates a significant difference in correlations.

(a)

| BOYS | Estimated age | Years of education | Number of visits |
|---|---|---|---|
| **Estimated age** | - | - | - |
| **Years of education** | r=.453**<br>*p*=.008<br>N=33 | - | - |
| **Number of visits** | r=.474*<br>*p*=.017<br>N=25 | r=-.003<br>*p*=.989<br>N=25 | - |

(b)

| GIRLS | Estimated age | Years of education | Number of visits |
|---|---|---|---|
| **Estimated age** | - | - | - |
| **Years of education** | r=.493**<br>*p*=.003<br>N=.35 | - | - |
| **Number of visits** | r=.182<br>*p*=.365<br>N=27 | r=-.098<br>*p*=.626<br>N=27 | - |

(c)

| FISHER'S Z TEST | Estimated age | Years of education | Number of visits |
|---|---|---|---|
| **Estimated age** | - | - | - |
| **Years of education** | Z= -0.20<br>*P*= 0.421 | - | - |
| **Number of visits** | Z= 1.21<br>*p*= .131 | Z= 0.32<br>*p*= .375 | - |

* *p*<.05, ***p*<.01, ****p*<.001

In order to assess the relationship between each of the IVs and *Frequency of global-similarity choices*, simple correlations were performed between *Number of visits to town*, *Years of formal education, and Age* and the DV, *Frequency of global-similarity choices (*see table 4). As it was not clear that any relationships between our measures of urbanisation and education and performance on the Navon task should be the same for boys and girls, analyses were carried out for boys and girls separately. Results are shown in table 16 below. *Age* and *Years of education* were both positively correlated with *Frequency of global-similarity matching* for boys but not for girls. *Number of visits* did not correlate with *Frequency of global-similarity choices* for either boys or girls.

Table 16: Table to show the correlations between Age, Years of education, and Number of visits to town and the DV, Frequency of global-similarity choices, for UN boys and girls. All participants estimated to be aged 4-15 years old. *p<.05, **p<.01, ***p<.001

| | Estimated age | Years of education | Number of visits |
|---|---|---|---|
| **Boys** | r=.540***<br>*p*=.001<br>N=33 | r=.631***<br>*p*<.001<br>N=33 | r=.115<br>*p*=.583<br>N=25 |
| **Girls** | r=.163<br>*p*=.348<br>N=.35 | r=.261<br>*p*=.129<br>N=35 | r=.184<br>*p*=.357<br>N=27 |
| **Fisher's Z score** | Z= 1.73<br>*p*= .042* | Z= 1.87<br>*p*= .031* | Z= -0.28<br>*p*= .390 |

### 4.3.4 Assessing the relative contributions of Age and Education in TN participants

For boys, the effects of *Age and Years of education* were examined alongside each other in regression modelling to assess their unique contribution to explaining the variance in *Frequency of global-similarity choices*. Simple correlations had shown that *Age* and *Years of education* were both significantly correlated with *Frequency of global similarity choices*, but that *Number of visits to town* was not (see table 4). For this reason, *Number of visits* was not included in the regression model.

Regression modelling was not performed for the girls' data because none of the simple correlations reached significance.

The overall numbers of participants, as well as the ratio of cases to variables, were relatively small for regression modelling. As such, the following procedures are best thought of as exploratory, and results interpreted with some degree of caution.

#### *4.3.4.1 regression modelling: Boys' data*

*4.3.4.1.1 Main effects*

The overall regression model for the main effects of *Ranked Age and Ranked Years of education* was a significant predictor of *Ranked Frequency of global-similarity choices* ($F(2,30)=11.446$; $p<.001$), and accounted for approximately 40% of the variance ($R^2 = .443$; adjusted $R^2 = .395$). The only variable to significantly account for unique variance in the regression model was *Years of education* ($t=3.652$; $p=.001$. Standardised β = .582, 95% CI for B = .062, .363). *Age* did not account for any unique variance in the model ($t=-.0821$; $p=.418$. Standardised β = .131, 95% CI for B = -.006, .017).

*4.3.4.1.2 Mediation*

The regression model with *Ranked Age* and *Ranked Years of education* showed that with both variables entered together only *Years of education* was a significant predictor of *Frequency of global-similarity choices.* This was despite the previous finding (see table 4) that *Age* was highly correlated with *Frequency of global-similarity choices* when the relationship was considered in isolation.

The disappearance of the significant relationship between *Age* and *Frequency of global-similarity choices* in the presence of *Years of education* was consistent with a possible mediatory effect of *Years of education*. A mediation analyses was performed, for the mediatory effect of *Years of education* on the relationship between *Age* and *Frequency of global-similarity choices*. The initial criteria for a mediatory effect were met by confirming that the pathways between each of the two Ranked IVs and the Ranked DV, and between each of the two ranked IVs themselves, were all significant. Simple correlations confirmed that *Ranked Age* and *Ranked Frequency of global-similarity choices* were significantly correlated (r=.425, *p*=.014) as were *Ranked Years of education* and *Ranked Frequency of global-similarity choices* (r=.648, *p*<.001) and *Ranked Age* and *Ranked Years of education* (r=.506, *p*=.003).

To formally test the mediatory effect, the regression model was rerun as a hierarchical regression with *Ranked Age* entered first and both *Ranked Age* and *Ranked Years of education* entered together in the second stage. Based on these outcomes, the unstandardised regression coefficients for *Age* (the IV, with *Years of education* not present in the model) and *Years of education* (the mediator, with *Age* also present in the model) and their associated standard errors were entered into an online Sobel calculator (www.quantpsy.org). The Sobel test of mediation confirmed the mediatory effect of *Years of education* on *Age* (z=2.187, p=.029).

#### ***4.3.4.2 Examining the effects of education across Gender in TN***

As already explained, in the TN sample, whilst very few of the younger children had ever been to school, around 40% of older participants (9-15 year olds) had received some amount of formal education. The overall levels of education for this 40%, however, were generally very low. For this reason, it was thought that education may be better represented as a categorical measure, distinguishing between participants with no formal education and with some formal education. For older children only, so as not to confound age with education, participants were categorised as schooled or unschooled depending on whether they had received any degree of formal education. Table 17 shows mean *Age*, *Years of education*, and *Number of visits to town,* for Schooled and Unschooled boys and girls. All groups were well matched in terms of *Age* and *Number of visits to town*, and schooled boys and schooled girls were well matched in terms of *Years of education*.

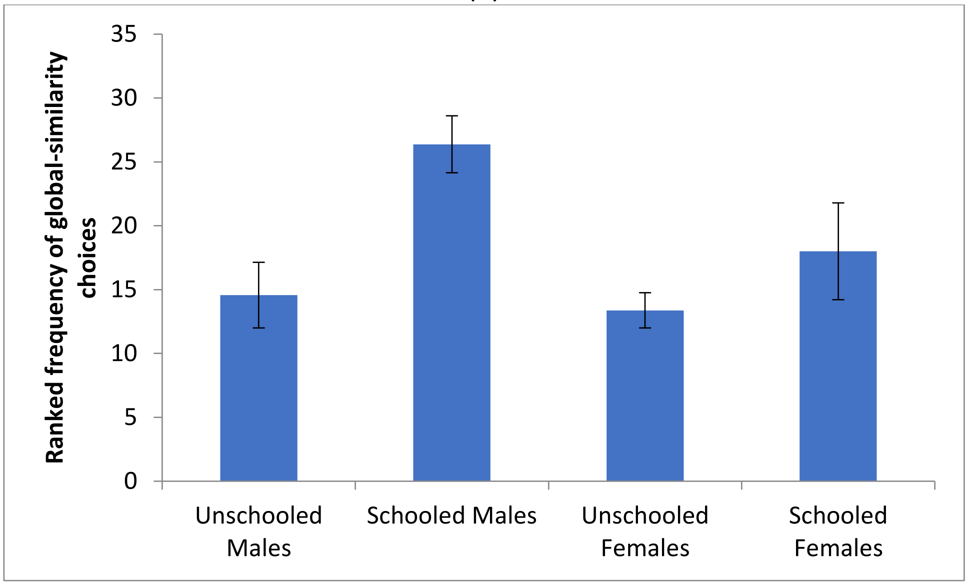
Table 17: Table to show the range of values, means standard deviations, for Age, Years of education and Number of visits to town for schooled and unschooled TN boys and girls. All participants are estimated to be aged 9-15 years.

| | Estimated age | Years of education | Number of visits |
|---|---|---|---|
| **Unschooled Boys (N=7)** | Range = 9-15<br>Mean = 12.3<br>SD = 2.36 | - | Range = 0-3<br>Mean = 1.00<br>SD = 1.095 |
| **Schooled Boys (N=8)** | Range = 9-15<br>Mean = 12.0<br>SD = 2.27 | Range = 0.25-4<br>Mean = 1.4<br>SD = 1.24 | Range = 0-3<br>Mean = 1.13<br>SD = 0.991 |
| **Unschooled Girls (N=13)** | Range = 9-15<br>Mean = 11.3<br>SD = 2.50 | - | Range = 0-2<br>Mean = 1.00<br>SD = 0.943 |
| **Schooled Girls (N=6)** | Range = 11-15<br>Mean = 13.7<br>SD = 1.51 | Range = 1-2<br>Mean = 1.7<br>SD = 0.52 | Range = 0-2<br>Mean = 0.67<br>SD = 0.816 |

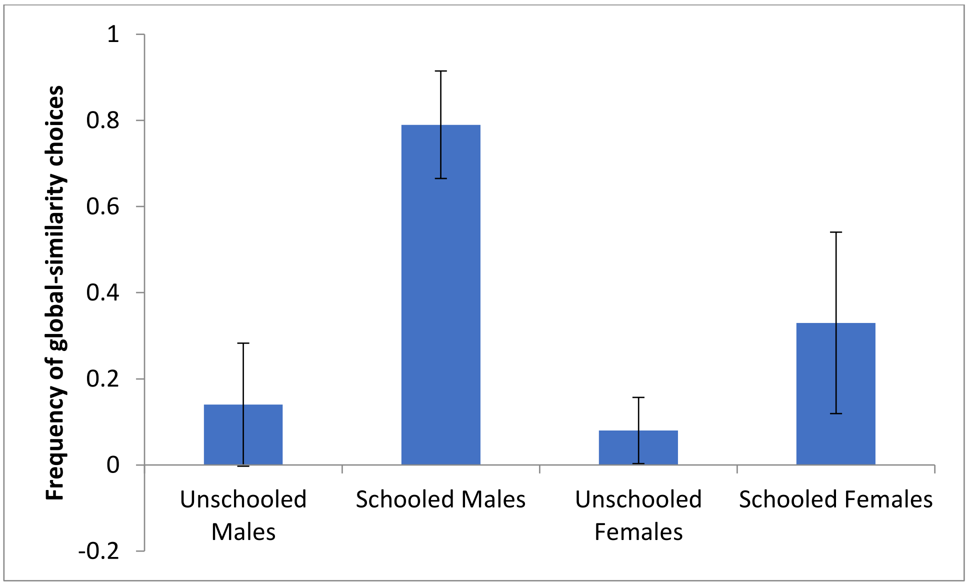
Mean *Ranked Frequency of global-similarity choices* were calculated for schooled and unschooled boys and girls and are shown in figure 12(a) below. Figure 12(b) additionally shows the raw values for ease of interpretation. A two-way ANOVA was conducted for the effects of *Schooling* and *Gender* on *Ranked Frequency of global-similarity choices.* There was a highly significant main effect of *Schooling* (F(1,30)=12.276, *p*<.001, $\eta^2$ =.064), and a main effect of *Gender* (F(1,30)=4.163, *p*=.050), but no *Schooling by Gender* interaction (F(1,30)=2.353, *p*=.136).

Although the *Schooling by Gender* interaction was not significant, because the results of the simple correlations showed the effect of education to be evident for boys only, t-tests were performed to assess the main effect of *Schooling* separately in boys and in girls. The effect of *Schooling* was only significant for boys (*t*(13)=-3.484, *p*=.004, *d* = .045) and not for girls, (*t*(17)= -1.143, *p*=.294, Equal variances not assumed) applying an alpha correction of .05/2=.025. The effect of *Gender* did not remain significant when examined separately for schooled (*t*(12)=2.014, *p*=.067) and unschooled participants (*t*(18)=0.447, *p*=.660), applying an alpha correction of .05/2=.025, although tended towards significance for the schooled group when compared at an uncorrected alpha level of .05.

(a)




(b)




Figures 12(a) and 12(b). Graphs to show mean ranked (a) and unranked (b) Frequency of global-similarity choices for schooled and unschooled TN boys and girls. All participants are estimated to be aged 9-15 years. Error bars represent +/- 1 SEM.

### 4.3.5 Cross-cultural comparisons across Age and Gender

For the cross-group analyses on adults presented in the first empirical chapter, participants who were considered unrepresentative of the group stereotype (educated TN participants and uneducated UN participants) were removed from analyses before comparing across *Groups*. For the current TN sample, however, removing the participants with schooling would have created very small sample sizes for the older age groups, and so these participants were retained in the cross-group analyses. For the current UN sample, almost all children who were of school age (from aged 7 years upwards) were currently attending school, with the exception of only two children (one aged 7 and one aged 10 years) and so for the older age groups the UN group can be considered a good representative of schooled children. It is unclear, however, how representative the youngest age groups are of children who would be expected to go on to further education, and it is possible there may be a more diverse sample at these age groups. Removing the schooled TN and unschooled older UN children would have had very little impact on the results presented below. Instances where the exclusion of these participants would have had significant bearings on the results are clearly signalled and discussed in the summary section below.

Two cross-group analyses were performed, an ANOVA for the effects of *Group, Age* and *Gender* on *Frequency of global-similarity choices*, and binary logistic regression for the categorical measure of *Preferred matching strategy*, using the same variables.

#### *4.3.5.1 Continuous measure Frequency of global-similarity choices*

Mean *Ranked Frequency of global-similarity choices* were calculated for TN, UN and UB boys and girls at *Age* 4, 6 (5-7-years old), 10 (9-11-years-old) and 14 (13-15-years old) and are shown in figure 13(a) below. Figure 13(b) additionally shows the raw values for ease of interpretation. A three-way, between-subjects ANOVA was conducted for *Group*, *Age,* and *Gender*. The main effects of *Group* ($F(2,219)=49.602$, $p<.001$, $\eta^2 = .229$ ) and *Age* ($F(3,219)=14.799$, $p<.001$, $\eta^2 = .160$) were highly significant; however, there was no main effect of *Gender* ($F(1,219)=1.223$, $p=.270$). In addition to the main effects of *Group* and *Age*, there was a highly significant *Group* by *Age* interaction ($F(6,219)=5.033$, $p<.001$, $\eta^2 = .118$), and finally, there was also a significant *Gender* by *Age* interaction ($F(3,219)=3.863$, $p=.010$, $\eta^2 = .034$ ). Neither the *Group* by *Gender* ($F(2,219)=0.972$, $p=.380$), nor the three-way interaction ($F(6,219)=0.103$, $p=.996$), were significant.

##### *4.3.5.1.1 Examining the main effect of Group*

Bonferroni corrected post-hoc analyses for the main effect of *Group* showed that the effect of *Group* was highly significant at all levels: TN made fewer global-similarity choices than both UN ($p=.001$ 95% CI of the mean difference = 0.084, 1.352) and UB ($p<.001$, 95% CI of the mean difference = -0.388, -0.145), and UN made fewer global-similarity choices than UB ($p<.001$, 95% CI of the mean difference =-0.613, -0.357).

##### *4.3.5.1.2 Examining the main effect of Age*

Bonferroni corrected, post-hoc analyses for the main effect of *Ag*e showed that the effect of *Age* was not significant at all levels. Participants in *Age* groups 4 and 6 did not differ in their similarity matching ($p=1.000$). Participants in *Age* group 4 made significantly fewer global-similarity choices compared to participants in *Age* group 10 ($p=.002$, 95% CI of the mean difference = -4.575, -0.050) and *Age* group 14 ($p$<.001, 95% CI of the mean difference = -0.531, -0.135), and participants in *Age* group 6 also made significantly fewer global-similarity choices than participants in *Age* group 10 ($p$=.002, 95% CI of the mean difference = -0.450, -0.058) and *Age* group 14 ($p$<.001, 95% CI of the mean difference = -0.525, -0.144). Participants in *Age* groups 10 and 14 did not differ in their similarity matching (p = 1.000).

#### *4.3.5.1.3 Examining the Group by Age interaction*

Follow up *t*-tests and ANOVAs were conducted to investigate the significant *Group* by *Age* interaction. Bonferroni corrected alpha adjustments were made to compensate for multiple comparisons. Adopting a conservative alpha of .05/3=.017, the effect of *Age* was only significant for the UN participants ($p$<.001, $\eta^2$ = .057); the effect was only significant at an uncorrected alpha of .05 for both TN ($p$=.018) and UB ($p$=.050) participants. The effect of *Group* remained highly significant at all levels of *Age* (for *Age* groups 4, 6, and 10, $p$<.001; for *Age* group 14, $p$=.002), even adopting a conservative alpha of .05/4=.013.

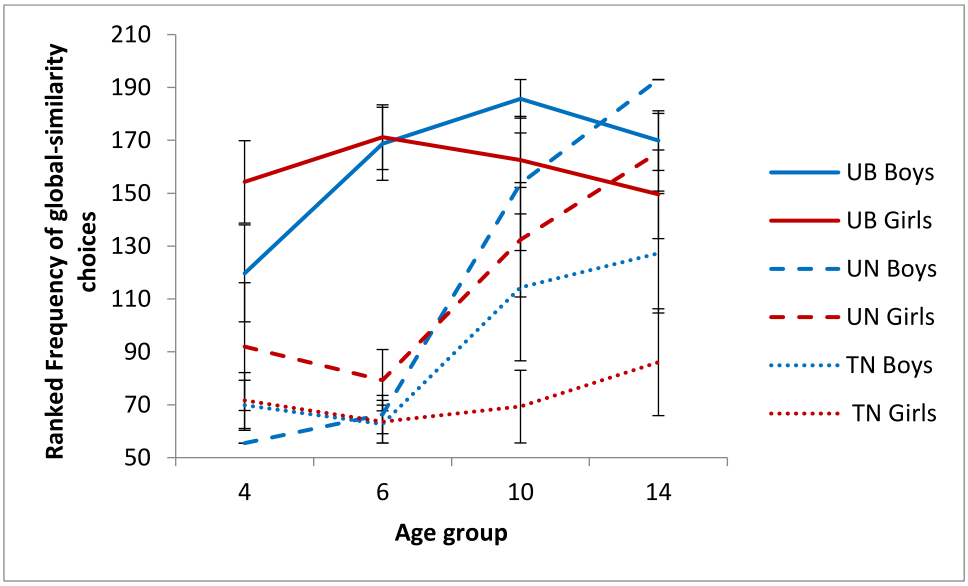
Comparisons for each level of *Group* at each level of *Age* were conducted at a corrected alpha of .05/12=.004. At *Age* group 4, TN and UN did not differ in their similarity matching ($p$=.901), whereas TN participants made fewer global-similarity choices than UB participants ($p$=.001) and UN participants also made fewer global-similarity choices than UB participants ($p$<.001). At *Age* group 6, TN and UN did not differ in their similarity matching ($p$=.240; equal variances not assumed), whereas TN participants made fewer global-similarity choices than UB participants ($p$<.001) and UN participants also made fewer global-similarity choices than UB participants ($p$<.001). At *Age* group 10, TN did not make significantly fewer global-similarity choices than UN when compared at a conservative alpha of .004, and this difference was significant only at an uncorrected alpha of .05 ($p$=.020). TN participants, however, did make fewer global-similarity choices than UB participants ($p$<.001) whereas UN participants did not make significantly fewer global-similarity choices than UB participants ($p$=.073; equal variances not assumed), although this difference tended towards significance if compared at an uncorrected alpha of .05. At *Age* group 14, TN participants made fewer global-similarity choices than UN participants ($p$=.003; equal variances not assumed), and TN participants also made near-significantly fewer global-similarity choices than UB participants at a conservative alpha of .004 ($p$=.005; equal variances not assumed), whereas UN participants and UB participants did not differ in their similarity matching ($p$=.561).

#### *4.3.5.1.4 Examining the Gender by Age interaction*

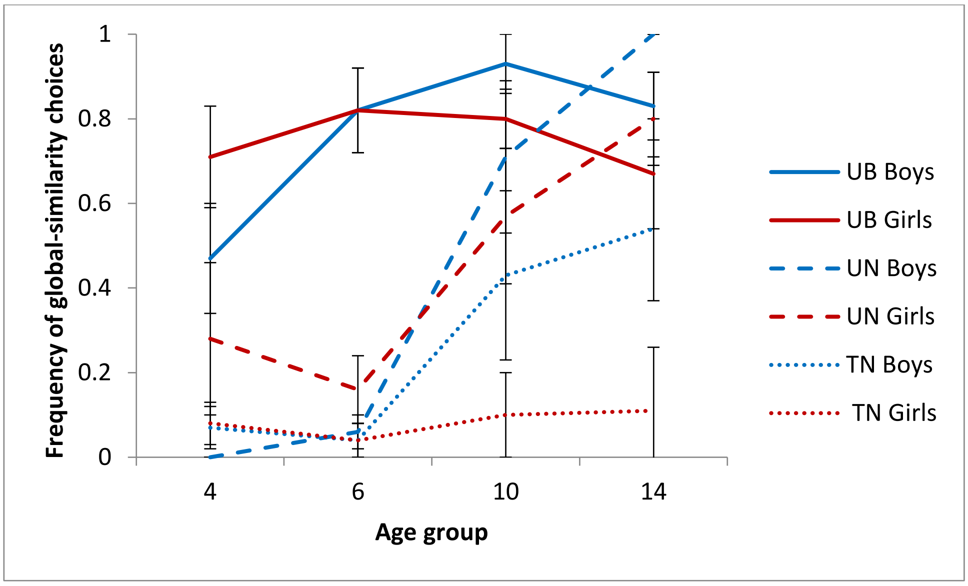
Follow up *t*-tests and ANOVAs were conducted to investigate the significant *Gender* by *Age* interaction. Bonferroni alpha adjustments were made to compensate for multiple comparisons. Adopting a conservative alpha of .05/2=.025, the effect of *Age* was only significant for male participants (p<.001, $\eta^2$ = .276), and was not significant even at an uncorrected alpha of .05 for female participants (p=.144). The effect of *Gender* was not significant at any level of *Age* at a conservative alpha of .05/4=.013, although at an uncorrected alpha of .05 it was significant at *Age* group 10 (at *Age* group 4, *p*=.098; *Age* group 6, *p*= .638; at *Age* group 10, *p*=.048; and at *Age* group 14, *p*=.231).

The *Age* by *Gender* interaction was further examined by comparing the effect of *Gender* for participants of the combined *Age* groups 4 and 6 and for the combined *Age* groups 10 and 14. The rationale for combining these *Age* groups was based on the Post Hoc analyses on the main effect of *Age* which had indicated that participants in *Age* groups 4 and 6 did not differ in their similarity matching, and participants in *Age* groups 10 and 14 also did not differ in their similarity matching. For the combined *Age* groups of 4 and 6, boys and girls did not differ in their similarity choices (p=.139) although boys made numerically *fewer* global-similarity choices. For the combined *Age* groups of 10 and 14, boys made significantly more global-similarity choices, adopting a conservative alpha of .05/2=.025 (p=.023; equal variances not assumed, d = .333, CI = .002, .261).

(a)



(b)




Figures 13(a) and 13(b). Graphs to show mean ranked (a) and unranked (b) Frequency of global-similarity choices for TN, UN, and UB boys and girls for Age groups 4, 6, 10, and 14. Age group 4 consists of 4-year-olds, Age group 6 consists of 5-7-year-olds, Age group 10 consists of 9-11-year-olds, and Age group 14 consists of 13-15-year-olds. TN ages are based on estimates. Error bars represent +/- 1 SEM.

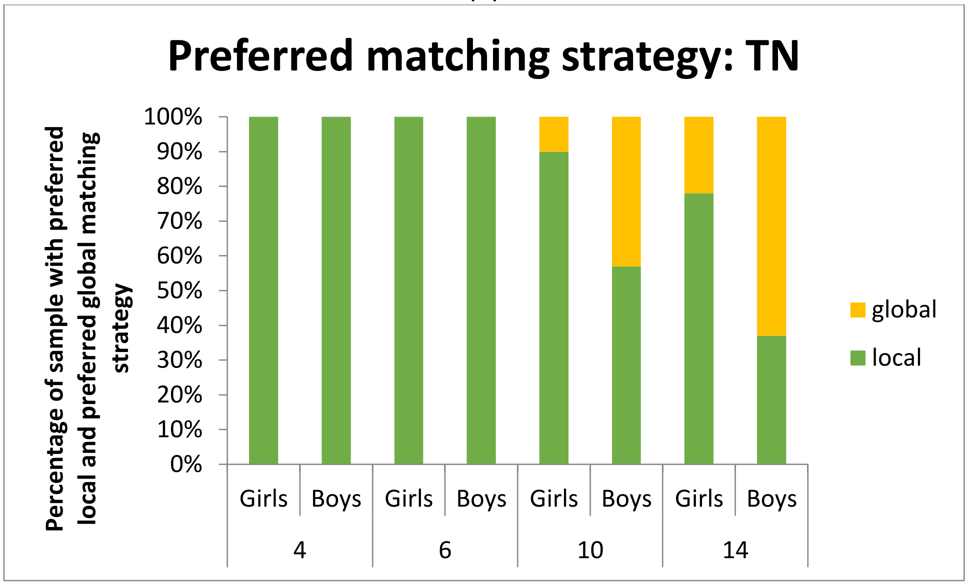
#### *4.3.5.2 Categorical measure: Preferred matching strategy (local or global)*

ANOVA analysis showed that mean *Frequency of global-similarity choices* varied significantly across *Group* (TN, UN, and UB) and *Age* (groups 4, 6, 10, and 14 years) and also according to *Group* by *Age,* and *Gender* by *Age,* interactions (see section above). However, it is unclear from these average scores how individual participants in each subpopulation responded to the Navon task. For example, a small difference in *Frequency of global-similarity choices* across groups could result either from all or most participants in one group making global-similarity choices slightly more often than members of the other group, or alternatively could result from a few participants making many more global-similarity choices.

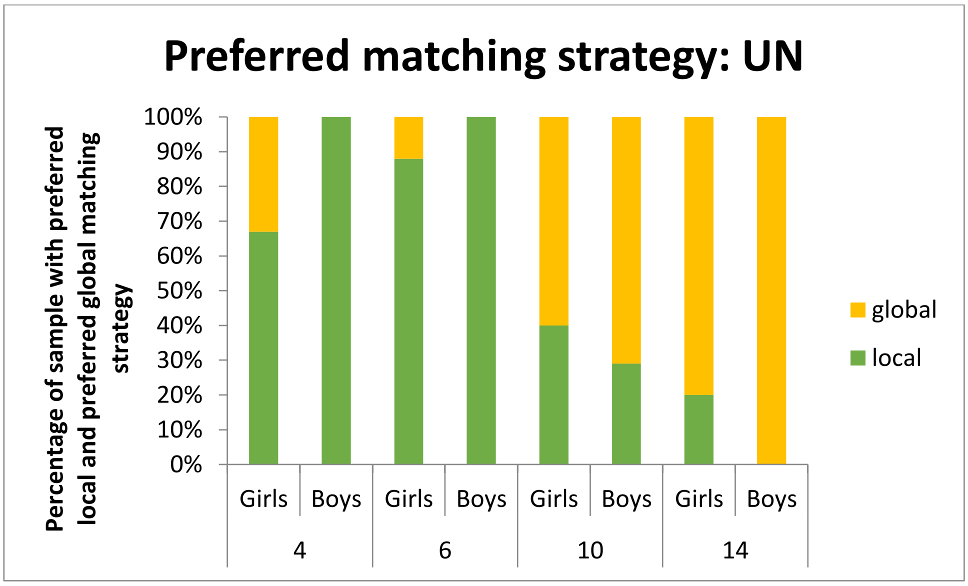
In order to differentiate between these possibilities, a categorical analysis was performed. Participants were classified as preferring either a local (*Frequency of global-similarity choices* <.5) or global (*Frequency of global-similarity choices* > .5) matching strategy. Participants were also reclassified as Older participants or Younger participants based on *Age*: participants in *Age* groups 4 and 6 were classified as Younger participants and participants in *Age* groups 10 and 14 were classified as Older participants. This reclassification was necessary because including all four *Age* groups would have meant that some cells would have had too few cases and caused instability in the analysis.

Figures 14 (a), 14 (b) and 14(c) below show the proportion of participants at each level of *Age* (before classification into Older and Younger participants) and *Gender* preferring local or global matching strategies, for TN (a), UN (b), and UB (c) participants, respectively.

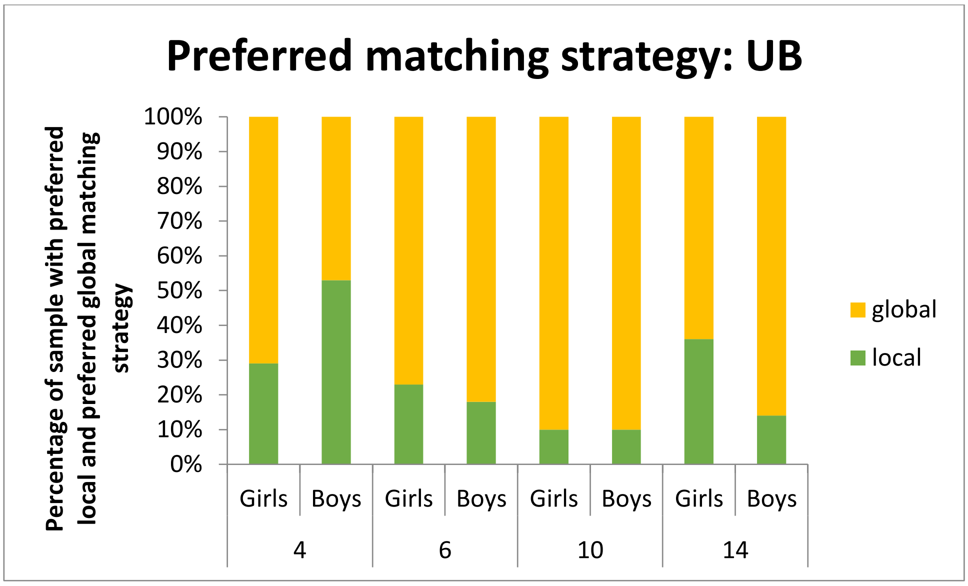
(a)




(b)



(c)




Figures 14(a), 14(b), and 14(c). Graphs to show percentage of each sample of TN (a) UN (b) and UB (c) boys and girls with preferred local and preferred global matching strategies for *Age* groups 4, 6, 10, and 14 years. Preferred local and preferred global matching strategy percentages add cumulatively to 100 for each subpopulation.

Binary logistic regression was used to test whether the likelihood of a participant preferring a specific matching strategy (local or global) was dependent on *Group* (TN, UN, and UB), *Age* (Younger or Older), and *Gender*.

A preliminary hierarchical logistic regression was run to determine which variables should be included in the final model. In the first stage of the model, only the main effects of *Group, Age level* and *Gender* were entered into the model. In the second stage, all two-way interactions were included, and in the third stage the three-way interaction was included.

The three-way interaction and the *Group* by *Gender* interaction did not improve the model and were not retained. The *Group* by *Ag* interaction did significantly improve the model; however, its inclusion created unreasonably large parameter estimates for one of the comparisons and so it was also not retained in the final model. *Gender* did not significantly contribute to the model; however, it was retained because the *Gender* by *Age* interaction was significant, and it is generally not advised to include interactions in the model without their main effects (e.g., Steinberg and Colla, 1991, cited in Tabachnick and Fidell, 2007, P.469). The final model therefore consisted of *Group*, *Age*, *Gender,* and the *Gender* by *Age* interaction.

The final model was overall a significant predictor of *Preferred matching strategy* ($\chi^2(5)=110.607$, $p<.001$), with a 79.8% overall classification success rate (correct classification for 86.8% of the participants with a preferred local matching strategy, and 73.6% of the participants with a preferred global-matching strategy).

Table 18 shows the coefficients for the final model when, for *Group*, UB were chosen as the reference category, for *Gender*, boys were chosen as the reference category, and for *Age*, Older children were chosen as the reference category, and when the model predicted a preferred *global* matching strategy.

The main effects of *Group* (Wald statistic (2) = 50.715, $p$<.001) and *Age* (Wald statistic (1) = 29.222, $p$<.001) were significant contributors to the model. The odds of a UB participant presenting with a global preferred matching strategy were approximately 40 times higher than those of a TN participant, and approximately 7 times higher than those of a UN participant. The odds of an Older participant presenting with a global preferred matching strategy were approximately 25 times higher than those of a Younger participant.

Note that whilst the main effect of Gender was neither significant nor near-significant when only the main effects were included in the model, when the *Age* by *Gender* interaction was included in the model, the main effect of *Gender* became near-significant (Wald statistic (1) = 3.767, $p$=.052), in the direction of the odds for boys presenting with a Preferred global matching strategy tending to be higher than those for girls. However, although the main effect of *Gender* was near significant in the model, confidence intervals on the odds ratio and bootstrapped confidence intervals on the log odds (*b*) demonstrate that this finding is not robust (confidence intervals for the odds ratio cross 1, and confidence intervals for the log odds cross 0).

The *Gender* by *Age level* interaction was a significant contributor to the model (Wald statistic (2) = 5.997, $p$=.014); however, the direction of the effect was *opposite* to that which was expected. Once all other factors in the model had been taken into account, the odds of an Older participant presenting with a global bias compared to a Younger participant were .183 times lower for boys than for girls. This finding is counterintuitive because it suggests that being older compared to being younger means that you are more likely to present with a global bias, particularly if you are a girl, however this is inconsistent with the ANOVA findings which suggest that the *Age* effect on *Frequency of global-similarity choices* is stronger for boys. The surprising direction of the *Gender* by *Age* interaction is likely to be accounted for by the fact that *Gender* in the final model is accounting for a greater amount of variance than it would be in the absence of the interaction. In this light, the meaningfulness of the *Gender* by *Age* interaction presented here is perhaps best not afforded too much significance.

Table 18. Table to show coefficients of the model predicting whether or not participants used a global matching strategy. TN and UN participants are compared to UB participants. Younger children are compared to Older children. Girls are compared to boys. [95% BCa bootstrap confidence intervals based on 1000 samples]

| | | Wald statistic | b | | 95% CI for odds ratio | |
|---|---|---|---|---|---|---|
| **Included** | | | | Lower | Odds | Upper |
| **Constant** | | 34.656 (df=1) *P*<.001 | -3.226*** | | | |
| **Group** | | 50.715 (df = 2) *p*<.001 | | | | |
| | TN vs. UB | 48.280 (df=1) *p*<.001 | 3.652*** [2.781, 5.368] | 13.497 | 37.523 | 104.318 |
| | UN vs. UB | 22.441 (df=1) *P*<.001 | 1.904*** [1.154, 2.926] | 3.053 | 6.712 | 14.754 |
| **Age** | Younger vs. Older | 29.222 (df=1) *p*<.001 | 3.218*** [2.035, 5.071] | 7.778 | 24.980 | 80.228 |
| **Gender** | Girls vs. Boys | 3.767 (df=1) *p*=.052 | 1.019 [-0.168, 2.394] | 0.990 | 2.770 | 7.752 |
| **Age X Gender** | Younger vs. Older X Girls vs. Boys | 5.997 (df=1) *p*=.014 | -1.696* [-3.373, -0.335] | .047 | .183 | .713 |

Note: $R^2$= .366 (Cox & Snell) .488 (Nagelkerke). Model $\chi^2(5)$ = 110.607. * *p*<.05, ***p*<.01, ****p*<.001

# 4.4 Discussion

## 4.4.1 Discussion of results

### 4.4.1.1 Summary of the roles of Age, Urbanisation and Education for UN participants

*Years of education, Age,* and *Age of initial urbanisation* were all significantly correlated with *Frequency of global-similarity choices* (albeit with the correlation with *Age of initial urban exposure* in the opposite direction to what would be expected. Note that this is because older children tended to have become urbanised later in life), both for boys and for girls. However, all three variables were also highly correlated with each other.

When their effects were assessed alongside each other in the regression modelling, for boys, *Years of education* emerged as the only variable to explain any of the unique variance in *Frequency of global-similarity choices*. Mediation analyses showed that the full extent of any effect of *Age* could be accounted for by *Years of education*. In other words, once *Years of education* had been accounted for, *Age* was not a significant predictor of *Frequency of global-similarity choices.* Similarly, mediation analyses also showed that the counterintuitive positive relationship between *Age of initial urbanisation* and *Frequency of global-similarity choices* was fully accounted for by the fact that more educated children had come to town later in life.

In contrast to the boys' data, when the effects of *Years of education, Age,* and *Age of initial urbanisation* were assessed alongside each other in the regression modelling for girls, no one variable was able to explain any unique variance in *Frequency of global-similarity choices.* The girls' model also accounted for only around 30% of the variance, which, although still a significant amount, was substantially less than was explained by the boy's model which accounted for a full 70% of the variance.

Taken together these findings suggest that education may be a considerable explanatory factor for the matching behaviours of UN boys, but far less so for the matching behaviours of UN girls. This is broadly consistent with the findings from the adult UN data presented in the first empirical chapter.

Note also that for UN adults, *Extent of urbanisation* and *Years of Education* were highly correlated with each other for men, but not at all for women (see chapter two). This mirrors the finding presented here that *Cumulative years of urban exposure* was correlated with *Years of education* for boys but not girls (see table 1). This may suggest that, even in childhood, males and females may become urbanised under different circumstances and have different relationships with the urban environment, and may also suggest that education could serve different functions for boys and for girls. The factors which govern the extent of urbanisation and education a child will be subject to do not appear to be equivalent for boys and for girls.

#### 4.4.1.2 Summary of the roles of Age, Urbanisation and Education for TN participants

*Frequency of global-similarity choices* was correlated with both age and education for TN boys but not girls. Regression modelling for the boys' data showed that the effect of *Age* was fully mediated by the effect of *Years of education*; once *Years of education* had been taken into account, *Age* did not account for any unique variance in *Frequency of global-similarity choices*.

The effect of education was further confirmed by ANOVA analysis comparing schooled and unschooled participants. For this comparison, only older children were included in the analyses, in order to disconfound age and education. Schooled children made more global-similarity choices than unschooled children and boys made more global similarity choices than girls. Although the interaction was not significant, evidence from the follow up *t*-tests, in conjunction with the correlation findings across the whole age range, suggest that TN boys and girls are not equally affected by education.

Overall, whilst there was fairly clear evidence that education increases *Frequency of global-similarity* for TN boys, there was no evidence for the same effect on girls. These findings are consistent with the findings from the UN children, which also suggest that UN boys are disproportionately affected by education as compared to girls.

Also in accordance with the UN findings, there was some suggestion in the data that the factors which govern how much urban exposure a child will receive may not be equivalent for boys and girls. This was suggested by the fact that *Age* and *Number of visits to town* were significantly correlated for boys but not for girls.

#### 4.4.1.3 Summary of Cross-cultural comparisons across Age and Gender

Cross-cultural comparisons showed that TN, UN and UB groups were each distinguishable from each other. Across *Age* and *Gender*, TN participants made fewer global similarity choices than both UN and UB participants and were also the least likely to present with a preferred global matching strategy. UB participants on the other hand made more global similarity choices than both TN and UN participants and were the most likely to present with a global *Preferred matching strategy*.

*Group* was an important distinguishing factor at all levels of *Age*; however, the relationships between TN, UN and UB participants' matching behaviours was not consistent across Age. At the younger *Age* groups (4 and 6 years), UN participants resembled TN participants in their *Frequency of global-similarity choices* and were distinguishable from UB, but at the oldest *Age* group (14 years) resembled UB and were distinguishable from TN. At *Age* group 10 years, UN participants were neither fully distinguishable from TN nor UB participants, though by this age already more closely resembled UB.

Not surprisingly, the effect of *Age* was most clearly evident for the UN group, as they were the only group to change from an overall local *Preferred matching strategy* for the younger children to an overall global *Preferred matching strategy* for the older children. At an adjusted alpha to allow for multiple comparisons, the effect of *Age* for TN and UB participants did not reach full significance, and was only significant for the UN group. Note that had the schooled TN participants been excluded from the analysis the effect of *Age* for TN participants would not have been significant even at the uncorrected alpha value.

Contrary to the predictions based on studies in Western children, no overall effect of *Gender* was observed, and indeed at the younger ages (4 and 6 years) girls made more global-similarity choices than boys, albeit non-significantly so. When only the older children (10 and 14 years) were compared, however, boys made significantly more global-similarity choices than girls. The overall effect of Age, across TN, UN and UB, was significant only for the boys and not the girls. This may suggest that the *Age* by *Gender* interaction may be accounted for primarily by boys overall being more impacted by drivers of global bias than girls. Note that had the schooled TN participants been excluded from the analysis the *Age* by *Gender* interaction would only have tended towards statistical significance, further supporting the claim that gender differences in matching behaviours are strongly dependent on environmental factors.

## 4.4.2 Chapter discussion

By following the trajectories of three separate populations we have seen that the developmental processes of local-global bias do not follow a set developmental course, as indicated by the significant *Group* by *Age* interaction. This is most clearly demonstrated in the comparison between the trajectories of UN and UB children. Although both groups ultimately develop a global bias, the behavioural measure of the transition from local to global bias is not expressed until later in childhood for the UN participants as compared to UB participants.

At age 4, British children already demonstrated a preference for global matching (*Frequency of global-similarity choices >.5*), and by age 5-7 this preference was firmly established (i.e. children rarely chose the local similarity-match). For the urbanised Namibian group, however, even at age 5-7 children still showed a firm preference for the local similarity match and it was not until age 9-11 that a global bias became established. Thus, even though the two groups can resemble each other later in development, they are clearly distinguished from each other earlier in life.

The Group by Age interaction appears to reflect both group-dependent differences in the *magnitude* of the age-related effects as well as group-dependent differences in the developmental *timings* of the age-related effects. For example, the size of the effect of *Age* was greatest for UN and indeed for TN and UB was only *near*-significant and additionally, there were differences in the age at which the greatest developmental effects were seen for each group. Whereas for TN and UN the greatest age-related change was seen between the 5-7 and 9-11-year-old groups, for the British this occurred between the 4 and 5-7-year-old groups. This latter observation shows that the timings of the maturational processes by which a global bias emerges (as measured by the current paradigm) clearly do not adhere to the pattern predicted by a strictly biological account.

The fact that UN and UB children differed in the age at which the greatest age-related changes were seen (as well as the age at which a global bias became established) was somewhat unexpected given the previous finding that UN and UB children began to show susceptibility to the Ebbinghaus illusion at the same age (Bremner at al., 2016). It is notable, however, that for both groups the age at which the greatest age-related changes were observed directly followed the age at which children typically start school (aged 4 in the UK and aged 7 in Namibia), and this timing may well not be coincidental given the important influence that education has been shown to exert, at least for boys.

The finding that already by age 4 British children most often made global-similarity matches was surprising given that previous studies have reported a developmental switch to occur between 5-7 years of age (e.g., Poirel et al., 2008) This earlier than expected age of developing a global bias may simply relate to the particular parameters of the stimuli used in the current experiment and/or task procedure. However, it is also worth noting that British children start school at an earlier age than many other nationalities and it is possible that the early age of global bias may relate to the particular population under study. An additional possibility is that the rapid pace of change of modernisation may have brought forward the developmental process in the current Western sample as compared to earlier Western samples. Further research will be needed to conclude which of these possibilities may be most likely; however, the possibility that local-global bias may develop in line with age of starting school is certainly intriguing given the effects of education observed here in Namibian children.

For both UN and TN boys, education was shown to be a highly influential factor in determining local-global bias. Indeed, for both groups of boys, education fully mediated the effect of age and, remarkably, TN educated boys (aged 9-15) were as global as both UN and UB boys, making global-similarity matches on a full 79% of trials. This finding was all the more remarkable given that on average these TN boys had only received 1.4 years of educational training and none had acquired even basic literacy skills. The fact that none could read or write indicates that the perceptual learning required for literacy acquisition is not a primary (or, at least, not a necessary) factor in driving the effect of education. This is consistent with the finding that literacy level had no observable impact on similarity-matching for the Romanian Roma population, as reported in chapter three.

By contrast, for TN girls, matching choices remained consistently local across all ages, regardless of educational status, and indeed at the oldest age TN girls were the only group to still show an overall preference for the local level of structure. Whereas even only a small amount of education had a profound effect on the local-global bias of TN boys, TN girls (of the same age) demonstrated no observable effect of the equivalent education. A clear discrepancy was also seen in the effects of education for UN boys and girls. For UN girls, although *Years of education* was significantly correlated with local-global similarity matching when no other variables were taken into account, this effect did not remain significant when entered into the regression model alongside *Age* and *Age of initial urbanisation*. Whereas for UN girls no one factor emerged as explaining any unique variance, in strong contrast, for UN boys, education was a very strong predictor of local-global similarity-matching.

The finding that education was more strongly related to boys' similarity-matching that girls' is consistent with the adult findings presented in chapter two which showed that education fully-mediated the effect of urban exposure on local-global similarity matching for UN men but was entirely uncorrelated with local-global similarity matching for UN women. The evidence in chapter three, however, does not support the idea that education is *always* unimportant for determining local-global bias for women and/or girls. Although the Romanian women clearly showed no effect of education, the effect of education observed for the Hungarian sample as a whole (men's and women's combined data) appeared to be driven equally by men and women. However, nonetheless, the findings presented across all three empirical chapters of this thesis consistently indicate that education has a profound effect on local-global bias for males.

The fact that education is only sometimes and not always related to local-global bias, particularly for women, seems to suggest an indirect mechanism and may for example relate to the utility value of the education or to the status that it brings. Indeed, several pieces of evidence suggest that, for Namibians, males and females have different relationships with education, and these different relationships may well indicate gender-based differences in the utility value of education.

For UN adults, *Years of Education* and *Extent of urbanisation* were highly correlated with each other for men, but not at all for women (see chapter two). This mirrors the finding presented in the current chapter that *Years of education* was correlated with *Cumulative years of urban exposure* for boys but not girls. This may suggest that, even in childhood, males and females may become educated and urbanised under different circumstances, and may also suggest that education could serve different functions for boys and for girls.

Whereas there was a clear indication in the developmental data that, at least for boys, education, through whatever means, impacts the development of local-global bias, the role of urban exposure, however, is less clear. Based on the findings from chapter one which showed a strong relationship between urbanisation and local-global similarity matching for

UN women, it was predicted that urbanisation would also be a strong predictor for local-global bias in UN girls. However, we did not find evidence to support this theory.

For the UN developmental sample, two measures of urbanisation were obtained from participants, namely, *Cumulative years of urbanisation* (synonymous with *Years since initial urbanisation* for this sample), and *Age of initial urbanisation. Years since initial urbanisation* did not correlate at all with *Frequency of global-similarity choices* for the UN sample for either boys or girls and *Age of initial urbanisation* was in fact *negatively* correlated with *Frequency of global-similarity choices* because of the tendency for older children to have come to town later in life.

Clearly, however, local-global bias in UN girls is strongly influenced by at least some aspect of the environment. This is evident because whilst TN girls remained very local in their bias at all ages, UN girls, by contrast, from 10-years-old showed a clear global bias. However, whilst the regression modelling showed that 70% of variance in UN boys' local-global matching could be attributed to the combined effects of education, urbanisation, and age (albeit clearly predominantly driven by education), the same regression modelling could only account for around 30% of the variance in UN girls' local-global matching. It seems highly likely that differences in the local-global similarity matching of TN girls and UN girls should be associated in some way with urbanisation and/or education. However, the fact so much less variance was explained by the regression model for UN girls than for UN boys could perhaps suggest that some other unaccounted-for variable is contributing to local-global processing in UN girls. Based on the work with the Hungarian and Romanian participants in chapter three, one candidate variable may be socioeconomic status, and this may be an important variable for future studies of the environmental drivers of local-global bias to consider.

Although we found clear evidence that boys and girls are impacted in different ways by environmental drivers of local-global bias, rather surprisingly, we did not find any overall effect of gender. This was particularly surprising given that, although not unequivocal, previous work had suggested that gender differences in local-global bias during childhood are substantial (e.g., Kramer et al., 1996). There was, however, a significant *Age* by *Gender* interaction (when groups were combined), and when data for the 10-year-old and 14-year-old groups were pooled (also combined across groups) boys did indeed make significantly more global-similarity choices, although the overall difference was not large.

Gender differences in the development of local-global bias, however, have generally been attributed to differences in the maturational rates of development of the two hemispheres, presumed to relate to early prenatal testosterone exposure levels (see e.g., Toga & Thompson, 2003). In this light, it is perhaps surprising then that a gender-difference did not emerge earlier, at least for the British participants. For example, British boys did not make more global-similarity matches than girls at the earliest age group even though a global bias had already emerged, and indeed if anything it was the girls who showed a stronger global preference at age 4. If gender differences in local-global bias are driven by early biological influences, then one might expect those differences to be most strongly expressed during the earlier stages of development. The fact that our data showed only weak evidence for gender differences in local-global bias in childhood whereas other studies have previously shown strong effects (e.g., Kramer et al., 1996) suggests that gender differences even in childhood are strongly dependent on environmental context.

The fact that gender differences in the development of local-global bias are dependent on environmental factors of course does not necessitate that biological factors have no part to play. Rather, these findings place important limitations on what can be claimed with regards to the role of biological differences between the sexes. One suggestion, similar to the suggestion made in chapter two regarding gender differences in adulthood, could be that boys may have a biologically predisposed greater sensitivity to environmental drivers of global bias.

Our findings neither support nor refute this hypothesis. However, we find evidence to suggest that at least during childhood girls are highly responsive to environmental drivers of local-global bias and do demonstrate a global bias even after only limited exposure to the urban environment. This is important because in chapter two we showed that UN- women who had come to town later in life (average age 21) and had only spent a few years in town (average 4 years) presented with a strong local bias, despite being educated (average 9 years). Here we show that adolescent girls with around the same level of education (average 8 years) but with considerably *less* years of urban exposure (average 2.5 years), conversely demonstrate a global bias as strong as that of UB girls.

These findings do not discount the possibility raised in chapter two that hormonal changes after puberty may perhaps dampen the influence that environmental drivers of global bias may exert on women. However, given the so comparatively little urban exposure required for the UN girls in the current sample to present with a global bias, it does perhaps seem less plausible that environmental factors should have *no* effect on women whatsoever later in life. This leaves open the possibility that other factors (e.g., relating to socioeconomic status and/or the cultural treatment of men and women) that are unaccounted for in the current study may moderate the effects of urbanisation and/or education, at least for women.

# Chapter five: General discussion

The research presented in this thesis capitalised on naturally occurring groups of people from a diverse range of environmental settings in order to investigate the role that experience plays in shaping the development of local-global bias. Specifically, urbanisation, education, and gender (as both a biological and a sociocultural construct) were identified as candidate variables which might explain individual variance in local-global bias, and it is these hypotheses that are tested here in the thesis.

It was predicted that urbanisation and education would both promote a global bias, but that the influence of these two variables may not necessarily influence males and females equally, and that males may present with a stronger global bias than females under certain circumstances. Here we assess how well our evidence supports these predictions, and how our findings relate to the existing body of empirical work and theoretical modelling.

## 5.1 The effects of urbanisation

We build on previous research (e.g., Caparos et al., 2012) to show further evidence that local-global bias is related to urban exposure, but also illuminate several important limitations regarding its influence. The clearest evidence for a specific effect of urbanisation was observed in the urban Namibian (UN) women. Urban exposure was shown to have a clear impact on UN women, that could not be explained by education. Regression modelling showed that urban exposure uniquely accounted for variance in UN women's local-global similarity matching. Furthermore, dividing the educated UN participants into a group of only moderately urbanised UN participants (UN-) and a group of more highly urbanised UN participants (UN+) revealed that whereas UN- women showed a strong preference for local-similarity matching, by contrast UN+ women showed an equally strong preference for global-similarity matching, and indeed, made global-similarity matches as often as urban British (UB) women. The two groups of UN women (UN- and UN+) differed only in terms of their extent of education and did not significantly differ in terms of overall levels of education. The finding that urbanisation may contribute uniquely to variance in local-global bias for UN females could not be replicated in the developmental data. However, this may well have been due to the fact that the developmental data were not adequately suited to detecting a specific effect of urbanisation, because older children had typically come to town much later in life than younger children.

In contrast to the UN women, UN men did not demonstrate any variance in local-global similarity matching that could be attributed specifically to urbanisation; although urbanisation did correlate with local-global similarity matching, this effect was fully mediated by level of education. For UN men, however, but not UN women, urbanisation was heavily confounded with education. This finding in itself is interesting as it suggests that men and women have different relationships with urbanisation and education. It is possible then that had a more diverse UN sample been available (i.e., if there had been some highly urbanised but uneducated participants), and education and urbanisation less highly confounded, a unique effect of urbanisation, separate to an effect of education, may perhaps have been observed.

Although an overall effect of urbanisation was observed for UN women, however, UN- women, despite still having received considerable urban exposure relative to traditional Namibian (TN) women, nonetheless presented with a local bias that was as strong as that of the TN women. This suggests that, at least for moderate levels of urban exposure, urbanisation does not automatically lead to observable changes in local-global similarity matching. Two other findings also supported this conclusion. Uneducated and illiterate UN men with urban exposure levels equivalent to those of the UN- group (which only included educated participants) also did not differ significantly from TN men, and overall made matches more often at the local level of structure. Additionally, Romanian women from the Eastern-European sample also presented with a strong local bias, despite living within easy access of a large city (Cluj-Napoca).

In sum, although we found evidence for an effect of urbanisation on the local-global bias of UN women, we did not find any evidence for a unique effect of urbanisation on the local-global bias of UN men. This suggests that men and women are not impacted in the same way by urban exposure, and that the effects of urbanisation are not generalisable across gender. In addition, we also showed that urban exposure, at least when received during adulthood, is not always sufficient to produce an observable effect on local-global bias, and this was true both for women (i.e., UN- women) and for men (i.e., uneducated UN men). The findings also suggest that even urban exposure during childhood may not always be sufficient to produce an observable effect on local-global bias, as indicated by the strong local bias of the Romanian Roma women, who are likely to have received at least some urban exposure during childhood. However, we did not attempt to quantify urbanisation in the Eastern-European sample and so this assumption cannot be confirmed.

## 5.2. The effects of education

The second hypothesis tested was that Education would also impact local-global bias. We provide strong evidence that indeed education has a marked impact on local-global bias, but that, like urbanisation, there are important limitations on its influence. The most noticeable limitation was that, in direct contrast to the effects of urbanisation, clear effects of education could be observed for males but not females in our samples. Regression modelling demonstrated that for UN men, UN boys, and TN boys, education uniquely accounted for variance in local-global similarity matching and mediated the effects of all other variables (urbanisation and/or age). Furthermore, after controlling for urbanisation, educated UN men were shown to make significantly more global-similarity matches than uneducated and illiterate UN men, demonstrating that even after controlling for urbanisation education remains important. Further evidence that the effects of education can be disconfounded from urbanisation was provided by the Eastern-European data. For the Hungarian data (men and women combined), there was a significant correlation between education and global-similarity matching, which could not be attributed to urbanisation because participants were all from very similar backgrounds. Furthermore, for Romanian and Hungarian men, combined, level of education (high or low), but not group (Romanian or Hungarian), was shown to exert a significant main effect on local-global similarity matching, and again, these results could not be attributed to urbanisation.

We did not find evidence to support the possibility that literacy, as a specific aspect of education which has previously been linked to enhanced performance on a task requiring global perception (Szwed et al., 2012), was a causal factor in the link between education and global bias. Literate and illiterate Romanian participants did not differ from each other in their local-global similarity matching, regardless of whether the effect was examined in men and women separately or combined. Furthermore, TN boys (aged 9-15) with only very limited education made more similarity matches than TN boys with no education, despite the fact that none of the educated TN boys were literate. These TN boys with only very limited education and no literacy skills in fact made global-similarity matches on nearly 80% of trials, which was comparable to both UN and UB boys' matching behaviour.

In stark contrast to the male data, there was only very limited evidence that education may sometimes work to promote a global bias for females as well as males. As already noted above, for Hungarian men and women combined, education was significantly correlated with local-global similarity matching. Although this correlation did not remain significant when men and women were compared separately, men's and women's correlation coefficients suggested that the effect was attributable to the men's and women's data equally, and that Hungarian women may have been as affected by education as Hungarian men. Whilst not indisputable, this finding suggests that in some environmental contexts education may also impact the local-global bias of females. The only other possible suggestion that the local-global bias of the females in our samples may have been impacted by education was for the UN girls. For UN girls, as noted in above, education was significantly correlated with global-similarity matching, but education did not account for any unique variance when age and urbanisation were also taken into consideration. Education therefore may have contributed to the higher rate of global-similarity matching of UN girls compared to TN girls, but this effect could not be confirmed, and was in contrast to the unequivocal relationship between education and local-global similarity matching that was observed for UN boys of the same age and with equivalent levels of urbanisation and education.

For UN women and TN girls, however, despite the fact that they were as educated as their male counterparts, not only did education not account for any *unique* variance in local-global similarity matching once other factors had been accounted for, but in fact education was *entirely uncorrelated* with local-global similarity matching. The finding that education seems to be more strongly linked to local-global bias in males than in females was shown to be generalisable beyond the Namibian sample. When Romanian and Hungarian Roma men and women with (comparatively) high and low levels of education were compared, there was a significant main effect of level of education for the men but not the women. As discussed above, whilst there was some suggestion that education may have been an important factor for Hungarian women, for the Romanian women on the other hand, it was clear that education did not impact their matching behaviour, and regardless of level of education Romanian women most often made matches at the local level of structure.

In sum, in direct contrast to the effects of urbanisation, we found very strong and highly replicable evidence that education promotes a global bias for males, but only weak evidence that education may also *sometimes* promote a global bias in women. We also showed clear evidence that under certain conditions, at least for women, even fairly substantial levels of education can sometimes have no observable effect on local-global bias whatsoever; even with substantial levels of education, some women demonstrate a strong local bias. These results bear striking resemblance to the effects of urbanisation, in the sense that results cannot be generalised across genders, and that education, like urbanisation, is not sufficient in and of itself to produce a global bias (at least not for women).

## 5.3. Additional effects of urbanisation and/or education

In addition to the above findings into the specific effects of urbanisation and education, we also found several effects which could not be attributed directly to one factor over the other, but which nonetheless are likely to relate to either urbanisation and/or education in some way.

For example, for the cross-cultural analyses between UN and UB participants, whilst it was shown that for educated and more highly urbanised urban Namibians (i.e., UN+), UN participants were indistinguishable from UB participants, this was not the case for UN and UB children. Although at older ages (9-15) the two groups were indistinguishable from each other, there were clear group differences at the younger ages (4-7); at the younger ages, UB children made more global-similarity matches than the UN children. Furthermore, whereas UB children already made global-similarity choices most often from 4-years-old (the youngest age group in the study) and showed the largest age-related increase in global-similarity choices between 4-years-old and 5-7-years-old, UN children did not make global-similarity choices most often until age 9-11 and showed the largest age-related increases in global-similarity choices between 5-7- and 9-11-years-old. Although it is possible that these differences could relate to other cultural differences between the two groups, these results are nonetheless consistent with the hypothesis that urbanisation and/or education work to promote a global bias, since UB children were more urbanised and started school from an earlier age. The finding that the age at which a global bias was first observed differed for UN and UB children further suggests that, for populations that do develop a global bias, the developmental timings of the processes which facilitate a shift from local to global bias can be brought forward or delayed according to specific environmental pressures.

Cross-cultural analyses also revealed group differences in reaction time and switching behaviour, which, in contrast to the effects of urbanisation and education on local-global similarity matching, broadly speaking were independent of gender. Reaction time data could only be obtained for the computerised version of the task (presented in chapter one) and could not be obtained for the card version of the task (chapters two and three). Analysis across TN, UN-, UN+, and UB adults showed that TN participants were substantially slower than all other groups, whereas all other groups were equally fast. It is unclear whether this difference may have related to TN's unfamiliarity with technology, or if it may have reflected a more fundamental aspect of their character (e.g., low baseline arousal). However, the fact that UN- women made local-similarity matches as often as TN women yet were far faster in their reactions, demonstrated that the slow speed of response of the TN participants, though still possibly related, could not account for their local bias. The faster reaction times of UN participants relative to TN participants could relate to either urbanisation and/or education. However, the fact that uneducated and educated UN men did not differ in reaction time may suggest that urbanisation on its own is sufficient to exert the full effect.

The relationship between switching behaviour and urbanisation/education was less clear. For the computerised version of the task, switching behaviour was measured by the variable *Number of switches*. UN- participants were shown to make significantly fewer switches than TN and UB participants. We could not obtain an exactly analogous measure of switching from the card version of the task. However, participants who were classified as having a mixed matching strategy (for the categorical variable *Preferred matching strategy*) by definition were the only participants who made any switches during the task (the task included only 3 test trials). We were unable to include a 'mixed matching strategy' group for the developmental data as too few participants made any switches. However, for the Eastern-European data we found that Hungarian participants were less likely than British participants to use a mixed matching strategy as compared to consistently using a global matching strategy, despite the fact that both groups overall made global-similarity choices equally often.

Therefore, British adult participants appeared to make more switches as compared to Hungarian and UN- participants, who were less urbanised and less educated than the British. Yet at the same time, British participants did *not* appear to make switches any more often than either Romanian or TN participants who were even less urbanised (TN) and educated (Romanian and TN) than the British compared to the Hungarians and UN-, respectively. Therefore, although group differences were observed, it is unclear precisely how these differences relate to urbanisation and/or education.

Switching data were included in the analyses on the premise that it may reflect some aspect of cognitive flexibility. However, it is possible also that switching could result from poor performance on the task (if participant's responses did not match their actual similarity-judgements), or a less firmly established bias in either direction (local or global). It is perhaps possible then that, if switching behaviours do indeed index some aspect of cognitive flexibility, they may not index it equally well in all populations. Although impossible to confirm for the available data, it is possible that British participants may exhibit greater cognitive flexibility during the similarity-matching task as compared to UN-participants and Hungarian participants, but that the failure to find a difference between British participants and TN and Romanian participants may reflect instead increased noise in the data. These proposals remain highly speculative, but the finding that cross-cultural differences in switching behaviour can be observed at all is nonetheless intriguing and deserving of further investigation.

## 5.4 The effects of gender

As already alluded to, despite the fact that urbanisation and education were both clearly shown to be associated with a more global processing style, the influence of both these variables on male's and female's local-global similarity matching followed strikingly different patterns of association. Whereas, broadly speaking, female's local-global similarity matching was better explained by urbanisation, male's local-global similarity matching was better explained by education.

As well as these strong differences in the specific effects of urbanisation and education on local-global bias in males and females, we also found evidence that under some circumstances, but not others, there were additionally some overall effects of gender on local-global bias. For example, when comparing TN, UN-, UN+ and UB men and women, there was a main effect of gender. Women in all groups made numerically fewer global-similarity matches; however, this difference was significant only for UN- participants and was small in all other groups. Furthermore, whereas UN- men showed an overall global bias and resembled UN+ and UB participants, UN- women showed an overall local bias and resembled TN participants. The difference between UN- men's and women's matching behaviours could not be attributed to differences in overall levels of urbanisation or education as the two groups did not differ in these regards.

A similar observation was also seen in the Eastern-European data. British and Hungarian men and women did not differ in their local-global similarity matching. However, Romanian men made significantly more global-similarity matches than Romanian women and resembled Hungarian and British participants, whereas Romanian women showed an overall local bias and were distinguishable from all other groups.

For the developmental data comparing TN, UN, and UB children, a main effect of gender was observed only when the data for the eldest two groups (9-11- and 13-15-years-old) was pooled. Boys at these ages made significantly more global-similarity matches than girls in all populations, although the gender difference was not significant within any individual population. For younger children (4-7-year-olds) boys and girls did not differ, although if anything boys in fact made, numerically, slightly fewer global-similarity matches.

Notably, however, there were no instances at any age group (adult or child) or in any population (Namibian, Eastern-European, British) where females made significantly more global-similarity matches than males. Gender differences were dependent on environmental context and age, but were always in the direction of increased global processing by males relative to females.

## 5.5 Relationship of the current findings to the extant literature

Although many of the findings summarised above were novel and surprising, broadly speaking the results are not irreconcilable with previous findings from the extant literature, and indeed often provide a complementary perspective.

Perhaps the most surprising finding of all was that certain groups of participants (UN- women, UN uneducated men, and Romanian women) presented with a strong local bias in spite of considerable exposure to the urban environment and/or education. This was surprising because previous findings had indicated that even very limited urban exposure, in the form of occasional (1, 2, or 3+) visits to town, was linked to a diminishing effect on the local bias of traditional Namibians (Caparos et al, 2012). The same study also showed that urban Namibian participants, broadly comparable to the UN- participants in the current study, made significantly more global-similarity matches than traditional Namibians, but, crucially, neither the urban-traditional group comparison, nor the visits effect, were dependent on gender. Since no gender effects were observed in the 2012 study, and since the visits effect demonstrated in the TN group was independent of education, it was expected that even the least urbanised and least educated UN participants, men and women, in the current study should nonetheless be distinguishable from TN participants.

The current findings presented here, showed that UN- (educated) women did not differ from TN women, and that uneducated UN men (with urban exposure equivalent to the UN- group) did not differ from TN men. The current findings, however, can be reconciled with the previous (Caparos et al., 2012) findings because extent of urbanisation and extent of education of the urban Namibian group were not taken into consideration in the 2012 study, and as such may have masked the considerable within-group and between-gender variability that we now provide evidence for in the current study. It also is not necessary to assume that the visits effect for TN that was observed in the 2012 study (Caparos et al., 2012; though, not replicated in the current research here) and the group difference between TN and UN should relate to the same processes. Thus, the current urbanisation-related findings should not be considered as contradictory to previous findings, but rather, as refinements in our understanding of the relationship between urbanisation and local-global bias.

## 5.6 Relationship of the findings to theoretical models

In the general introduction, we outlined several ways in which urbanisation and education might work to promote a global bias (see schema in figure 2). These included both physical (e.g., visual clutter, pictures and the written word, etc.) and sociocultural (e.g., increased social diversity, increased dependence on abstract representation, etc.) aspects of the environment. It was proposed that these aspects of urbanisation and education might be expected to stimulate greater development of global perceptual and/or conceptual apparatus relative to local apparatus, due to environmental demands requiring increased activation of global processing. It was further proposed that this environment-dependent selective activation and selective development may be subject to hormonal regulation (either prenatal or post-pubescent) which may amplify the effect for males, possibly in an age-dependent (pre- and post-puberty) way. However, it was also identified that the differential cultural-treatment of males and females might also mediate gender differences in matching behaviour through creating gender-differences in the functional need for global processing (e.g., work-based activities versus domestic activities, etc.). Additionally, it was proposed that education may similarly mediate gender differences in matching behaviour in ways which could produce differential functional need for global processing (e.g., managerial roles versus menial work), and, perhaps more so in more highly genderised societies.

In addition, we highlighted the possibility that physiological/psychological state (power, affect, arousal, etc.) and/or cognitive flexibility may have an additional moderating effect on local-global processing (see general introduction) We identified that, under certain circumstances, hormonal regulation may also impact physiological/psychological state (and, more speculatively, cognitive flexibility) because of the roles that sex-hormones have been shown to exert on stress-response strategies (Ollf et al., 2007), and furthermore, that under conditions of negative arousal this hormonal regulation may perhaps selectively enhance global processing for men relative to women and enhance local processing for women relative to men (Cahill et al., 2003). However, additionally, we also identified that potential gender differences in the role of psychological state (and, by association, cognitive flexibility) may be mediated by the differential cultural treatment of males and females, and, perhaps especially for males in highly genderised societies, also by education. Women and less educated men, for example, may be afforded lower social status and may be more negatively affected by urban poverty.

The current research was not intended to provide any empirical support for the above suppositions. Rather, these observations from the existing literature, as summarised in the schema presented in chapter one (see figure 2), were intended to provide a conceptual framework to aid the interpretation of our findings. In this sense, the model proved successful, even though we were not able to disambiguate between competing possibilities (e.g., hormonal regulation versus cultural genderisation). Furthermore, this conceptual framework may be useful for generating testable hypotheses that future research can address.

To summarise, our evidence suggests that at least some of the variance in our data set is likely to relate to sociocultural aspects of the environment. For example, it seems unlikely that a purely ecological account could explain why UN- women with still considerable exposure to the urban visual environment and to the written word remained consistently local in their bias, especially given previous findings (Caparos et al., 2012) that even a handful of visits to town was accompanied by an increase in global similarity-matching. This observation that sociocultural factors may play an important role provides an important extension to previous discussions which focused primarily on physical aspects of the environment (e.g., Caparos et al, 2012).

The results also suggest that is highly likely that some of the observed gender-differences relate to socioculturally defined aspects of gender rather than a purely biological account. For example, it seems unreasonable to suggest that education should have such strikingly differential patterns of association with local-global similarity matching for the males and females in our sample due solely to innate differences between the sexes. It remains unclear how sociocultural aspects of the environment should exert their effects on local-global bias and how these processes may interact with visual input from the physical environment and biological factors associated with sex and age. Implications for future research are addressed below.

Our measures of cognitive flexibility (Number of switches and mixed matching strategy versus a consistent local or global matching strategy) did not provide any concrete clarification of the role  that cognitive flexibility may contribute to environment-dependent differences in local-global bias. However, neither the measure itself nor the experimental design was adequately suited to providing such clarification. Nonetheless, the inclusion of both reaction time and switching data provided useful insights into more nuanced cross-cultural differences in local-global similarity matching.

## 5.7 Limitations of the study and recommendations for further research

In the current study, socioeconomic status was a notable confound with our measures of urbanisation and education, and also with gender. For example, the Namibian and Eastern-European samples were all from low socioeconomic populations, whereas the British control sample was not. Furthermore, within the urban Namibian sample, less urbanised participants (i.e., UN- participants) and less educated participants (e.g., uneducated UN men) were likely to have been of lower socioeconomic status as compared to more highly urbanised and more highly educated UN participants. Similarly, Romanian Roma, who were less well educated than Hungarian Roma, were also of lower socioeconomic status than the Hungarian Roma. Assuming that socioeconomic status can be extended to include social standing within one's own community, then females and less well-educated participants also, in general, may have been of lower socioeconomic status as compared to males and better-educated participants.

It is quite likely that these confounds may have contributed to the observed pattern of results on several occasions. For example, it is notable that all participants who presented with a local bias *in spite of* fairly substantial urban exposure and/or education (i.e., UN-women, uneducated UN men, Romanian women) were from subpopulations who would be expected to be of particularly low socioeconomic status and particularly marginalised.

Given this considerable indication from the data that socioeconomic status may play an important role in determining local-global bias, in addition to the theoretical reasons (e.g., low power, negative affect, increased exposure to environmental stressors, etc.) to assume that socioeconomic status may play an important role, we identify socioeconomic status as an important factor for future research to address.

Secondly, given that we only used one measure of local-global bias, it will be important to see how well the findings presented here may be replicated using other measures of local-global bias in similar populations. This will aid not only our understanding of the environmental factors involved in shaping local-global bias, but may also provide the opportunity to explore how consistent the different measures of local-global bias are with each other across different environmental contexts. Such research would add greatly to our overall conceptual understanding of local-global bias, which is increasingly understood not to be a unitary construct (see, e.g., Chamberlain et al., 2017).

The interpretation of cross-cultural research into local-global bias would be greatly facilitated by advances in our understanding of both the underlying neuronal and cognitive mechanisms which give rise to our perceptual biases and also by more focused attempts to disambiguate what processes are being measured by each of the different local-global tasks. Whilst cross-cultural studies surely have a role to play in aiding these advancements, highly controlled laboratory-based studies will also be an important aspect of this process.

Important issues to be resolved include the questions of whether local-global perceptual processing can be directly influenced by real-time activation of local-global conceptual processing, whether, similarly, factors such as power and affect can impact perceptual as well as conceptual processing, and whether and to what extent conceptual processing and attention (as opposed to solely perceptual processing) exert their own independent effects on local-global similarity matching.

Furthermore, since local-global processing style has sometimes been associated with more general cognitive styles (e.g., Nisbett et al., 2001), it will be interesting to examine to what extent the same factors that influence local-global perceptual processing also impact higher-level cognitive processes. Such findings would add greatly to our more general understanding of the link between culture and cognition.

Finally, the findings presented in this thesis reinforce the importance of cross-cultural research more generally. The majority of current scientific work focuses predominantly on only a narrow section of the world's population. Not only does this have consequences for the quality of our scientific modelling, but, furthermore, the exclusion of certain sections of the world's population – typically some of the most disadvantaged sections – will only serve to further disadvantage those sections of society in the long term. Attempts to address this current imbalance will surely impact important issues in the lives of these underrepresented populations.

## 5.8 Conclusions

We provide further evidence to show that local-global bias is subject to mechanisms of phenotypic plasticity and is not a fixed universal quality. We also show that variation in local-global bias may be more widespread than has previously been acknowledged, for example by showing that even groups of Western participants (e.g., Romanian Roma women) can sometimes present with a local rather than a global bias.

By building on previous work, we show that urbanisation, education and gender are all important factors in determining local-global bias. However, we also show that each of these factors are interrelated with each other in ways more complex than perhaps previously appreciated, and that their effects may be contingent on a number of psychological and biological processes, the roles of which are not often fully accounted for in accounts of local-global bias.

# References

Ahluwalia, A. (1978). An intra-cultural investigation of susceptibility to 'perspective' and 'non-perspective' spatial illusions. *British Journal of Psychology*, *69*(2), 233-241

Alexander, J. K., Hillier, A., Smith, R. M., Tivarus, M. E., & Beversdorf, D. Q. (2007). Beta-adrenergic modulation of cognitive flexibility during stress. *Journal of cognitive neuroscience*, *19*(3), 468-478.

Amodio, D. M., Master, S. L., Yee, C. M., & Taylor, S. E. (2008). Neurocognitive components of the behavioral inhibition and activation systems: Implications for theories of self-regulation. *Psychophysiology*, *45*(1), 11-19.

Andreano, J. M., Arjomandi, H., & Cahill, L. (2008). Menstrual cycle modulation of the relationship between cortisol and long-term memory. *Psychoneuroendocrinology*, *33*(6), 874-882.

Austen, E., & Enns, J. T. (2000). Change Detection: Paying Attention To Detail Detail. *Psyche*, *6*(11).

Avargues-Weber, A., Dyer, A. G., Ferrah, N., & Giurfa, M. (2015). The forest or the trees: preference for global over local image processing is reversed by prior experience in honeybees. *Proceedings of the Royal Society of London B: Biological Sciences*, *282*(1799), 20142384.

Baker, D. P., & Jones, D. P. (1993). Creating gender equality: Cross-national gender stratification and mathematical performance. *Sociology of Education*, 91-103.

Barsalou, L. W. (1999). Perceptions of perceptual symbols. *Behavioral and brain sciences*, *22*(4), 637-660.

Basso, M. R., & Lowery, N. (2004). Global-local visual biases correspond with visual-spatial orientation. *Journal of Clinical and Experimental Neuropsychology*, *26*(1), 24-30.

Baumann, N., & Kuhl, J. (2002). Intuition, affect, and personality: unconscious coherence judgments and self-regulation of negative affect. *Journal of Personality and Social Psychology*, *83*(5), 1213.

Baumann, N., & Kuhl, J. (2005). Positive affect and flexibility: Overcoming the precedence of global over local processing of visual information. *Motivation and Emotion*, *29*(2), 123-134.

Behrmann, M., & Kimchi, R. (2003). What does visual agnosia tell us about perceptual organization and its relationship to object perception?. *Journal of Experimental Psychology: Human Perception and Performance*, *29*(1), 19.

Berman, M. G., Jonides, J., & Kaplan, S. (2008). The cognitive benefits of interacting with nature. *Psychological science*, *19*(12), 1207-1212.

Best, C. T. (1988). The emergence of cerebral asymmetries in early human development: A literature review and a neuroembryological model. *Brain lateralization in children*, 5-34.

Blais, C., Jack, R. E., Scheepers, C., Fiset, D., & Caldara, R. (2008). Culture shapes how we look at faces. *PloS one*, *3*(8), e3022.

Blakemore, C., & Cooper, G. F. (1970). Development of the brain depends on the visual environment. *Nature*, *228*(5270), 477.

Bogin, B. A. (1997). Evolutionary hypotheses for human childhood.

Bollig, M., & Heinemann, H. (2002). Nomadic savages, ochre people and heroic herders: Visual presentations of the Himba of Namibia's Kaokoland. *Visual Anthropology*, *15*(3-4), 267-312.

Bremner, A. J., Doherty, M. J., Caparos, S., Fockert, J., Linnell, K. J., & Davidoff, J. (2016). Effects of culture and the urban environment on the development of the Ebbinghaus illusion. *Child development*, *87*(3), 962-981.

Burack, J. A., Enns, J. T., Iarocci, G., & Randolph, B. (2000). Age differences in visual search for compound patterns: Long-versus short-range grouping. *Developmental Psychology*, *36*(6), 731.

Burgoon, E. M., Henderson, M. D., & Markman, A. B. (2013). There are many ways to see the forest for the trees: A tour guide for abstraction. *Perspectives on Psychological Science*, *8*(5), 501-520.

Cahill, L., & van Stegeren, A. (2003). Sex-related impairment of memory for emotional events with β-adrenergic blockade. *Neurobiology of learning and memory*, *79*(1), 81-88.

Caldara, R., Zhou, X., & Miellet, S. (2010). Putting culture under the ‘spotlight’ reveals universal information use for face recognition. *PLoS One*, *5*(3), e9708.

Caparos, S., Ahmed, L., Bremner, A. J., de Fockert, J. W., Linnell, K. J., & Davidoff, J. (2012). Exposure to an urban environment alters the local bias of a remote culture. *Cognition*, *122*(1), 80-85.

Caparos, S., Fortier-St-Pierre, S., Gosselin, J., Blanchette, I., & Brisson, B. (2015). The tree to the left, the forest to the right: Political attitude and perceptual bias. *Cognition*, *134*, 155-164.

Caparos, S., Linnell, K. J., Bremner, A. J., de Fockert, J. W., & Davidoff, J. (2013). Do local and global perceptual biases tell us anything about local and global selective attention?. *Psychological science*, *24*(2), 206-212.

Carli, L. L. (1999). Gender, interpersonal power, and social influence. *Journal of social issues*, *55*(1), 81-99.

Carli, L. L. (2001). Gender and social influence. *Journal of Social Issues*, *57*(4), 725-741.

Carr, N. (2010). *The shallows: How the internet is changing the way we think, read and remember*. Atlantic Books Ltd.

Carver, C. S. (2006). Approach, avoidance, and the self-regulation of affect and action. *Motivation and emotion*, *30*(2), 105-110.

Cast, A. D. (2003). Power and the ability to define the situation. *Social Psychology Quarterly*, 185-201.

Chamberlain, R., Van der Hallen, R., Huygelier, H., Van de Cruys, S., & Wagemans, J. (2017). Local-global processing bias is not a unitary individual difference in visual processing. *Vision research*, *141*, 247-257.

Clearfield, M. W., & Niman, L. C. (2012). SES affects infant cognitive flexibility. *Infant Behavior and Development*, *35*(1), 29-35.

Cole Jr, T., & Sapp, G. L. (1988). Stress, locus of control, and achievement of high school seniors. *Psychological Reports*, *63*(2), 355-359.

Conover, W. J., & Iman, R. L. (1981). Rank transformations as a bridge between parametric and nonparametric statistics. *The American Statistician*, *35*(3), 124-129.

Corbetta, M., Kincade, J. M., Ollinger, J. M., McAvoy, M. P., & Shulman, G. L. (2000). Voluntary orienting is dissociated from target detection in human posterior parietal cortex. *Nature neuroscience*, *3*(3), 292.

Corson, Y., & Verrier, N. (2007). Emotions and false memories: Valence or arousal?. *Psychological Science*, *18*(3), 208-211.

Crawford, C. B., & Anderson, J. L. (1989). Sociobiology: An environmentalist discipline?. *American Psychologist*, *44*(12), 1449.

Dale, G., & Arnell, K. M. (2013). Investigating the stability of and relationships among global/local processing measures. *Attention, Perception, & Psychophysics*, *75*(3), 394-406.

Das, A., & Gilbert, C. D. (1997). Distortions of visuotopic map match orientation singularities in primary visual cortex. *Nature*, *387*(6633), 594.

Das, A., & Gilbert, C. D. (1999). Topography of contextual modulations mediated by short-range interactions in primary visual cortex. *Nature*, *399*(6737), 655.

Davidoff, J., Fonteneau, E., & Fagot, J. (2008). Local and global processing: Observations from a remote culture. *Cognition*, *108*(3), 702-709.

Daw, N. W. (2014). Critical Periods. In *Visual Development* (pp. 147-165). Springer, Boston, MA.

De Dreu, C. K., Baas, M., & Nijstad, B. A. (2008). Hedonic tone and activation level in the mood-creativity link: toward a dual pathway to creativity model. *Journal of personality and social psychology*, *94*(5), 739.

De Dreu, C. K. D., Nijstad, B. A., & Baas, M. (2011). Behavioral activation links to creativity because of increased cognitive flexibility. *Social Psychological and Personality Science*, *2*(1), 72-80.

Dehaene, S. (2009). *Reading in the brain: The new science of how we read*. Penguin.

Dehaene, S., Pegado, F., Braga, L. W., Ventura, P., Nunes Filho, G., Jobert, A., ... & Cohen, L. (2010). How learning to read changes the cortical networks for vision and language. *science*, *330*(6009), 1359-1364.

Derryberry, D., & Reed, M. A. (1998). Anxiety and attentional focusing: Trait, state and hemispheric influences. *Personality and individual differences*, *25*(4), 745-761.

Derryberry, D., & Tucker, D. M. (1994). Motivating the focus of attention.

Doherty, M. J., Tsuji, H., & Phillips, W. A. (2008). The context sensitivity of visual size perception varies across cultures. *Perception*, *37*(9), 1426-1433.

Dukette, D., & Stiles, J. (1996). Children's analysis of hierarchical patterns: Evidence from a similarity judgment task. *Journal of experimental child psychology*, *63*(1), 103-140.

Dukette, D., & Stiles, J. (2001). The effects of stimulus density on children's analysis of hierarchical patterns. *Developmental science*, *4*(2), 233-251.

Edelman, G. M. (1993). Neural Darwinism: selection and reentrant signaling in higher brain function. *Neuron*, *10*(2), 115-125.

Eisenstein, C. (1994). The ascent of humanity. Panenthea Press.

Eisler, R. M., & Skidmore, J. R. (1987). Masculine gender role stress: Scale development and component factors in the appraisal of stressful situations. *Behavior modification*, *11*(2), 123-136.

Estes, Z., & Felker, S. (2012). Confidence mediates the sex difference in mental rotation performance. *Archives of sexual behavior*, *41*(3), 557-570.

Everett, D., Berlin, B., Gonalves, M., Kay, P., Levinson, S., Pawley, A., ... & Everett, D. (2005). Cultural constraints on grammar and cognition in Pirahã: Another look at the design features of human language. *Current anthropology*, *46*(4), 621-646.

Fang, L., Hoorelbeke, K., Bruyneel, L., Notebaert, L., MacLeod, C., De Raedt, R., & Koster, E. H. (2017). Can training change attentional breadth? Failure to find transfer effects. *Psychological research*, 1-15.

Feldman, D. E., & Brecht, M. (2005). Map plasticity in somatosensory cortex. *Science*, *310*(5749), 810-815.

Fiedler, K., & Stroehm, W. (1986). What kind of mood influences what kind of memory: The role of arousal and information structure. *Memory & Cognition*, *14*(2), 181-188.

Field, S. M., Wagenmakers, E. J., Newell, B. R., Zeelenberg, R., & van Ravenzwaaij, D. (2016). Two Bayesian tests of the GLOMOsys Model. *Journal of Experimental Psychology: General*, *145*(12), e81.

Finke, R. A. (1985). Theories relating mental imagery to perception. *Psychological Bulletin*, *98*(2), 236.

Firestone, C., & Scholl, B. J. (2016). Cognition does not affect perception: Evaluating the evidence for 'top-down' effects. *Behavioral & Brain Sciences*, *e229*, 1-77.

Förster, J., & Dannenberg, L. (2010). GLOMOsys: A systems account of global versus local processing. *Psychological Inquiry*, *21*(3), 175-197.

Förster, J., Friedman, R. S., & Liberman, N. (2004). Temporal construal effects on abstract and concrete thinking: consequences for insight and creative cognition. *Journal of personality and social psychology*, *87*(2), 177.

Galinsky, A. D., Gruenfeld, D. H., & Magee, J. C. (2003). From power to action. *Journal of personality and social psychology*, *85*(3), 453.

Gasper, K. (2004). Do you see what I see? Affect and visual information processing. *Cognition and Emotion*, *18*(3), 405-421.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological science*, *13*(1), 34-40.

Geisler, W. S. (2008). Visual perception and the statistical properties of natural scenes. *Annu. Rev. Psychol.*, *59*, 167-192.

Geschwind, N., & Galaburda, A.M. (1987). Cerebral Lateralization: biological mechanisms, associations and pathology. MIT press: Cambridge, MA.

Gilbert, D. T. (1991). How mental systems believe. *American psychologist*, *46*(2), 107.

Gilder, T. S., & Heerey, E. A. (2018). The Role of Experimenter Belief in Social Priming. *Psychological science*, 0956797617737128.

Giles, G. E., Mahoney, C. R., Brunye, T. T., Taylor, H. A., & Kanarek, R. B. (2013). Caffeine promotes global spatial processing in habitual and non-habitual caffeine consumers. *Frontiers in human neuroscience*, *7*, 694.

Goldstein, J. M., Jerram, M., Abbs, B., Whitfield-Gabrieli, S., & Makris, N. (2010). Sex differences in stress response circuitry activation dependent on female hormonal cycle. *Journal of Neuroscience*, *30*(2), 431-438.

Gray, J. A. (1990). Brain systems that mediate both emotion and cognition. *Cognition & emotion*, *4*(3), 269-288.

Greenfield, P. M., & Bruner, J. S. (1966). Culture and cognitive growth. *International Journal of Psychology*, *1*(2), 89-107.

Grimshaw, G. M., Bryden, M. P., & Finegan, J. A. K. (1995). Relations between prenatal testosterone and cerebral lateralization in children. *Neuropsychology*, *9*(1), 68.

Guinote, A. (2007). Power affects basic cognition: Increased attentional inhibition and flexibility. *Journal of Experimental Social Psychology*, *43*(5), 685-697.

Guiso, L., Monte, F., Sapienza, P., & Zingales, L. (2008). Culture, gender, and math. *SCIENCE-NEW YORK THEN WASHINGTON-*, *320*(5880), 1164.

Halpern, D. F. (2004). A cognitive-process taxonomy for sex differences in cognitive abilities. *Current directions in psychological science*, *13*(4), 135-139.

Han, Shihui, Janelle A. Weaver, Scott O. Murray, Xiaojian Kang, E. William Yund, and David L. Woods. "Hemispheric asymmetry in global/local processing: Effects of stimulus position and spatial frequency." *NeuroImage* 17, no. 3 (2002): 1290-1299.

Hoar, S., & Linnell, K. J. (2013). Cognitive load eliminates the global perceptual bias for unlimited exposure durations. *Attention, Perception, & Psychophysics*, *75*(2), 210-215.

Howell, D. C. (2012). *Statistical methods for psychology*. Cengage Learning.

Huntsinger, J. R., Clore, G. L., & Bar-Anan, Y. (2010). Mood and global–local focus: Priming a local focus reverses the link between mood and global–local processing. *Emotion*, *10*(5), 722.

Isen, A. M., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of personality and social psychology*, *47*(6), 1206.

Jandó, G., Mikó-Baráth, E., Markó, K., Hollódy, K., Török, B., & Kovacs, I. (2012). Early-onset binocularity in preterm infants reveals experience-dependent visual development in humans. *Proceedings of the National Academy of Sciences*, *109*(27), 11049-11052.

Jayachandran, S. (2015). The roots of gender inequality in developing countries. *economics*, *7*(1), 63-88.

Káldy, Z., & Kovács, I. (2003). Visual context integration is not fully developed in 4-year-old children. *Perception*, *32*(6), 657-666.

Kéïta, L., Mottron, L., Dawson, M., & Bertone, A. (2011). Atypical lateral connectivity: a neural basis for altered visuospatial processing in autism. *Biological psychiatry*, *70*(9), 806-811.

Kelly, D. J., Miellet, S., & Caldara, R. (2010). Culture shapes eye movements for visually homogeneous objects. *Frontiers in psychology*, *1*, 6.

Kelly, J. A., Amirkhanian, Y. A., Kabakchieva, E., Csepe, P., Seal, D. W., Antonova, R., ... & Gyukits, G. (2004). Gender roles and HIV sexual risk vulnerability of Roma (Gypsies) men and women in Bulgaria and Hungary: an ethnographic study. *Aids Care*, *16*(2), 231-245.

Keltner, D., Gruenfeld, D. H., & Anderson, C. (2003). Power, approach, and inhibition. *Psychological review*, *110*(2), 265.

Kemp, A. H., Silberstein, R. B., Armstrong, S. M., & Nathan, P. J. (2004). Gender differences in the cortical electrophysiological processing of visual emotional stimuli. *NeuroImage*, *21*(2), 632-646.
Kimchi, R. (1992). Primacy of wholistic processing and global/local paradigm: a critical review. *Psychological bulletin*, *112*(1), 24.

Kimchi, R., & Palmer, S. E. (1982). Form and texture in hierarchically constructed patterns. *Journal of Experimental Psychology: Human Perception and Performance*, *8*(4), 521.

Kimchi, R., Amishav, R., & Sulitzeanu-Kenan, A. (2009). Gender differences in global–local perception? Evidence from orientation and shape judgments. *Acta Psychologica*, *130*(1), 64-71.

Kimchi, R., Hadad, B., Behrmann, M., & Palmer, S. E. (2005). Microgenesis and ontogenesis of perceptual organization: Evidence from global and local processing of hierarchical patterns. *Psychological science*, *16*(4), 282-290.

Kitayama, S., & Uskul, A. K. (2011). Culture, mind, and the brain: Current evidence and future directions. *Annual review of psychology*, *62*, 419-449.

Klauer, K. C., & Singmann, H. (2015). Does global and local vision have an impact on creative and analytic thought? Two failed replications. *PloS* *one*, *10*(10), e0132885.

Klein, O., Ventura, P., Fernandes, T., Marques, L. G., Licata, L., & Semin, G. R. (2010). Effects of schooling and literacy on linguistic abstraction: The role of holistic vs. analytic processing styles. *European journal of social psychology*, *40*(7), 1095-1102.

Kovács, I. (2000). Human development of perceptual organization. *Vision research*, *40*(10-12), 1301-1310.

Kovacs, I., Kozma, P., Feher, A., & Benedek, G. (1999). Late maturation of visual spatial integration in humans. *Proceedings of the National Academy of Sciences*, *96*(21), 12204-12209.

Kovács, I., Polat, U., Pennefather, P. M., Chandna, A., & Norcia, A. M. (2000). A new test of contour integration deficits in patients with a history of disrupted binocular experience during visual development. *Vision research*, *40*(13), 1775-1783.

Kramer, J. H., Ellenberg, L., Leonard, J., & Share, L. J. (1996). Developmental sex differences in global-local perceptual bias. *Neuropsychology*, *10*(3), 402.

Kyuchukov, H. (2011). Roma girls: between traditional values and educational aspirations. *Intercultural Education*, *22*(1), 97-104.

LaFont, S., & Hubbard, D. (2007). Unravelling taboos. *Windhoek: Legal Assistance Centre*.

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1998). Emotion, motivation, and anxiety: Brain mechanisms and psychophysiology. *Biological psychiatry*, *44*(12), 1248-1263.

Lebron-Milad, K., Abbs, B., Milad, M. R., Linnman, C., Rougemount-Bücking, A., Zeidan, M. A., ... & Goldstein, J. M. (2012). Sex differences in the neurobiology of fear conditioning and extinction: a preliminary fMRI study of shared sex differences with stress-arousal circuitry. *Biology of mood & anxiety disorders*, *2*(1), 7.

Lederbogen, F., Kirsch, P., Haddad, L., Streit, F., Tost, H., Schuch, P., ... & Meyer-Lindenberg, A. (2011). City living and urban upbringing affect neural social stress processing in humans. *Nature*, *474*(7352), 498.

Levine, S. C., Vasilyeva, M., Lourenco, S. F., Newcombe, N. S., & Huttenlocher, J. (2005). Socioeconomic status modifies the sex difference in spatial skill. *Psychological science*, *16*(11), 841-845.

Lewin, K. M. (2009). Access to education in sub-Saharan Africa: Patterns, problems and possibilities. *Comparative Education*, *45*(2), 151-174.

Liberman, N., & Trope, Y. (2008). The psychology of transcending the here and now. *Science*, *322*(5905), 1201-1205.

Liberman, N., Trope, Y., & Stephan, E. (2007). Psychological distance. *Social psychology: Handbook of basic principles*, *2*, 353-383.

Linn, M. C., & Petersen, A. C. (1985). Emergence and characterization of sex differences in spatial ability: A meta-analysis. *Child development*, 1479-1498.

Linnell, K. J., Caparos, S., & Davidoff, J. (2014). Urbanization increases left-bias in line-bisection: an expression of elevated levels of intrinsic alertness?. *Frontiers in psychology*, *5*, 1127.

Linnell, K. J., Caparos, S., de Fockert, J. W., & Davidoff, J. (2013). Urbanization decreases attentional engagement. *Journal of Experimental Psychology: Human Perception and Performance*, *39*(5), 1232.

Lippa, R. A., Collaer, M. L., & Peters, M. (2010). Sex differences in mental rotation and line angle judgments are positively associated with gender equality and economic development across 53 nations. *Archives of sexual behavior*, *39*(4), 990-997.

Liston, C., McEwen, B. S., & Casey, B. J. (2009). Psychosocial stress reversibly disrupts prefrontal processing and attentional control. *Proceedings of the National Academy of Sciences*, *106*(3), 912-917.

Mahoney, C. R., Brunyé, T. T., Giles, G., Lieberman, H. R., & Taylor, H. A. (2011). Caffeine-induced physiological arousal accentuates global processing biases. *Pharmacology Biochemistry and Behavior*, *99*(1), 59-65.

Mak, A. S., Blewitt, K., & Heaven, P. C. (2004). Gender and personality influences in adolescent threat and challenge appraisals and depressive symptoms. *Personality and Individual Differences*, *36*(6), 1483-1496.

Martin, R. W., & Cooper, A. J. (2017). Subjective well-being in a remote culture: The Himba. *Personality and Individual Differences*, *115*, 19-22.

Masuda, T., & Nisbett, R. E. (2006). Culture and change blindness. *Cognitive Science*, *30*(2), 381-399.

McKone, E., Davies, A. A., Fernando, D., Aalders, R., Leung, H., Wickramariyaratne, T., & Platow, M. J. (2010). Asia has the global advantage: Race and visual attention. *Vision research*, *50*(16), 1540-1549.

McClelland, G. H., & Judd, C. M. (1993). Statistical difficulties of detecting interactions and moderator effects. *Psychological bulletin*, *114*(2), 376.

Miyamoto, Y., Nisbett, R. E., & Masuda, T. (2006). Culture and the physical environment: Holistic versus analytic perceptual affordances. *Psychological Science*, *17*(2), 113-119.

Müller-Oehring, E. M., Schulte, T., Raassi, C., Pfefferbaum, A., & Sullivan, E. V. (2007). Local–global interference is modulated by age, sex and anterior corpus callosum size. *Brain Research*, *1142*, 189-205.

National Planning Commission. (2015). Namibia Population and Housing Census 2011.

Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive psychology*, *9*(3), 353-383.

Nettle, D., & Bateson, M. (2015, August). Adaptive developmental plasticity: what is it, how can we recognize it and when can it evolve?. In *Proc. R. Soc. B* (Vol. 282, No. 1812, p. 20151005). The Royal Society.

Newcombe, N. S. (2007). *Taking Science Seriously: Straight Thinking About Spatial Sex Differences*. American Psychological Association.

Newcombe, N., Bandura, M. M., & Taylor, D. G. (1983). Sex differences in spatial ability and spatial activities. *Sex Roles*, *9*(3), 377-386.

Nielsen, S. E., Ahmed, I., & Cahill, L. (2013). Sex and menstrual cycle phase at encoding influence emotional memory for gist and detail. *Neurobiology of learning and memory*, *106*, 56-65.

Nisbett, R. E., Peng, K., Choi, I., & Norenzayan, A. (2001). Culture and systems of thought: holistic versus analytic cognition. *Psychological review*, *108*(2), 291.

Norenzayan, A., & Nisbett, R. E. (2000). Culture and causal cognition. *Current Directions in Psychological Science*, *9*(4), 132-135.

OECD (2014). Gender, Institutions and Development Database, http://stats.oecd.org; DHS (2006-2007) p.244

Oishi, Shigehiro, Vikram K. Jaswal, Angeline S. Lillard, Ai Mizokawa, Hidefumi Hitokoto, and Yoshiro Tsutsui. "Cultural variations in global versus local processing: A developmental perspective." *Developmental psychology* 50, no. 12 (2014): 2654.

Olff, M., Langeland, W., & Gersons, B. P. (2005). Effects of appraisal and coping on the neuroendocrine response to extreme stress. *Neuroscience & Biobehavioral Reviews*, *29*(3), 457-467.

Pesce, C., Tessitore, A., Casella, R., Pirritano, M., & Capranica, L. (2007). Focusing of visual attention at rest and during physical exercise in soccer players. *Journal of sports sciences*, *25*(11), 1259-1270.

Plessow, F., Kiesel, A., Petzold, A., & Kirschbaum, C. (2011). Chronic sleep curtailment impairs the flexible implementation of task goals in new parents. *Journal of Sleep Research*, *20*(2), 279-287.

Pletzer, B. (2014). Sex-specific strategy use and global-local processing: a perspective toward integrating sex differences in cognition. *Frontiers in neuroscience*, *8*, 425.

Pletzer, B., Petasis, O., & Cahill, L. (2014). Switching between forest and trees: Opposite relationship of progesterone and testosterone to global–local processing. *Hormones and behavior*, *66*(2), 257-266.

Poirel, N., Leroux, E., Pineau, A., Houdé, O., & Simon, G. (2014). Changes in cortical thickness in 6-year-old children open their mind to a global vision of the world. *BioMed research international*, *2014*.

Poirel, N., Mellet, E., Houdé, O., & Pineau, A. (2008). First came the trees, then the forest: developmental changes during childhood in the processing of visual local-global patterns according to the meaningfulness of the stimuli. *Developmental psychology*, *44*(1), 245.

Poirel, N., Simon, G., Cassotti, M., Leroux, G., Perchey, G., Lanoë, C., ... & Houdé, O. (2011). The shift from local to global visual processing in 6-year-old children is associated with grey matter loss. *PloS one*, *6*(6), e20879.

Porporino, M., Iarocci, G., Shore, D. I., & Burack, J. A. (2004). A developmental change in selective attention and global form perception. *International Journal of Behavioral Development*, *28*(4), 358-364.

Razumnikova, O. M., & Vol'f, N. V. (2011). Selection of visual hierarchical stimuli between global and local aspects in men and women. *Fiziologiia cheloveka*, *37*(2), 14-19.

Razumnikova, O. M., & Volf, N. V. (2011). Information processing specialization during interference between global and local aspects of visual hierarchical stimuli in men and women. *Human Physiology*, *37*(2), 137-142.

Riley, E., Okabe, H., Germine, L., Wilmer, J., Esterman, M., & DeGutis, J. (2016). Gender differences in sustained attentional control relate to gender inequality across countries. *PloS one*, *11*(11), e0165100.

Rivers, W. H. R. (1905). Observations on the senses of the Todas. *British journal of Psychology*, *1*(4), 321-396.

Roalf, D., Lowery, N., & Turetsky, B. I. (2006). Behavioral and physiological findings of gender differences in global-local visual processing. *Brain and Cognition*, *60*(1), 32-42.

Robertson, L. C., and M.R. Lamb. (1991) Neuropsychological contributions to theories of part/whole organization. *Cognitive psychology* 23(2), 299-330.

Scherf, K. S., Behrmann, M., Kimchi, R., & Luna, B. (2009). Emergence of global shape processing continues through adolescence. *Child Development*, *80*(1), 162-177.

Scheuringer, A., & Pletzer, B. (2016). Sex differences in the Kimchi-Palmer task revisited: Global reaction times, but not number of global choices differ between adult men and women. *Physiology & behavior*, *165*, 159-165.

Schöning, S., Engelien, A., Kugel, H., Schäfer, S., Schiffbauer, H., Zwitserlood, P., ... & Greb, R. R. (2007). Functional anatomy of visuo-spatial working memory during mental rotation is influenced by sex, menstrual cycle, and sex steroid hormones. *Neuropsychologia*, *45*(14), 3203-3214.

Schwarzkopf, D. S., & Kourtzi, Z. (2008). Experience shapes the utility of natural statistics for perceptual contour integration. *Current Biology*, *18*(15), 1162-1167.

Schwarzkopf, D. S., Song, C., & Rees, G. (2011). The surface area of human V1 predicts the subjective experience of object size. *Nature neuroscience*, *14*(1), 28.

Segall, M. H., Campbell, D. T., & Herskovits, M. J. (1963). Cultural differences in the perception of geometric illusions. *Science*, *139*(3556), 769-771.

Sigman, M., Cecchi, G. A., Gilbert, C. D., & Magnasco, M. O. (2001). On a common circle: natural scenes and Gestalt rules. *Proceedings of the National Academy of Sciences*, *98*(4), 1935-1940.

Simoncelli, E. P., & Olshausen, B. A. (2001). Natural image statistics and neural representation. *Annual review of neuroscience*, *24*(1), 1193-1216.

Smith, P. K., & Galinsky, A. D. (2010). The nonconscious nature of power: Cues and consequences. *Social and Personality Psychology Compass*, *4*(10), 918-938.

Smith, P. K., & Trope, Y. (2006). You focus on the forest when you're in charge of the trees: power priming and abstract information processing. *Journal of personality and social psychology*, *90*(4), 578.

Smith, P. K., Wigboldus, D. H., & Dijksterhuis, A. P. (2008). Abstract thinking increases one’s sense of power. *Journal of Experimental Social Psychology*, *44*(2), 378-385.

Steinberg, D., & Colla, P. (1991). *LOGIT: A supplementary module for SYSTAT*. ICON Group International.

Stewart, V. M. (1973). Tests of the “carpentered world” hypothesis by race and environnement in America and Zambia. *International journal of Psychology*, *8*(2), 83-94.

Szwed, M., Dehaene, S., Kleinschmidt, A., Eger, E., Valabrègue, R., Amadon, A., & Cohen, L. (2011). Specialization for written words over objects in the visual cortex. *Neuroimage*, *56*(1), 330-344.

Szwed, M., Ventura, P., Querido, L., Cohen, L., & Dehaene, S. (2012). Reading acquisition enhances an early visual process of contour integration. *Developmental science*, *15*(1), 139-149.

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics*. Allyn & Bacon/Pearson Education.

Tacoli, C. (2012). *Urbanization, gender and urban poverty: paid work and unpaid carework in the city*. Human Settlements Group, International Institute for Environment and Development.

Toga, A. W., & Thompson, P. M. (2003). Mapping brain asymmetry. *Nature Reviews Neuroscience*, *4*(1), 37.

Trope, Y., & Liberman, N. (2003). Temporal construal. *Psychological review*, *110*(3), 403.

Trope, Y., & Liberman, N. (2011). Construal level theory. *Handbook of theories of social psychology*, *1*, 118-134.

Tucker, D. M., & Williamson, P. A. (1984). Asymmetric neural control systems in human self-regulation. *Psychological review*, *91*(2), 185.

Tzuriel, D., & Egozi, G. (2010). Gender differences in spatial ability of young children: The effects of training and processing strategies. *Child development*, *81*(5), 1417-1430.

UNICEF School Drop-Out and Out-Of-School Children in Namibia. A National Review 2015 (Abridged Version). https://www.unicef.org/namibia/resources_13836.html. Last retrieved 30.01.2018

UNICEF. "Namibia's women and girls: reaping the benefits of gender equality? A supplement to the UNICEF state of the world's children 2007." *New York: UNICEF* (2007).

United Nations Development Program (2012) Participatory assessment of the social situation in the Pata-Rât and Cantonului areas, retrieved from: http://www.undp.ro/libraries/projects/75023_UNDP-UBB_Research_Report_Participatory_Assessment_Para_rat_Cluj.pdf

Vinter, A., Puspitawati, I., & Witt, A. (2010). Children's spatial analysis of hierarchical patterns: Construction and perception. *Developmental Psychology*, *46*(6), 1621.

Voicu, M., & Popescu, R. (2009). Roma women-known and unknown: Family Life And The Position Of The Woman In The Roma Communities. *European Network on Social Inclusion and Roma*.

Wagner, D. A. (1977). Ontogeny of the Ponzo illusion: Effects of age, schooling, and environment. *International Journal of Psychology*, *12*(3), 161-176.

Weick, M., Guinote, A., & Wilkinson, D. (2011). Lack of power enhances visual perceptual discrimination. *Canadian Journal of Experimental Psychology/Revue canadienne de psychologie expérimentale*, *65*(3), 208.

Weiss, E. M., Kemmler, G., Deisenhammer, E. A., Fleischhacker, W. W., & Delazer, M. (2003). Sex differences in cognitive functions. *Personality and individual differences*, *35*(4), 863-875.

Weissman, D. H., Giesbrecht, B., Song, A. W., Mangun, G. R., & Woldorff, M. G. (2003). Conflict monitoring in the human anterior cingulate cortex during selective attention to global and local object features. *Neuroimage*, *19*(4), 1361-1368.

Weissman, D. H., Gopalakrishnan, A., Hazlett, C. J., & Woldorff, M. G. (2004). Dorsal anterior cingulate cortex resolves conflict from distracting stimuli by boosting attention toward relevant events. *Cerebral cortex*, *15*(2), 229-237.

West-Eberhard, M. J. (2003). *Developmental plasticity and evolution*. Oxford University Press.

Witelson, D. F. (1976). Sex and the single hemisphere: Specialization of the right hemisphere for spatial processing. *Science*, *193*(4251), 425-427.

Witelson, S. F., & Nowakowski, R. S. (1991). Left out axoms make men right: A hypothesis for the origin of handedness and functional asymmetry. *Neuropsychologia*, *29*(4), 327-333.

*World Bank. 2009. Namibia: Country Brief. World Bank. © World Bank. https://www.openknowledge.worldbank.org/handle/10986/2630 License: CC BY 3.0 IGO.*

Yoon, J. M. D., Winawer, J., Witthoft, N., & Markman, E. M. (2007). Striking deficiency in top-down perceptual reorganization of two-tone images in preschool children. In *Development and Learning, 2007. ICDL 2007. IEEE 6th International Conference on* (pp. 181-186). IEEE.

Yoon, J. M., Witthoft, N., Winawer, J., Frank, M. C., Everett, D. L., & Gibson, E. (2014). Cultural differences in perceptual reorganization in US and Pirahã adults. *PloS one*, *9*(11), e110225.