Towards a Characterisation of Emotional Intent During Scripted Scenes Using In-ear Movement Sensors

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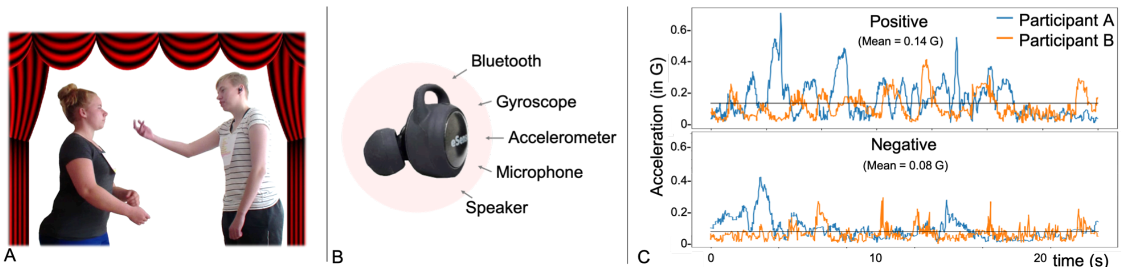

Fig. 1. A: Dyad during a trial, B: Nokia Bell Labs' eSense earbud [3], C: Head movement energy of two trials. The graphs show a higher average energy for both playing positive intent ('motivate', 'reassure') than negative ('displease', 'block').

Theatre provides a unique environment in which to obtain detailed data on social interactions in a controlled and repeatable manner. This work introduces a method for capturing and characterising the underlying emotional intent of performers in a scripted scene using in-ear accelerometers. Each scene is acted with different underlying emotional intentions using the theatrical technique of Actioning. The goal of the work is to uncover characteristics in the joint movement patterns that reveal information on the positive or negative valence of these intentions. Preliminary findings over 3x12 (Covid-19 restricted) non-actor trials suggests people are more energetic and more in-sync when using positive versus negative intentions.

CCS Concepts: • **Human-centered computing → Empirical studies in collaborative and social computing**.

Additional Key Words and Phrases: intent, emotion, affect, theatre, synchrony, earables, wearables

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1 INTRODUCTION

Nonverbal signalling, whether as a communicative back-channel, or as a direct gesture, does not occur in isolation but as a response to, or in synchrony with, the actions of others [4, 10]. Much attention has been paid to the role of physical coordination and interpersonal synchrony during social interactions [1, 8]. Of particular interest is understanding the physical mechanisms we use to convey emotional intent. Paxton and Dale, for instance, used video to show that when

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couples get into an argument, their interpersonal body synchrony breaks down - although they could not establish a more general link between synchrony and intent [15]. Recent work uncovered complex patterns of synchrony using fine-grained recordings of people's head movements in conversation, yet precisely what these patterns represent remains an open question [7, 9].

Studies on the mechanisms of affect are often hampered by a lack of ecological validity - the twin difficulty in eliciting realistic emotions, and of recording them in an unobtrusive manner. Wearable movement sensors can capture patterns of coordination in social interactions in an unobtrusive way, and with none of the occlusion problems that beset video [2, 21, 22]. Theatre (and the arts generally) has long provided a mechanism for exploring emotional subtext [13, 14, 16, 18, 19]. In this work we harness that mechanism as a means to elicit realistic nonverbal data, which we then capture using head-worn wearable sensors.

Specifically, we ask pairs of participants to repeatedly play one scene of a play by James Saunders [17] (Fig. 1 A), each time using different emotional intentions. The unique aspect of this setup is that we use the theatrical technique of *Actioning* whereby actors are given different transitive verbs to think on as they deliver a line [19, 20]. The idea is that these verbs colour a delivery in a subtle way without it appearing forced. The method is intuitive and intrinsically interpersonal (e.g. asking a participant to subconsciously 'attack' their partner, rather than the typically more unfocused, and often over-acted, 'be angry'). As such it is effective even for use by non-actors.

Head movements of participants are recorded using the eSense in-ear wearable (Fig. 1 B). The device's 3-axis accelerometer is used to capture frequency and amplitude of motions while its microphone captures audio for labelling purposes [11, 12]. The data was logged on an Android phone using an adapted version of an app originally developed by by S. Islam [5]. Due to the Covid-19 induced necessity of using non-actors, this preliminary study makes a simple comparison between scenes where both speakers use a clear positive intent, versus scenes where both use a negative intent. The main question is: What effect do the positive and negative conditions have on joint movement energy and synchronisation?

2 METHOD

The procedure is shown in Fig. 2. Each eSense earbud is connected to two phones running the Android app. With the recordings started, both devices are tapped gently together to create a distinct audio-motion synchronisation gesture, then each participant is given a left earbud to wear.

Each participant is assigned a role in the scene (M or W) and a pseudo-random transitive verb (from an even distribution of 9 positive and 9 negative verbs). The experimenter clicks a button on the app to indicate the start of a scene. The scene is then performed by the dyad. Lastly, the experimenter presses the button again to mark the end of a scene. One trial takes approximately 40 seconds.

After a two minute break the participants get a new set of transitive verbs. This is repeated until all verb pairs have been performed. The participants then switch roles and repeat the process, thus generating 18 trials (plus an initial 2 training trials that we discard). At the end, the recordings are stopped. For this preliminary study we analyse only instances where both participants receive a positive pair (++), or a negative pair (- -) of verbs (12 trials).

3 DATA AND ANALYSIS

Three participants from one household were recruited and paired up across three separate experiments. The sensor data is low-pass filtered by the device at 10Hz, with a sampling rate of 25Hz. The raw data of each dyad was manually synchronized using the sync gesture. Labels recorded by the experimenter are then used on both recordings to cut the

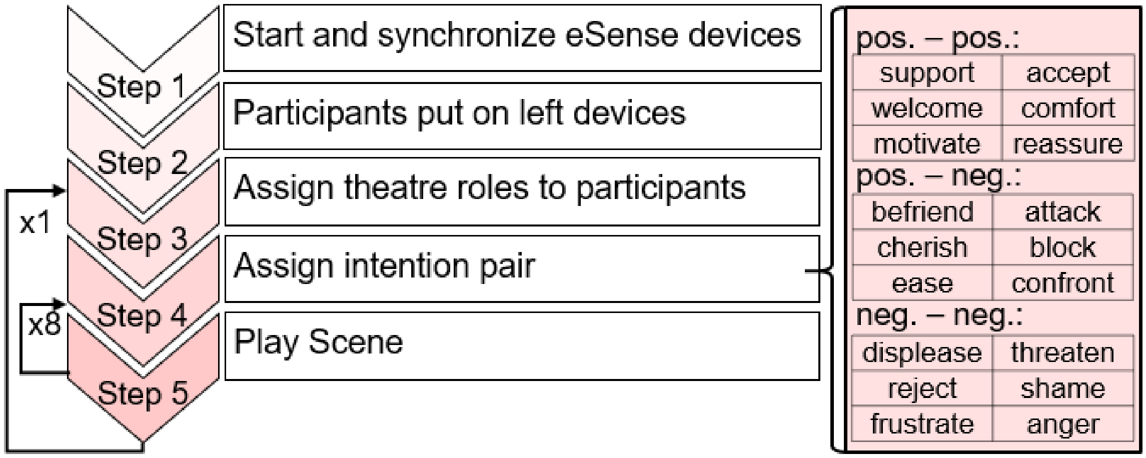

Fig. 2. Study procedure with transitive verbs used.

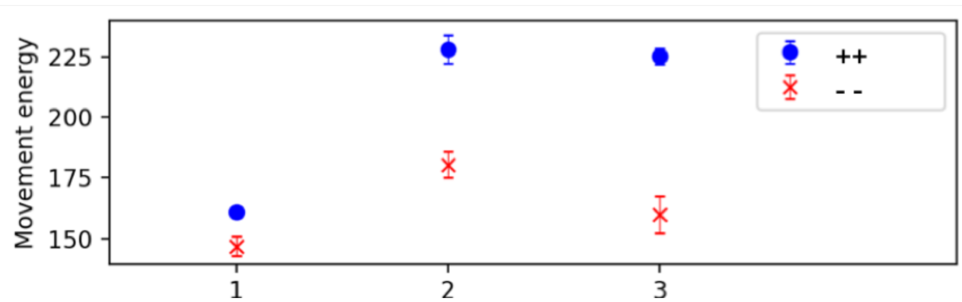

Fig. 3. Combined energy mean and SE for pos-pos (++) and neg-neg (- -) trials for each of the 3 dyad pairings.

data into separate trials. Before running the analysis the accelerometer data is re-centred to mean zero. The norm of the three axes are then calculated for each person to provide an orientation-invariant measure of overall movement energy. [1]

For each of the three dyad pairings, the ++ and - - trials are compared in two ways: 1) overall dyad movement energy, and 2) wavelet coherence analysis, a spectral method of capturing synchronicity [6, 9].

The mean and standard error (SE) over trials for each dyad's energy is shown in Fig. 3. Note how the ++ positive intents have consistently higher energy than the negative ones (e.g. Fig. 1 C.)

The mean and SE of the wavelet coherence analysis over the three pairings for both conditions are shown at the top of Fig. 4. This is shown for periods of 1 to 10 seconds (1 to 0.1 Hz), with Cohen's d effect size shown below. Note how the effect size is largely positive (with periods of around 2 and 8 s showing significance).

4 DISCUSSION

This work was planned for a large cohort of actors, however due to Covid-19 regulations, the procedure had to be adapted to a single household. Consequently, the acting quality is disputable and the participants had not learned the

[1]Download dataset and code at https://github.com/SabrinaFrohn/ISWC2020_paper.

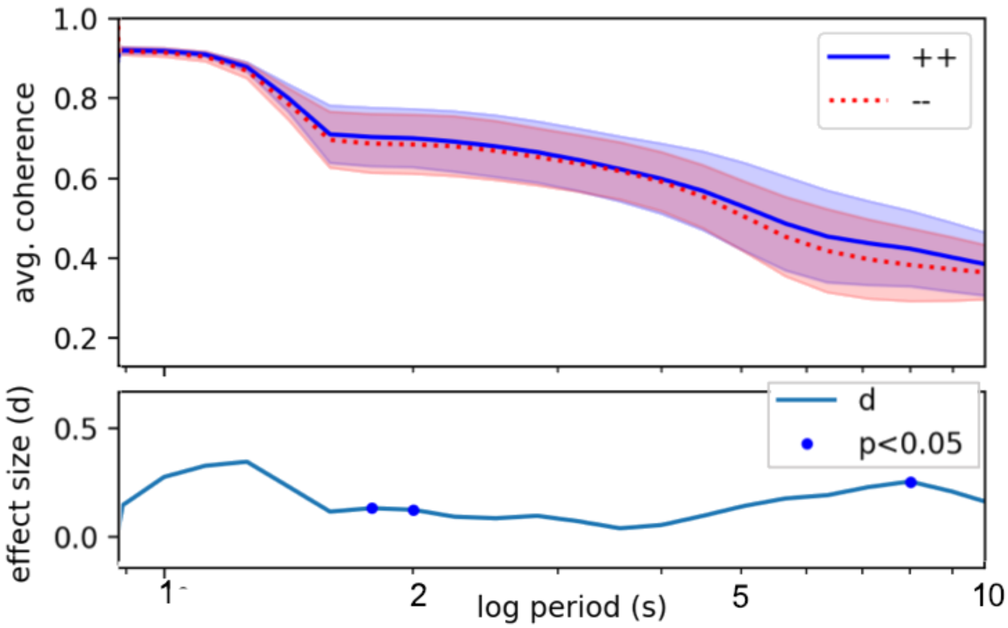

Fig. 4. Average wavelet coherence analysis with SE over 3 dyads for both positive (++) vs both negative (- -). Effect size and points of 0.05 significance shown below.

text completely by heart before taking part in the study. This reduces the reliability of the current results. However, the finding that joint positive intent can be more energetic and synchronous than negative aligns with existing (video-based) literature [15], and offers some support to the approach proposed.

Encouraged by this proof of concept, future work will enhance the experiment using professional actors, introduce a more detailed analysis of subtle interactions, and develop an attempt to automatically model and predict different emotional intentions.

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