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Drawing as a Window onto Expertise

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ABSTRACT

The ability to draw is a uniquely human activity, ubiquitous in childhood but seldom performed at expert levels in adulthood. Relative to other domains of expertise (chess, music, sport) drawing is understudied, and yet because it is a universal developmental ability mastered by so few, it provides an ideal testbed for competing theories of expertise. In this review, three strands of active research and debate in the field of expertise will be considered in relation to representational drawing ability: (1) The characterization of expertise in relation to altered visual attention and memory; (2) The relative roles of personality traits and cognitive abilities; and (3) The interaction between genes and environment in the development of expertise. The study of representational drawing sheds new light on these three strands and provides rich avenues for further research in this domain.

KEYWORDS: Expertise; Drawing; Individual Differences; Attention; Visual Memory

INTRODUCTION

'*Let whoever may have attained to so much as to have the power of drawing know that he holds a great treasure*.' Michelangelo (Holroyd & Hollande, 1903, p. 322)

The ability to accurately record and communicate our visual experience using mark making is a uniquely human capacity. Almost all children draw before they can read or write, their abstract scribbles becoming more figurative as they grow up (Harris, 1963). However, representational drawing is quite often abandoned in late childhood, as budding artists struggle to produce a satisfactory likeness of the visual world (Gardner, 1980). A subset of individuals who pursue representational drawing as a medium of expression can develop astounding representational skills, epitomized by the work of old masters like Leonard da Vinci, Michelangelo and Raphael. However, unlike other well-defined domains of expertise (e.g. chess, sports and music), the ability to draw has received surprisingly little empirical scrutiny. The bulk of research in this domain has focused on drawing as a window onto cognitive and emotional development, rather than as a domain of expertise. This could be due to the perceived subjectivity of drawing evaluation, whilst a key requirement for expertise research is that performance can be objectively assessed (Hambrick, Burgoyne, Macnamara, & Ullén, 2018). Recent developments in the field have demonstrated that representational drawing skill in adulthood *is* an objectively measurable and reliable construct (e.g. Chamberlain, McManus, Riley, Rankin, & Brunswick, 2014). It is important to note that representational drawing ability is regarded as neither a necessary nor sufficient precondition for the ability to create abstract or expressive art. However, associations between technical and creative properties of artworks have been found in past research (Kozbelt, 2004) suggesting that technical skills may provide a scaffold for creativity.

The purpose of this article is to position representational drawing as an overlooked and empirically rich domain of expertise, the study of which can contribute to active debates in the field. (1) Characterizations of expertise based on altered visual attention and memory can be investigated through the medium of drawing, particularly the relative roles of holistic and local visual processing, which has previously been investigated in the context of perceptual expertise for faces, birds and cars (Bukach, Phillips, & Gauthier, 2010), and where drawing studies appear to contrast with a perceptual expertise account. (2) Drawing skill provides a sound basis for understanding the relative contributions of and interactions between personality and cognitive factors, which is necessary for a complete account of expertise (Ullén, Hambrick, & Mosing, 2016), and is especially pertinent in light of recent debates concerning the predictive power of practice and innate talent. (3) Drawing is a skill that almost every human being learns but very few master, making it an ideal subject for testing competing theories about the roles of innate talent and practice in the development of expertise. Previous accounts of expertise have either argued that deliberate practice accounts for most of the variance in expertise development (e.g. Ericsson, Krampe, & Tesch-Romer, 1993) or have posited that innate ability and personality play a much larger role than previously thought (Hambrick et al., 2014). A recent multifactorial gene-environment model of expertise (MGIM; Figure 1) suggests that domain-general traits and domain-specific knowledge and skills exert direct and indirect influence over expertise and are governed by interplaying genetic and environmental factors (Ullén et al., 2016). What follows is a summary of research on representational drawing which speaks to these three debates in expertise research.

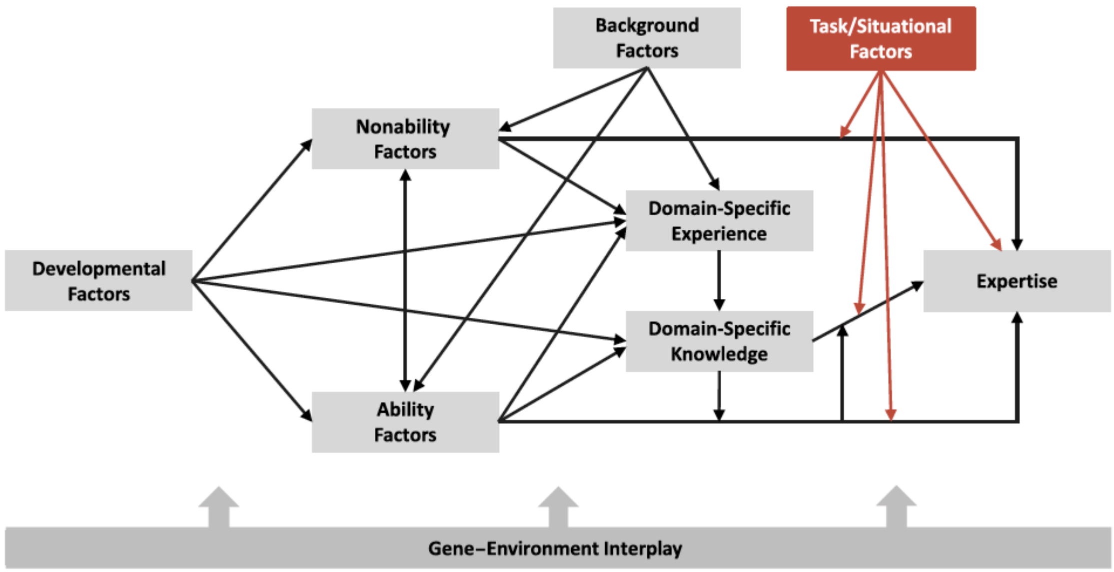

Figure 1. The multifactorial gene-environment model (MGIM) of expertise from Hambrick, Campitelli and Macnamara (2017). In this model ability factors (such as IQ and perceptual abilities specific to an expertise domain) and non-ability factors (personality traits such as grit and openness to experience) interact to shape an individual's experience and acquired knowledge in a domain which in turn shapes the development of expertise. These observable characteristics (phenotypes) are themselves influenced by genetic and environmental factors. Note that this is a general model of expertise, and not one specific to drawing. For an in-depth treatment of this model, see Ullén et al. (2016).

ATTENTION AND MEMORY

Representational drawing can be viewed as an instance of perceptual expertise. Research suggests that expert portrait artists show enhanced facial recognition and discrimination in much the same way as an ornithologist would show enhanced recognition and discrimination of birds (Devue & Barsics, 2016), although more recent research suggests that face recognition abilities are too highly developed in adulthood to be shaped by representational drawing experience (Tree, Horry, Riley, & Wilmer, 2017). The perceptual expertise account (Richler, Wong, & Gauthier, 2011) suggests that experts witness a shift toward automatic holistic visual processing in their domain of expertise, which results from the requirement to consistently individuate particular members from a highly similar set of stimuli. In contrast to the perceptual expertise account, research on representational drawing has shown a robust relationship between drawing expertise and performance on *local* visual processing tasks such as finding a figure embedded in a complex pattern and recreating a complex pattern using individuated colored blocks (e.g. Chamberlain, McManus, Riley, Rankin, & Brunswick, 2013; J. E. Drake & Winner, 2011). Furthermore, Tso and colleagues (2014) found a dissociation between perceptual expertise for reading and writing Chinese characters, with reading engaging a more holistic and writing a more local approach to visual analysis. This suggests that the holistic model of perceptual expertise does not generalize to all domains, particularly those that invoke action at the same time as perception, and require skills supplementary to recognition and identification.

It seems plausible to suggest that representational drawing requires *both* local and global selective attention at different stages in the drawing process. When drawing the human body in a life drawing class, it is advantageous to pay attention to local elements (e.g. the angle of an elbow) at some moments and holistic spatial relations (e.g. the relative length of the torso to the legs) at others. In support of this intuition, evidence suggests that artists can successfully integrate parts of an object into a meaningful whole using less information than novices (Perdreau & Cavanagh, 2013), and are better at selecting the most salient aspects of an image for rendering a convincing global representation (Kozbelt, Seidel, ElBassiouny, Mark, & Owen, 2010). It can be argued that superior performance on representational drawing tasks is more likely to reflect attentional flexibility than a failure of selective attention to parts or wholes (Chamberlain, Heeren, Swinnen, & Wagemans, 2018; Chamberlain & Wagemans, 2015). To return to the example of portraiture, presenting a face upside-down disrupts the ability to draw long-range spatial relationships between facial features (holistic processing) but has no impact on the processing of the features themselves (Ostrofsky, Kozbelt, Cohen, Conklin, & Thomson, 2016), suggesting that accuracy in drawing faces is dependent on both holistic and featural processing (for a full treatment of perceptual expertise effects in representational drawing see Chamberlain & Wagemans (2016) in the recommended readings section).

Much like other domains of expertise (such as chess), the ability to draw well (i.e. render an accurate representation of a stimulus as judged by an observer) is also associated with superior visual memory. Expert adult artists encode visual stimuli in larger chunks than novices, allowing for more efficient integration of visual information across eye movements (Perdreau & Cavanagh, 2014). Representational drawing ability is associated with an enhanced ability to recall a complex geometric figure previously drawn, both immediately and after a 30-minute delay (McManus et al., 2010). Expert artists are also more likely than novices to notice subtle changes to an object they are drawing or in their drawing itself. However, they show no advantage on memory tasks in which drawing is not required (Perdreau & Cavanagh, 2015). This pattern of data echoes the predictions of existing models of expertise, particularly chunking theory in which units of perception or meaning are stored in long-term memory (Chase & Simon, 1973) and long-term working memory theory in which stored structures facilitate encoding of visual information in a domain-specific manner (Ericsson & Kintsch, 1995).

These findings suggest that enhanced visual memory for drawing may not always be related to specific classes of objects, but to the kinds of visual analysis which are associated with the drawing process, and this deviates from a traditional account of perceptual expertise. This echoes the conclusions of Kozbelt (2001) who suggested that artists' perceptual abilities are developed largely to the extent that they underpin drawing abilities. To summarize, expertise in the domain of drawing appears to be characterized by attentional flexibility and enhanced visual encoding. Enhanced encoding, rather than being specific to visual stimuli (notwithstanding specific domains of perceptual expertise such as face processing in portraiture), may be associated with the kinds of visual analysis required for drawing. This highlights the importance of regarding drawing as a motor skill, with as much in common with domains such as dance and sports, as with perceptual domains such as ornithology and chess.

PERSONALITY AND COGNITION

In the spirit of the MGIM model of expertise (Ullén et al., 2016), current research is pivoting towards paradigms that encompass numerous personality and cognitive variables and outcome measures of expertise. Personality factors such as openness to experience and motivation may interact (particularly through engagement with practice activities) to produce an expert. For example, correlations have been found between grit and deliberate practice in spelling bee contestants (Duckworth, Kirby, Tsukayama, Berstein, & Ericsson, 2011) and openness to experience with chess skill (Bilalić, McLeod, & Gobet, 2007). Openness to experience also appears to be consistently linked to engagements with the arts more generally. For example, a recent study revealed associations between openness to experience and realistic and expressive drawing ability (Pelowski, Markey, Goller, Förster, & Leder, in press). Finally, evidence suggests that practice and cognitive factors such as IQ have independent and additive effects on expertise acquisition (e.g. in art; Drake & Winner, 2009; in music; Ruthsatz, Detterman, Griscom, & Cirullo, 2008).

In a study of 300 adults at art schools in the UK, we explored the complex interactions between, traits, abilities and performance in the context of representational drawing expertise. Individual differences in IQ, visual memory, personality and approaches to learning were measured in relation to drawing practice and externally-rated and self-evaluated representational drawing ability (Chamberlain, McManus, Brunswick, Rankin, & Riley, 2015). We predicted that personality (particularly openness to experience) would correlate with drawing practice and approaches to learning, which in turn would be correlated with self- and externally-rated drawing skill (accuracy of representation). It was also predicted that cognitive factors (IQ and visual memory) would exert independent effects on drawing skill, in the same way as in the musical domain.

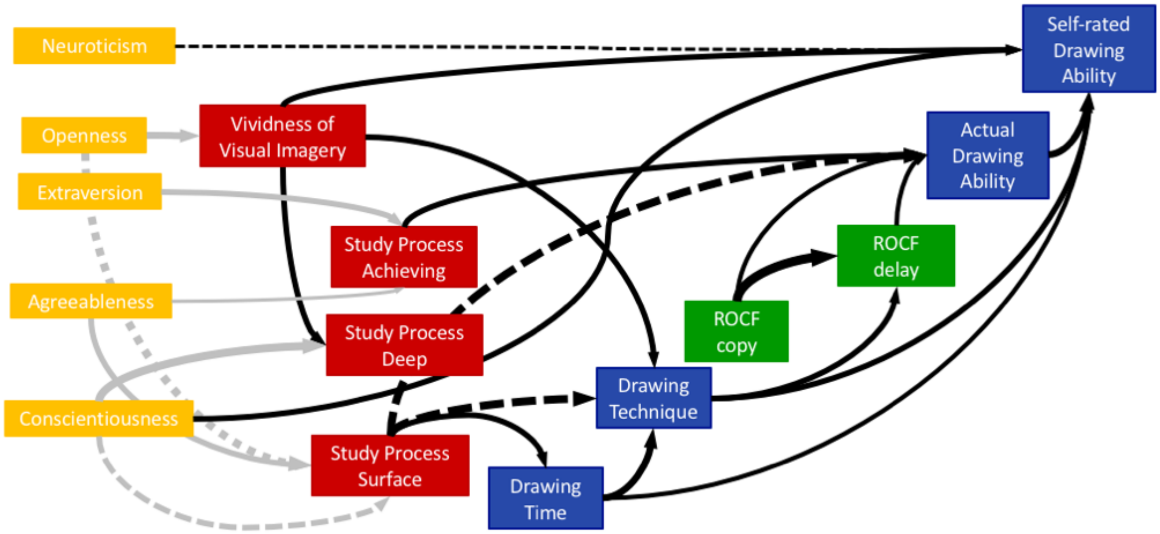

Figure 2. A simplified diagram of the association between personality variables (shown in yellow and red) to four measures of drawing performance (shown in blue) and two measures of visual memory (shown in green), adapted from Chamberlain et al. (2015). Actual drawing ability was derived from accuracy ratings provided by a set of judges on participants' drawings of a hand and block construction. Self-rated drawing ability was given by participants' responses to a questionnaire on their drawing abilities (e.g. ability at drawing from observation, ability to use perspective, confidence in mark-making). Paths indicating positive relationships between variables are drawn as solid lines and those with negative relationships are drawn as dashed lines. Gender was included as a predictor in the full model but is not visualized here for simplicity.

A summary of the overall pattern of data from Chamberlain et al. (2015) can be seen in Figure 2. IQ was not included in the final model, as it did not predict drawing expertise or any of the background variables associated with drawing. On the other hand, visual memory exerted positive effects on drawing expertise, which were largely independent of personality and practice factors. The findings revealed that individual differences in approaches to learning were related to drawing ability, and they themselves were driven by differences in personality. A surface strategy to learning (a desire to avoid failure), negatively related to openness to experience and conscientiousness, increased the amount of time spent practicing drawing, but decreased the range of practice techniques used and resulted in a lower level of ability. An achieving strategy to learning (a desire to succeed) by contrast, positively related to extroversion and agreeableness, and proved the most successful for drawing expertise development. An achieving learning style may be related to the concept of motivation, which has previously been found to predict technical artistic skill in young art students (Rostan, 2010). Overall the findings of this study suggest that practice alone is not sufficient for the development of expertise unless it is associated with flexible use of various techniques. In support of this conclusion, the uptake of strategies for practice, rather than cumulative time spent practicing, has been shown to be a prominent predicting factor in expertise development in other domains such as music (e.g. Hallam, 2001).

In summary, cognitive and dispositional traits appear to contribute relatively independently to the development of representational drawing expertise in line with previous research (Ruthsatz et al., 2008), but personality factors interact with practice to impact performance, supporting research that shows that the development of expertise is dependent on factors such as motivation and personality (e.g. Bilalić et al., 2007; Rostan, 2010). The inclusion of approaches to learning was novel in this context, and aimed to explore motivational factors in expertise development, a neglected issue which is also addressed in the subsequent section on practice and ability. Additional large-scale correlational studies are required to validate and test the generalisability of this model of representational drawing expertise to more creative expertise domains (such as the creation of imagined or abstract images) which require the invention of new images or concepts rather than the accurate mapping of stimuli in the environment to the page, which seem to show divergent associations with personality variables such as openness to experience (Kandler et al., 2016) and need for cognitive closure (a desire to avoid ambiguity; Pelowski et al., in press).

PRACTICE AND ABILITY

An active area of debate in the expertise literature concerns the relative roles of genetic and environmental factors in the acquisition of expertise (Ullén et al., 2016). Several meta-analyses have discovered that deliberate practice plays a modest role in expertise development in games, music, sports, education and professional contexts (e.g. Macnamara, Hambrick, & Oswald, 2014), leaving the door open for latent ability and other genetically-moderated factors. Studies of child prodigies suggest that the foundations of drawing expertise are largely independent of deliberate practice and include: enhanced working memory and attention to detail, and strong internal motivation coined a ‘rage to master’ (Drake & Winner, 2012, p. 13). There is sparse literature on the genetic basis of drawing expertise in contrast to other arts domains such as music (e.g. Mosing, Madison, Pedersen, Kuja-Halkola, & Ullén, 2014), however the study of genetic and environmental impacts on drawing expertise could shed further light on how genes and environment might interplay in expertise development. Considering artistic ability in a more general sense, Vinkhuyzen et al. (2009) found that genes accounted for a substantial amount of variation in self-reported artistic and creative talent and the impact of shared (familial) environmental was low. A study by Arden et al. (2014) in which the drawings of nearly 8000 pairs of identical and non-identical twins were analysed, also demonstrated that genes exerted a greater influence on children's inclusion of details in figure drawing at age 4 than between-family environmental effects. However, it is unknown whether this rather constrained conception of artistic ability at age 4 predicts later artistic skill, or whether those that perform less well at this task at a young age catch up in later stages of development. Therefore, whilst these studies are not a direct test of the role of genes versus deliberate practice in expertise development (as they do not include any measures of practice in their design), they do suggest that drawing ability is under substantial genetic control in childhood, and that this genetic variability could carry through to influence performance later in life.

All children draw to some degree or another and yet the number of adults with drawing expertise is relatively few. As a result, it is possible to track the contributions of genetic and environmental factors to drawing skill from childhood into adulthood. There is likely to be substantial gene-environment interplay in the development of drawing expertise, particularly in terms of motivation to practice. The influence of genes on the amount of practice an individual engages in has been shown to be as great as the influence of genes on ability in the musical domain (Mosing et al., 2014). Similarly, the drive to practice may also be under substantial genetic control in the visual arts domain as it appears very early and seemingly without (environmental) parental influence in child drawing prodigies (Drake & Winner, 2012).

CONCLUSION

This article has provided evidence that representational drawing ability is a tractable domain, the study of which can provide new insights into the characteristics and mechanisms of expertise. (1) Expertise in representational drawing appears to run against theories of perceptual expertise by demonstrating that professional artists show superior local *and* global processing of visual stimuli, rather than a tendency to process stimuli automatically in a holistic way. In addition, enhanced visual encoding and retrieval appears to be associated with the development of drawing expertise, which tends not to be associated with classes of visual stimuli. (2) A large-scale correlational study revealed the relative independence of cognitive and personality factors in determining expertise in drawing, but showed an interaction between personality variables and the quality and quantity of practice which ultimately influenced objectively measured ability, highlighting the important of factors like motivation in the development of expertise. (3) Genetic studies have indicated that drawing ability is heritable and that genes are likely to play a direct role in ability but possibly in the tendency to practice as well, however this finding has yet to be validated in an adult sample. This speaks to the current debate over the relative role of innate, talent-based factors in the acquisition of expertise, pointing toward a substantial genetic component.

Areas where more research is required in this domain are many and have been highlighted throughout this article. Future research should aim to employ research paradigms with a wide range of cognitive, personality, and performance variables, in large participant samples, and with the potential to explore both genetic and environmental contributions to expertise. It may be particularly interesting to explore expertise in the context of the arts by conducting studies which contrast disciplines (e.g.

music, dance and visual art) with one another in a similar manner to studies of child prodigies (Ruthsatz, Ruthsatz-Stephens, & Ruthsatz, 2014). Historically, arts domains have been treated relatively independently, and the study of expertise may reveal surprising similarities in the personality, cognitive and perceptual profiles of experts across disciplines. Differentiating those aspects of practice and innate talent that predict expertise in creative and technical domains (e.g. architectural drawing) would be particularly pertinent for expertise in the arts. Research that identifies the genetic and environmental contributions to arts expertise more generally will undoubtedly have broad implications for art and design education.

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