The effects of self-awareness on body movement indicators of the intention to deceive

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1. Introduction

This research was conducted for the Shades of Grey EPSRC research project (EP/H02302X/1) which aims to develop scientific interventions for eliciting robust and reliable indicators of suspicious behaviour. The project was funded in response to an increase in acts associated with terrorism (Home Office Statistical Bulletin, 2010). This study was conducted as part of a work package which aimed to investigate mechanisms for revealing behavioural cues to deception.

Prior research has demonstrated that there is no single, reliable cue to deceptive behaviour (Vrij, 2004). However, liars may experience one or more of three interlinking processes: emotion, cognitive effort and attempted behavioural control, which evoke verbal, non-verbal or physiological responses that differ to those made by truth-tellers (Zuckerman et al., 1981; Vrij, 2004). While other papers in this special issue focus on speech (Kirchhüebel and Howard, in press) and physiological aspects (Eachus et al., in press) of deception, this study aimed to investigate non-verbal behaviour. Several non-verbal behaviours have previously been associated with the processes mentioned above, although the effect sizes are often small and hence these behaviours only provide weak cues to deception (e.g. DePaulo et al., 2003).

The emotions associated with deception include fear (of being caught), guilt (for acting deceptively) and duping delight (a consequence of success or anticipated success in a deceptive act) (Ekman, 1985). Fear and duping delight may both result in signs of arousal in the deceiver, for example an increase in limb movements (Vrij, 2008). Excitement (caused by duping delight) may also result in signs of joy, such as smiling (Memon et al., 2003), whereas guilt is more likely to result in gaze aversion (Vrij, 2008). Furthermore, as part of their deception liars may have cause to mask signs of the true emotion they are experiencing. The effects of this masking can fail, in which case emotional leakage, identifiable in facial expressions, can provide an indication of deception (Ekman and O'Sullivan, 2006).

Lying sometimes requires greater mental and cognitive effort than truth-telling. Because deceivers might be pre-occupied by creating lies, they need to pay special attention to their behaviour (Vrij, 2008). They must also monitor the reactions of their targets, and suppress the truth when lying. These activities all require cognitive effort (Walczyk et al., 2003, 2005; Vrij, 2008; Carrión et al., 2010). Engaging in cognitive complexity can result in changes in the frequency or speed of gestures (Ekman and O'Sullivan, 2006), less blinking (Bagley and Manelis, 1979), and more gaze aversion (Ekman, 1997). Cognitive effort may also result

in a decrease in body movements, since the high demand leads to the neglect of body language (Vrij, 2008).

Liars adjust their behaviours during a deceptive act by monitoring the reactions from their targets (Buller and Burgoon, 1996). Perceiving, monitoring and communicating with targets helps liars to successfully deceive (e.g. Burgoon et al., 2001, 2008). To appear honest or normal, liars may attempt to control their behaviour during deception. Some evidence shows that liars try to exhibit behaviour which they believe is credible, such as trying to behave positively and friendly (DePaulo et al., 2003). However, this deliberate self-regulation can sometimes make liars appear over-controlled (Vrij, 2008). Thus, attempted behavioural control can result in liars who look too rigid and tense (Memon et al., 2003; DePaulo et al., 2003).

This study aimed to investigate a forced increase in self-awareness as a mechanism to amplify behavioural differences between truth-tellers and liars. Raised self-awareness has previously been shown to affect performance through focus and evaluation of oneself. For example, Wicklund and Duval (1971) found that performance on a writing task improved when participants faced a mirror, which was explained through their increased self-awareness and greater focus on themselves and their standard of performance. Thus, while a mirror is an effective tool for raising self-awareness (Fenigstein et al., 1975), the effects of this on deceivers had not previously been investigated. In this study, the mirror was used to investigate whether greater self-awareness would increase the emotion, cognitive effort, and attempted behavioural control experienced by deceivers, and hence exaggerate the differences in non-verbal behaviour between them and truth-tellers. Furthermore, existing research has often been based on participants' behaviour during interviews in which they are required to act deceptively, which as discussed above has revealed few strong cues to deception (DePaulo et al., 2003; Vrij, 2004). This study aimed to investigate cues to deception exhibited by people as they prepared to act deceptively, prior to the interview starting. The outcome of this research could be used to support security personnel, for example as they monitor suspects in a waiting area prior to interview.

A summarised version of this study is provided by Lawson et al. (2011). Full details are provided in the following sections.

2. Method

2.1. Participants

In this study 80 participants were recruited: 39 male and 41 female (mean age ¼ 20.14 years, SD ¼ 1.30 years, range ¼ 18e24 years). All were undergraduate students from the University of Nottingham. Recruitment was conducted by opportunistic participant self-selection in response to posters around the campus and emails sent to student mailing lists. These specif ed that applicants should not suffer from any mental ill-health. This was a requirement of the University of Nottingham Faculty of Engineering Ethics Committee to minimise the impact of any potential distress participants might have experienced when expecting to lie in the deception condition. The self-selection process also avoided the necessity for participants to reveal any mental health conditions to the experimenter, thus there was no further screening for this criteria.

2.2. Apparatus/equipment

The experiment was conducted in a small laboratory which contained a reception area and an interview area with chairs for the participant and the interviewer (Fig. 1). Fig. 1a shows the high-self awareness (i.e. mirror) condition; for the low-self awareness (i.e. no mirror) condition the mirror was removed from the room. The environment was deliberately created such that it was relatively distraction free: participants could not see out of any windows and objects were removed from the walls. Only the participant and the researcher were allowed access to the laboratory during the experiment.

Fig. 1b was taken from the participant's seat looking towards the interviewer's seat. A camcorder, used to capture participants' movements, was hidden within the large green box f le (Fig. 1c). The aperture on the f le had to be widened to enable the camera to capture the area in which the participant was seated. Thus, it was possible to identify the lens, but only with close attention. Typical off ce products (glue stick, CD, marker pen) were located around the aperture to divert the participants' attention from the lens.

The short state-trait anxiety inventory (STAI) questionnaire (Marteau and Bekker, 1992) was also used in the trial, unchanged from its original form. This determines anxiety based on 4-point subjective rating scales for six associated states, namely: calm, tense, upset, relaxed, content, and worry. This was used to gain some understanding of the emotional state of the participant, in particular an indication of whether there was greater fear (of getting caught) in those intending to deceive (Vrij, 2004).

2.3. Experimental design

A 2*2 between-subjects design was developed for this experiment, with the independent variables of self-awareness and deception. Self-awareness contained two levels: high and low. In

Fig. 1. (a) Interview room set-up (high-self awareness condition); (b) View to the right from the participant's seat; (c) Close up of objects in the interview area. The largest folder contains a covert camera.

the high self-awareness condition, participants faced a full length mirror during the waiting period (Fig. 1a). In the low self-awareness condition the mirror was removed and participants faced a blank wall. Deception also contained two levels: truth/lying. In the truth condition participants were told that during the interview they were to answer all questions truthfully; in the lying condition participants were told to give no truthful answers during the interview. Thus, four experimental conditions were developed, each with 20 participants (Table 1). A random number generator was used to assign each participant to one of these conditions before they arrived at the trial.

2.4. Procedure

Participants were recruited expecting to take part in a trial to investigate deception skills in interview. Before each participant arrived, the hidden video camera was started. Upon arrival, participants were first taken to a reception area where a researcher re-iterated that the study was being conducted as part of research into deception skills in interview; no other details about the purpose of the study were provided. The researcher explained that when the trial started, an interviewer would arrive and ask them about their degree courses. It was also explained that the questions would not be of a sensitive nature (e.g. name, degree course, year of study, favourite module and number of people on your course).

Depending on the condition, participants were told that they should either give the correct answers (e.g. truth condition) or give no truthful responses (e.g. lying condition). They were told that the interviewer would not know to which condition the participants had been assigned. Participants' were asked if they were happy to continue after this initial instruction, and if so informed consent to participate was recorded. They were then asked to complete the short form STAI (Marteau and Bekker, 1992).

The researcher then led the participant to interview area (Fig. 1). The researcher asked the participant to wait for the interviewer to arrive. He told the participant he would return at the end of the session to organise the £10 gratuity payment. The researcher then left the room under the pretence of finding the interviewer, although he actually hid outside the laboratory and waited for 5 min.

After this period, the researcher re-entered the room and apologised for the delay. He told the participant that he had spoken to the interviewer, who would arrive shortly. The participant was asked to re-complete the short form STAI (Marteau and Bekker, 1992) for how they felt at that moment in time. This was again used to understand the emotional state of the participant, and to investigate whether anxiety had changed over the waiting period.

The researcher then asked the participant to return to the reception area. He told the participant that there was not actually going to be an interview, and that they had been recorded during the waiting period. The participant was asked to estimate how long they had been waiting. Finally, they were fully de-briefed and given the option to review or delete the video footage; if this was not required they were asked to sign consent for the data to be analysed.

Table 1
Experimental conditions.

		Self-awareness	
		High	Low
Deception level	Truth	1 (mirror/truth)	2 (no mirror/truth)
	Lying	3 (mirror/lying)	4 (no mirror/lying)

3. Results

3.1. Body movement

The video footage taken using the covert camera was analysed using the ObserverPro software. The coding scheme was based on previous research into cues to deception described in the introduction (Ekman, 1997; DePaulo et al., 2003; Memon et al., 2003; Vrij, 2004, 2008; Ekman and O'Sullivan, 2006) but was simplified due to the practical requirements for coding, and due to an emphasis on coarse gestures in the funding project. The coding scheme used is shown in Table 2. Hand or arm movement includes any finger, hand or arm movement on either left, right or both sides. Similarly foot or leg includes movement of the relevant body parts on left, right or both sides.

While all 80 participants were coded by a single researcher, 8 participants (10%) were randomly selected to be coded by a second researcher to investigate inter-rater reliability. These data were not used in the analysis of the behaviours, only to investigate reliability. Cohen's Kappa was found to be towards the upper limits of "moderate" agreement (Kappa ¼ 0.57; $p < 0.01$) (moderate agreement: 0.41e0.6; substantial agreement: 0.61e0.80; Landis and Koch, 1977). This relatively low agreement was investigated further with correlations of the duration and frequency of movements. For each movement category and for the directions of gaze the results were correlated between the raters, for both duration and frequencies. The results are shown in Table 3.

The durations all demonstrated significant findings and large effect sizes ($r \geq 0.5$ according to the values given by Cohen (1988)). The frequencies of "hand/arm movement" and gaze directions for "camera" and "other" demonstrated less reliability between the raters. Given that only the data from the primary-rater were used in this study, the results were deemed acceptable. However, future work should aim to increase the reliability of the coding taxonomy, particularly for frequencies of acts.

The results (as coded by the primary researcher) are shown below. Initially MANOVAs were run to investigate the duration of movements (i.e. total time spent moving) and frequency of movements (i.e. total number of times the body part was moved regardless of duration) for hands/arms, feet/legs and whole body/torso. Significant findings were followed up with further tests. As the specific direction of gaze was measured (rather than movement/non-movement for the other dependant variables) this was investigated separately and is reported in Sections 3.1.5 and 3.1.6. All results were tested for significance at $p < 0.05$.

3.1.1. Body part movement MANOVAs

The hands/arms, feet/legs, whole body/torso movement data were investigated using 2*2*3 (deception*self-awareness*body part) MANOVAs for both duration and frequencies of movements. The results for duration of movement are shown in Table 4.

The significant main effect for body part indicates that people moved each body part differently. Post hoc pairwise comparisons with Bonferroni correction revealed differences between each body part (hand/arms and whole body: mean difference ¼ 164.947; $p < 0.001$; hand/arms and feet/legs: mean difference ¼ 96.225;

Table 2
Coding scheme.

Hand or arm (either left or right)	Foot or leg (either left or right)	Whole body or torso	Gaze direction
Moving	Moving	Moving	Directly forwards
Still	Still	Still	Towards camera
			Other

Table 3
Pearson's correlation (r_p) between primary and secondary raters.

Body part	Duration	Frequency
Hand/arm	r_p ¼ 0.968; n ¼ 8; p < 0.001*	r_p ¼ 0.509; n ¼ 8; p ¼ 0.198
Foot/leg	r_p ¼ 0.979; n ¼ 8; p < 0.001*	r_p ¼ 0.766; n ¼ 8; p ¼ 0.027*
Body/torso	r_p ¼ 0.924; n ¼ 8; p ¼ 0.001*	r_p ¼ 0.929; n ¼ 8; p ¼ 0.001*
Gaze: forwards	r_p ¼ 0.751; n ¼ 8; p ¼ 0.032*	r_p ¼ 0.872; n ¼ 8; p ¼ 0.005*
Gaze: camera	r_p ¼ 0.873; n ¼ 8; p ¼ 0.005*	r_p ¼ 0.552; n ¼ 8; p ¼ 0.156
Gaze: other	r_p ¼ 0.763; n ¼ 8; p ¼ 0.028*	r_p ¼ 0.523; n ¼ 8; p ¼ 0.184

*Indicates signif cance at p < 0.05.

p < 0.001; whole body/torso and feet/legs: mean difference ¼ -68.723; p < 0.001). Descriptive statistics for body part durations are shown in Table 5.

Arguably more interesting is the interaction between body part*deception*self-awareness shown in Table 4, which indicates that body part movements were inf uenced differently based on deception and self-awareness. This is investigated further with ANOVAs for each body part in Sections 3.1.2e3.1.4.

The results of the MANOVA for frequency of body part movements is shown in Table 6. Only body part reveals a signif cant difference.

Pairwise comparisons with Bonferroni correction indicate differences between hand/arm and whole body/torso (mean difference ¼ 4.550; p < 0.001) and whole body/torso and feet/legs (mean difference ¼ -5.875; p < 0.001). There was no signif cant difference between hand/arm and feet/legs (mean difference ¼ -1.325; p ¼ 0.053). The descriptive statistics are shown in Table 7.

As no interaction was seen in Table 6, the frequency of body movements were not investigated further with individual ANOVAs.

3.1.2. Hands/arms: duration of movements

Hand and arm movement was f rst investigated using a 2*2 (deception*self-awareness) between-subjects ANOVA. The results for duration of movement are shown in Table 8. This demonstrates a signif cant interaction between deception and self-awareness. The interaction plot in Fig. 2 shows that without a mirror, participants expecting to tell the truth spend more time moving their hands than those expecting to lie; the opposite was observed in the mirror condition.

The descriptive statistics for the durations of hand/arm movements are shown in Table 9 below.

3.1.3. Legs/feet: duration of movement

No signif cant main effects, or interaction, were found for duration of leg/foot movements (Table 10).

3.1.4. Whole body/torso: duration of movements

A main effect of self-awareness was found for duration of whole body/torso movements (Table 11). Those with the mirror spent longer moving (mean duration: 28.584 s; SD ¼ 46.192) than those without the mirror (mean duration: 12.225 s; SD ¼ 11.838). No signif cant main effect was seen for deception, or interaction between deception and self-awareness.

Table 4
MANOVA for duration of body part movements.

Effect	F[a]	df	p	Eta^2
Body part	211.375	2,75	<0.001*	0.849
Body part*deception	1.668	2,75	0.196	0.043
Body part*self awareness	0.165	2,75	0.849	0.004
Body part*deception*self-awareness	3.505	2,75	0.035*	0.085

*Indicates signif cance at p < 0.05.
[a] Pillai's Trace.

Table 5
Descriptive statistics for duration (seconds) of body part movements.

Body part	Mean	Standard deviation
Hand/arm	185.351	68.859
Feet/legs	89.127	57.716
Whole body/torso	20.405	34.501

3.1.5. Gaze direction: duration

The dependant variable for gaze direction contained three levels: directly forwards, towards camera and other. Therefore, this was investigated using a 2*2*3 mixed ANOVA, with the variables of deception (expecting to lie/expecting to tell the truth), self-awareness (high/low) and gaze direction (described above).

A main effect was seen for gaze direction, with most time spent looking at "other" (mean ¼ 205.682; SD ¼ 67.350) followed by "forward" (mean ¼ 65.879; SD ¼ 67.885) and f nally looking towards the "camera" (mean ¼ 28.440; SD ¼ 23.957). Pairwise comparisons with Bonferroni correction revealed signif cant differences between each gaze direction (forward-camera: mean difference ¼ 37.439; p < 0.001; forward-other: mean difference ¼ -139.803; p < 0.001; camera-other: mean difference ¼ -177.242; p < 0.001). A signif cant interaction for gaze direction and self-awareness can also be seen in Table 12, indicating a change in gaze direction in the presence/absence of a mirror.

3.1.6. Gaze direction: frequency

For frequencies, the main effect of gaze direction was found to be signif cant with the highest frequency for "other" (mean ¼ 11.925; SD ¼ 5.233) followed by "camera" (mean ¼ 7.375; SD ¼ 3.921) and f nally "forward" (mean ¼ 6.450; SD ¼ 5.348). Pairwise comparisons with Bonferroni correction revealed signif - cant differences between forward and other (mean difference ¼ -5.475; p < 0.001) and camera and other (mean difference ¼ -4.550; p < 0.001). There was no signif cant difference between forward and camera (mean difference ¼ -0.925; p ¼ 0.416). Table 13 shows that the interaction between direction and self-awareness was found to be signif cant (as for durations), which indicates a change in gaze direction in the presence/absence of a mirror. The main effect of self-awareness revealed a higher frequency of gaze (i.e. a greater number of changes in gaze direction) in the presence of a mirror (mean ¼ 9.758; SD ¼ 5.657) than without (mean ¼ 7.408; SD ¼ 4.914).

3.2. State-trait anxiety questionnaire

A score was derived from the short form state-trait anxiety (STAI) questionnaire by summing the ratings for each scale item (positive items, e.g. I feel calm were negatively scored). Mean values were calculated for the anxiety score across each group. This was done for the scores obtained prior to the waiting period, and immediately after the 5 min wait, before the participants had been told there would be no interview (Fig. 3).

Table 6
MANOVA for frequency of body part movements.

Effect	F[a]	df	p	Eta^2
Body part	82.743	2,75	<0.001*	0.688
Body part*deception	0.244	2,75	0.784	0.006
Body part*self awareness	0.175	2,75	0.840	0.005
Body part*deception*self-awareness	0.292	2,75	0.748	0.008

*Indicates signif cance at p < 0.05.
[a] Pillai's Trace.

Table 7
Descriptive statistics for frequency of body part movements.

Body part	Mean	Standard deviation
Hand/arm	8.225	3.785
Feet/legs	9.550	4.121
Whole body/torso	3.675	3.056

Table 8
ANOVA for duration of hand/arm movements.

Effect	F	df	p	Eta^2
Deception level	0.034	1,76	0.853	0.000
Self-awareness	0.280	1,76	0.598	0.004
Deception*self-awareness	4.335	1,76	0.041*	0.054

*Indicates signif cance at p < 0.05.

A 2*2*2 mixed ANOVA (deception*self-awareness*pre/post trial) was run to investigate further the state-trait anxiety scores. The results, shown in Table 14, show signif cant main effects of deception and timing (pre/post trial). Regarding deception, those who were lying had greater anxiety (mean ¼ 10.863; SD ¼ 2.427) than those who were telling the truth (mean ¼ 9.150; SD ¼ 2.392). For timing, anxiety increased over the waiting period from mean ¼ 9.713; SD ¼ 2.517 to mean ¼ 10.300; SD ¼ 2.568.

3.3. Time waiting estimates

Finally, participants' responses to the question "how long do you think you were waiting" were analysed. A main effect was seen for deception level (Table 15), with truth tellers reporting a longer waiting period (mean ¼ 4.774; SD ¼ 1.494) than those expecting to deceive (mean ¼ 3.967; SD ¼ 1.531) (Fig. 4).

4. Discussion

In this study, few differences in body movements were found between participants expecting to act deceptively and those expecting to tell the truth. The most notable f nding was an interaction between self-awareness and deception for the duration of hand/arm movements. Participants in the lying condition moved their arms more in the presence of a mirror; truth-tellers moved their arms less in the presence of a mirror. Further research is required to fully understand this result, particularly given the indication that a mirror may be useful in pre-interview settings to magnify the hand-arm movements (and therefore help with identif cation) of those expecting to lie. Previous research has demonstrated that people engaged in cognitive complexity (associated with lying) present fewer hand and arm movements through the neglect of body language (Ekman, 1997; Vrij, 2008). However, in this instance, the mirror may have heightened self-awareness, which raised participants' awareness of their postures and movement, causing them to move more.

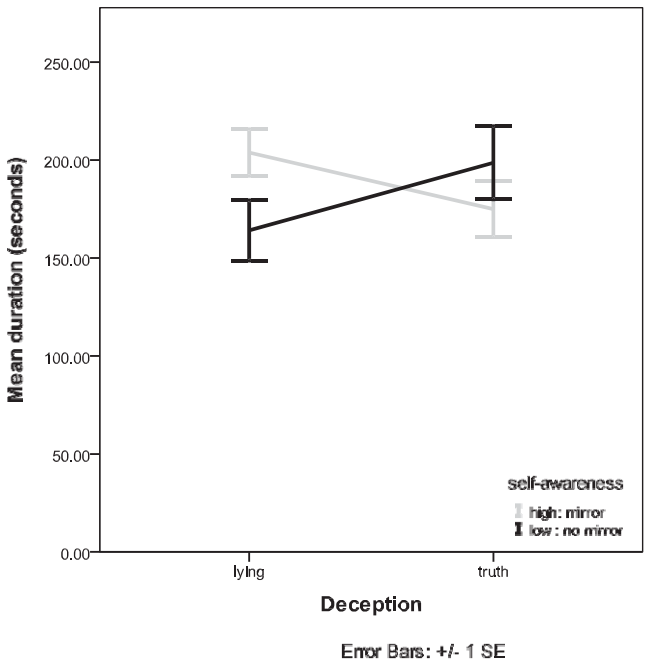

Fig. 2. Interaction plot for duration of hand/arm movements: deception*self-awareness.

Table 9
Means (and standard deviations) for the duration (seconds) of hand/arm movements.

Deception	Self-awareness	
	High	Low
Truth-tellers	174.934(63.873)	198.597(83.427)
Liars	203.834(53.077)	164.042(68.710)

Table 10
ANOVA for duration of leg/foot movements.

Effect	F	df	p	Eta^2
Deception level	0.386	1,76	0.536	0.005
Self-awareness	0.807	1,76	0.372	0.011
Deception*self-awareness	2.125	1,76	0.149	0.027

Based on this experiment, it was investigated whether a threshold for hand movement duration could be developed which would be useful for identifying liars and truth tellers. A threshold of 196e198 s could be applied (by discounting participants on appropriate sides of this threshold according to Fig. 4) to correctly identify 53 of the 80 participants, split evenly between the self-awareness and deception levels (27 from the mirror condition/26 from the no-mirror condition; 27 liars/26 truth-tellers). It is recognised that this was applied retrospectively, and that further work is required to prove the validity of this approach, but it indicates that it may be possible to develop a threshold which could provide evidence to support detection of deception. Further work is required to identify whether these differences are notable by subjective evaluation, rather than analysis using video tagging software.

The mirror also resulted in an increase in whole body/torso movements, although no interaction was found with deception level. While this f nding may not be useful for identifying those expecting to lie, it contributes to an understanding of how people behave with increased levels of self-awareness. Similarly, signif - cant main effects were found for gaze direction, and the interaction between gaze direction and self-awareness, but these f ndings do not provide information with obvious use for detecting deceit. Despite the f nding that none of the body movements showed

Table 11
ANOVA for duration of whole body/torso movements.

Effect	F	df	p	Eta^2
Deception level	3.635	1,76	0.060	0.046
Self-awareness	5.035	1,76	0.028*	0.062
Deception*self-awareness	3.789	1,76	0.055	0.047

*Indicates signif cance at p < 0.05.

Table 12
ANOVA for duration of gaze direction.

Effect	F	df	p	Eta^2
Gaze direction	426.523[a]	2,75	<0.001*	0.919
Direction*deception	1.618[a]	2,75	0.205	0.041
Direction*self-awareness	24.877[a]	2,75	<0.001*	0.399
Direction*deception*self-awareness	0.216[a]	2,75	0.806	0.006
Deception	0.037	1,76	0.849	0.000
Self-awareness	1.794	1,76	0.184	0.023
Deception*self-awareness	0.329	1,76	0.568	0.004

*Indicates signif cance at p < 0.05.
[a] Pillai's Trace.

Table 13
ANOVA for frequency of gaze direction.

Effect	F	df	p	Eta^2
Gaze direction	136.183[a]	2,75	<0.001*	0.784
Direction*deception	0.152[a]	2,75	0.859	0.004
Direction*self-awareness	15.388[a]	2,75	<0.001*	0.291
Direction*deception*self-awareness	1.793[a]	2,75	0.174	0.046
Deception level	0.668	1,76	0.416	0.009
Self-awareness	7.904	1,76	0.006*	0.094
Deception*self-awareness	1.528	1,76	0.220	0.020

*Indicates signif cance at p < 0.05.
[a] Pillai's Trace.

a main effect of deception level (truth telling vs. lying), the interaction in hand/arm movements suggests that self-awareness is worth further investigation as a possible tool for detecting deception. Future work could investigate specif c hand/arm movements (for example: fold arms, tap f ngers, touch face) to determine whether a certain type is prevalent in those intending to deceive. For practicality this study used a high-level behavioural coding scheme, which could be broken down into further sub-categories for more detailed analysis. Behaviours could also be coded in a more subjective approach, for example, tagging when the rater believes the participant demonstrated signs of nervousness, rather than adopting the specif c movement categories used for this study. Future work also aims to investigate the ability of observers to determine subjectively (based on instinct) whether a participant is intending to deceive.

This research also demonstrated that the participants who expected to tell the truth felt that they waited longer than those who expected to lie. This may have been because those expecting to lie were actively rehearing their responses, whereas those waiting to tell the truth had little to occupy them. This indicates another area

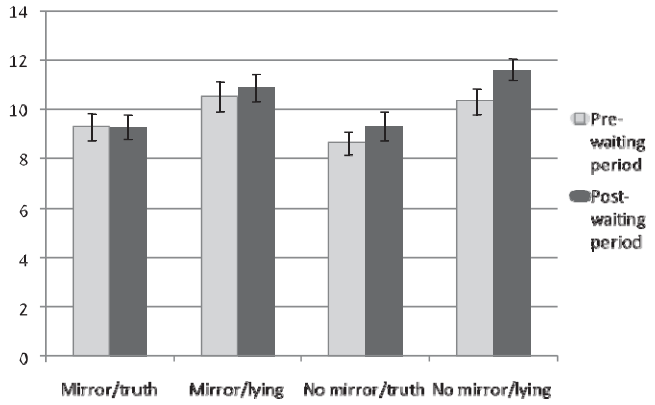

Fig. 3. Mean state-trait anxiety scores. Error bars indicate þ/- 1 SE.

Table 14
Analysis of state-trait anxiety scores.

Effect	F	df	p	Eta^2
Self-awareness	0.001	1,76	0.980	0.000
Deception	11.969	1,76	0.001*	0.136
Self-awareness*deception	0.337	1,76	0.563	0.004
Pre/post trial	7.164[a]	1,76	0.009*	0.086
Pre/post trial*self-awareness	3.531[a]	1,76	0.064	0.044
Pre/post trial*deception	1.171[a]	1,76	0.283	0.015
Pre/post trial*self-awareness*deception	0.081[a]	1,76	0.777	0.001

*Indicates signif cance at p < 0.05.
[a] Pillai's Trace.

Table 15
ANOVA for estimated time spent waiting.

Effect	F	df	p	Eta^2
Deception level	4.239	1,57	0.044*	0.069
Self-awareness	0.111	1,57	0.740	0.002
Deception*self-awareness	1.068	1,57	0.306	0.018

*Indicates signif cance at p < 0.05.

worth further research, particularly if asking participants to esti mate time spent waiting can be demonstrated to provide an indi cation of their intention to deceive.

The study also revealed an increase in anxiety over the 5 min waiting period, and that those expecting to deceive indicated greater anxiety than those expecting to tell the truth. This f nding may have use in detecting an intention to deceive, if the anxiety levels of suspects can be established. The greater anxiety levels in the deception group in this experiment were particularly interesting given the low-stakes in this experiment. There were no (anticipated) consequences for the participants if they were detected as liars, other than participants' desire to follow the instructions provided and convince the experimenter they were telling the truth. However, this was suff cient to induce higher levels of anxiety. Future work should also investigate increasing the stakes of both groups (i.e. the consequences of getting caught for liars and of being believed for truth tellers) as would be the case in the target interview scenario. Higher stakes may be induced by using those which are identity-relevant to the participants, as these can increase participants' motivation to succeed (DePaulo et al., 2003), ref ecting more accurately the conditions of deception prior to an interview by police or security personnel. This approach may also the address the use of undergraduate students as participants in this trial, as it is recognised that their incentives to deceive would differ to the target sample (i.e. criminals prior to interview).

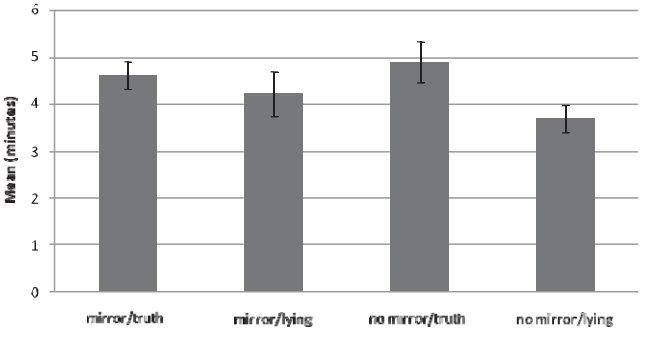

Fig. 4. Participants' mean estimates of length of time they were waiting. Error bars indicate þ/- 1 SE.

5. Conclusions

This paper investigated behaviours associated with intention to deceive while participants waited to be interviewed. Previous research has generally focused on behaviours demonstrated during an interview. This study also investigated the effects of self-awareness on cues to deception. An interaction was identified between deception and self-awareness for the duration of hand/arm movements ($F = 4.335$, $df = 1,76$, $p = 0.041$). Those expecting to lie moved their hands for longer when a mirror was present; the opposite was seen for truth-tellers. This finding suggests that further research is required to understand the effects of self-awareness on non-verbal behaviours, as it may result in interventions which can be used to identify those intending to deceive. This research may ultimately improve the capability of security personnel to detect people acting deceptively.

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