Telling the difference between deceiving and truth telling: An experiment in a public space

Telling The Difference Between Deceiving and Truth Telling: An Experiment in A Public Space

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***Abstract*—The behavioral experiment presented in this paper investigated deception tasks (both concealment and lying) undertaken in a public space. The degree of risk of deception detection and the demands of self-regulation when deceiving were manipulated. The results showed a significant interaction effect between veracity and risk of deception detection, emerged for the body movement of "hand(s) in pocket(s)". The incidence of "hand(s) in pocket(s)" was found to increase from truth telling to deceiving conditions when the risk of deception detection was higher, and to decrease from truth telling to deceiving conditions when the risk was lower. Higher risk of deception detection was also found in magnifying the "overall negative and controlled impression" displayed by both deceivers and truth tellers, compared to the lower risk of detection condition. We also discussed the possible effects of risk of deception detection and depletion of self-regulation, on deception behavior. Further studies and the connection between this study and the research community of computer vision and multimodel interaction is also discussed.**

Keywords—deception; detection; impressions; nonverbal cues; risk of deception detection; self-regulation

I. Cues to Deception and Their Underlying Psychological Processes

Many research questions in the field of deception behaviors are oriented towards practical outputs, and focus on four main areas (see reviews in [1], [2]). First, what are the behavioral cues to deception? Second, what behavioral cues to deception relate to what underlying psychological processes? Third, what are the factors influencing deception behaviors? Fourth, and most importantly, is how to discriminate between deceivers and truth tellers. With the ultimate goal of revealing the difference between deceivers and truth tellers, the first two questions are discussed in this section, and the third question is specified in the next section. Deception does not always take one form, but may be presented as a combination of types. We will present an experiment conducted in a public space in order to understand deception behavior regarding lying and concealment in this context, as well as the factors that may alter nonverbal behavioral cues to deception, that may distinguish deceivers from truth tellers. Nonverbal behaviors were manually coded using coding schemes for both body movements and impressions displayed by individuals.

A. Cues to Deception

Researchers have endeavored to identify deception-related behaviors since the 1930s [3]. At present, the most recognized categories of deception behavioral indicators are nonverbal and verbal cues [2]. Although it has been argued (e.g., [4]) that nonverbal cues are unstable and could be influenced by factors such as stakes (i.e., the negative or positive consequence of deceiving [2]), we believe that there is still a need to understand such cues. It is important since verbal statements are sometimes not involved in interactions, and/or deceivers can manipulate statements when engaging in deceit [5]. In this paper we focus on the nonverbal cues that are notable to people (e.g., hand movements) rather than the detection of minor cues such as micro-facial expressions, as the latter requires professional training and may not be learned easily. Moreover, on some occasions such as those involving immediate judgments of deceit (e.g., a security officer briefly interacting with a suspicious individual), detailed analyses are infeasible, and these judgments can only be made by relying on cues that are clearly observable.

Deception behaviors are presented inconsistently from time to time and more than 20 nonverbal observable indicators were identified in the meta-analysis of deception cues [1]. Specific deception cues such as decrease in hand/finger movements and change in foot movements were found in different studies [1], [2]. However, given the inconsistent findings emerging in the literature, it is recommended that more investigations be conducted so as to replicate and confirm previous findings, or to explore deception cues displayed by individuals in different settings [2], [6]. Our investigation of observable nonverbal cues was thus exploratory: that is, we did not target specific movements, but tested a number of observable nonverbal behaviors across body sections, as recognized by people following the coding process specified in Section III-D. Our tests were conducted by comparing any difference in the incidence (i.e., either increase, or decrease in the amount) of nonverbal movements acquired by blind coding between deception and truth telling conditions.

In addition to the specific body movements, there are some cues identified as impressions displayed by deceivers (e.g., "tenseness"). We believe that these impressions may contain

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implicit indicators of deception that are associated with the psychological processes underlying deception behavior (specified below and in Table II). Investigating impressions may also help us to understand intuitions that are used by successful deception detectors [7]. Given the important information that impression cues may carry, we studied impressions displayed by deceivers. The acquisition of impressions was conducted via a blind coding process where the impression items were developed according to three psychological processes of deception (specified below).

B. *Psychological Processes Underlying Deception Cues*

Most deception cues have been linked to specific psychological processes of deception (i.e., emotion, cognitive effort and attempted behavioral control) [2]. For example, an impression of tenseness might indicate a negative emotion of fear [5], and decrease in hand and arm movements might be a result of cognitive inhibition reacting to high cognitive demand [2]. The three underlying psychological processes are supported by theory (e.g., [5], [8]) and empirical evidence (e.g., [9]), which suggested that deception cues are driven by such processes. However, a consistent link between any specific deception cues and the three processes is not yet established, as it has been found that deception cues are not consistently presented by deceivers in studies that took place in different physical contexts or surroundings [2]. This reveals the demands for investigation in terms of the contextual factors that may alter deception cues, as discussed in the next section.

II. Contexts and Factors Altering Deception Behaviors

A. *Deception Cues are Subject to Contexts*

Context has been emphasized as important to the psychological processes involved in deception, as well as to the deception behavior and the nature of deception [2]. For example, an individual may not need to speak while passing through a security check. Perhaps s/he only needs to successfully conceal a weapon or smuggled goods. His or her behaviors are determined by such specific type of deception (concealment); thus no verbal cues are presented. The form of deception and relevant behaviors, as well as the involvement of varying psychological processes are inconsistent across contexts [2], which result in different cues presented by individuals. Therefore, it is difficult to generate a model for detecting deception across contexts. However, we believe that by assessing deception in different settings, researchers will have a better idea of how to discriminate between deceivers and truth tellers in similar settings. This is in line with DePaulo and Bond's [6] recent claim for encouraging researchers to explore deception in different contexts.

The present study investigated deception tasks undertaken in a public space in order to provide behavioral data about non lab-based deception. The deception task combined both concealment of an egg timer and a subsequent brief conversation with a role-played confederate (see the details in Section III-C). This design was employed due to the fact that deception does not always take one form, but could present as a combination of types. We aim to assess how people behave (in terms of body movements and impressions) while deceiving on such combined tasks in a public space.

B. *Risk of Failure to Convincingly Deceive*

We have discussed above that contextual factors are influential to deception behavior, as they may impact individuals' psychological processes and further influence behaviors. Deception in many cases is a risk-taking behavior, because failing to convincingly deceive can lead to negative consequences for the deceiver (e.g., the relationship between two people is affected following a discovered betrayal). People who engage in risk-taking behavior not only consider the seriousness of the negative outcome that could result from the failure to convincingly deceive, but also consider the probability of failing to convincingly deceive [10]. These are factors that can vary in contexts. The former relates to the stakes of deception [2], whereas the later relates to how likely a deception will fail, and thus leads to a negative consequence for the deceiver. In the present paper, we refer to "risk of deception detection" in describing the latter: the probability of failing to convincingly deceive.

Since risk of detection directly determines whether the consequence of deception (i.e., stakes) will happen, we propose that the risk of deception detection has a similar effect to stakes (identified as magnifying the extent to which the psychological processes are involved in deception [2], [11]), and thus alter the behavior presented by the deceivers. In addition, by manipulating the degree of risk of detection instead of stakes of deception in this study, we seek to minimize the problem that there are few stakes high enough that can be introduced in controlled laboratory experiments [2]. It is, however, possible to introduce a high probability of failing to convincingly deceive by involving a confederate playing the role of "well-trained lie detector". The present study manipulates the degree of risk of failure to convincingly deceive (i.e., risk of detection) by involving a confederate, playing either a trained detector or a layperson. Then the difference in nonverbal behavior was tested by comparing the incidence of behavior under the two conditions of high and low risk of detection.

Although stakes may magnify deception cues, it is also found that stakes can influence truth tellers' behaviors in a similar way [12]. Given the above discussion about the link between risk of detection and stakes, this problem may also be found in risk of detection. With the aim of minimizing this issue, we introduce another contextual factor (i.e., self-regulation), and predict that the joint effect of these two factors can elicit a difference in nonverbal behavior between deceivers and truth tellers (specified below).

C. *Self-focus in Relation to Self-regulation*

To return to the underlying psychological processes of deception, self-regulation, referring to both the conscious and unconscious forms of altering the self [13], is one of the fundamental processes of deliberate behavioral control. Deliberate deception requires voluntary behavioral control, and suppressing the truth can place high demands on self-regulation. The Self-Regulatory Resources Model [14], [15] proposes that self-regulation can be temporarily depleted due to high demand of the resources, and may result in failure or impaired self-regulation (e.g., [16]). Individuals with depleted self-regulation may fail to control their emotional, cognitive and/or behavioral responses [14]. Given the suggestions that intensive deception relates to deliberate behavioural control and brain activity that inhibits conflict between the false information and the default truth [17], we propose that the impaired or depleted self-regulation of deceivers may result in their failure to manipulate/fake behavior, and thus leak cues while deceiving. We tested this by comparing the nonverbal behaviors between the condition that enhanced demands for self-regulation and the control condition.

In terms of the manipulation of self-regulation, we do not want to introduce artificial tasks that induce self-regulation. This is because artificial tasks may not be easily introduced in real life in helping to spot deceivers from truth tellers. Nevertheless, it is recognized that self-focus (usually manipulated by inducing self-awareness with a mirror) can lead to task-focus, which is highly related to enhancing the demands of self-regulation [18]. Therefore, in order to alter the extent of the demands on self-regulation, we induced self-focus by installing a digital mirror and instructing participants to prepare for the deception task in front of the mirror. This not only increased the self-focus relating to task-focus, but also primed participants to control their behavior prior undertaking their tasks.

D. Predictions

The present research aims to test whether there are significant nonverbal cues and observable impressions discriminating deceivers from truth tellers. More specifically, we did not test any specific trend of nonverbal cues of deception; rather, we investigated any significant difference in the incidence (either increase or decrease in the amount) of a number of nonverbal body movements across body sections and impressions in relation to the underlying psychological processes, formed by observers (see details in Section III-D). Deception cues are difficult to detect not only because the cues are inconsistently presented in different contexts, but also because deceivers may attempt to manipulate their behavior during interactions by controlling the specific behaviors they present [8]. As a result, they may try to be credible and present fewer suspicious behaviors than truth tellers [2]. Therefore, in order to discriminate deceivers from truth tellers, it becomes important to manipulate contextual factors that may magnify the difference between them.

Based on the discussion in Sections II-B and C, contextual factors including risk of deception detection and the demands of self-regulation are proposed to influence the psychological processes of deception. Driven by such psychological processes, nonverbal behaviors may be altered by risk of detection and demand of self-regulation, showing a difference in their incidence between deceptive and honest conditions. By manipulating the demand of self-regulation and the risk of detection jointly, we aim to amplify the effects of these two factors on behaviors and predict a more significant difference between deceivers and truth tellers. The joint manipulation will also mitigate the problem that the risk of being detected may not only influence deceivers, but also truth tellers.

The study placed participants into high and low risk of detection groups, and enhanced the demands of their self-regulation (control groups of self-regulation were in place for making comparisons). Each participant undertook both deceiving and truth telling tasks. In line with the discussion on risk of detection and self-regulation above, we predict that when the demands of self-regulation are enhanced, deceivers in the group with the higher risk of deception detection are more likely to have their self-regulation impaired compared to truth tellers in the same group. Compared with truth telling, deceivers' effort to convincingly deceive increases demands on self-regulation. When a higher risk of detection magnifies the extent of psychological processes of deception, the magnified processes then places higher demands on resources of self-regulation [13]. Deceivers under conditions of higher risk and enhanced demand of self-regulation may experience higher overall demand of self-regulation than truth tellers, since truth telling does not require as much cognitive resource as deceiving (e.g., [2], [4]). The resource of self-regulation of deceivers is thus more likely to be exhausted. Following the discussion in Section II-C, when the overall demands exhaust the resources of self-regulation, the failure to control one's behavior may occur. Deceivers may thus present significantly different body movements and/or impressions, compared to when they are telling the truth.

However, different patterns of behavioral changes are predicted in groups with a lower risk of deception detection, since the impact on psychological processes involved in deception is decreased and hence reduced the demand of self-regulation. In line with the strength model of self-regulation [14], [15], the overall demands on the resources of self-regulation are thus not as high as those in the higher risk conditions. Deceivers in this condition are less likely to be exhausted and may still be able to successfully control their behaviors, presenting fewer suspicious and similar behaviors as when they are telling the truth. If, as predicted, by altering the risk levels under higher demand of self-regulation, we might be able to discriminate deceivers from truth tellers according to the distinct patterns of nonverbal cues. In all, the predictions for these joint manipulations are as follows.

When the demand of self-regulation is enhanced:

- There will be a higher difference[a] in the incidence of nonverbal body movements between deceivers and truth tellers under higher risk of deception detection, compared to the lower risk groups.
- There will be a higher difference in the extent of the psychological process-related impressions between deceivers and truth tellers under higher risk of deception detection, compared to the lower risk groups.

In addition, although there is little direct evidence to show that age, gender, cultural differences, and personality characteristics can influence deception behaviors [2], it is found that age and Big Five personality can influence risk-taking behavior [19]. The effect of these factors is not the main focus of this study, but they are included as covariates so as to

[a] This difference concerns both increases and decreases in the amount of behaviors (body movements and/or impressions). For some deception cues which present as reductions in body movements, we use "significant" referring to the significant degree of reduction.

prevent a significant influence on the results.

III. Methods

A. Participants

Ninety-two university students were recruited for a study entitled “A Smuggling Game”. Valid data from 83 participants (38 males, 45 females) were included in the analyses (mean age = 20.86 years; SD = 2.42 years). Participants had normal vision and hearing (or appropriately corrected to normal), and normal ability for body movements and communication.

B. Apparatus

The experiment, conducted by three PhD researchers (including the confederate playing different roles), took place in the corridor of a university building (see the settings in Fig. 1). As a departmental main building, there were passers-by walking through the corridor and passing the experiment area. The average number of journeys made by passers-by in the corridor was approximately 1270 per day (one single passer-by may have made multiple journeys within the experiment area). Normally, passers-by did not stay in the experiment area, and three participants who were disturbed by passers-by were excluded from the data analysis. Four computer bags, together with two egg timers were used in the experiment. Self-rated questionnaires were administered, containing, *a)* the Big Five Inventory (BFI) [20] assessing the five factors of personality, *b)* demographics form assessing age, gender, and country of residence for the majority of one’s life, and c) a short self-rating questionnaire checking that the manipulations for veracity (i.e., deceiving or telling truth), self-rated perception of self-focus, and perceived risk of deception detection were understood. For instance, the item “I was telling lies during the conversation” served to check whether people performed the instructed task for the deceptive condition or not. Data from three participants who did not understand the experimental task were excluded from the analyses. Two video cameras were used to record behaviors, one at the waiting area and another at the conversation area of the experiment. Each participant received £7 for the one-hour experiment (amount of reward decided according to the UK national minimum wage rates: £6.08/hour) as well as a small extra reward of chocolates.

C. Design and Procedures

Dependent variables were (1) individual nonverbal body movements and (2) impressions displayed by participants, both extracted from the video clips of the experiment sessions via content coding (see details in Section III-D). The independent variables were manipulated in a 2 (veracity: deceptive vs. honest) × 2 (risk of detection: higher vs. lower risk) × 2 (demand of self-regulation: enhanced vs. not enhanced) mixed design, with veracity as within-subject variable (i.e., all participants did the tasks for both the deceptive and honest conditions) and risk of detection and demand of self-regulation as between-subject variables (i.e., participants were separated into four groups, with each group doing tasks for one of the four combinations of conditions).

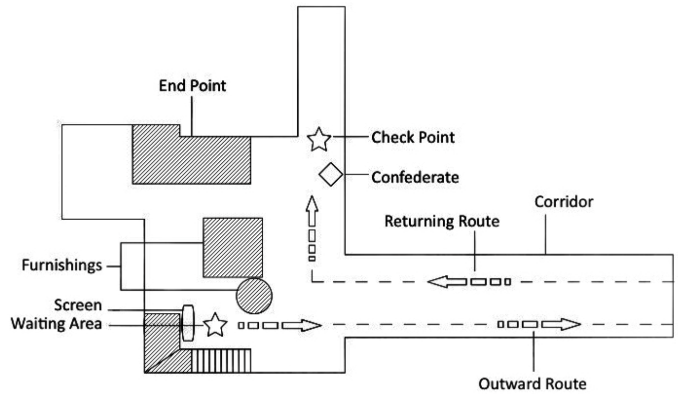

Figure 1. Layout of the experiment area.

The long corridor continues to the right side and, in all, is three times the length shown in the figure. See details in Section III-C.

Each participant completed a behavioral task session, followed by a questionnaire session. In the behavioral task session, participants were randomly assigned to the four between-subject conditions (specified below) and each of them performed a similar task twice: one round for deceiving and one round for truth telling. The sequence of veracity conditions was counterbalanced (i.e., all the possible orders of conditions were used) so as to control the order effect. For each round, participants were provided with a computer bag, and after two minutes of waiting in the waiting area, they then walked along the corridor of the university building following a route pre-designated by the experimenter (as in Fig. 1, they walked towards the end of the corridor then took the returning route towards a checkpoint). At the end of their route they reached the checkpoint (the conversation area) and had a conversation (on average lasting two minutes) with the confederate. Once the conversation finished, participants completed the short self-rated questionnaire to check that they understood the task. After a 5-10 minute break, they undertook a similar task again, with the other veracity condition. Following the completion of two rounds of behavioral tasks and the manipulation check questionnaires, participants completed a questionnaire pack (including the BFI and demographic information) and received £7 and chocolates. Debriefing forms were distributed to participants, with each participant session lasting approximately one hour.

Deception was introduced in two forms: (1) participants were provided with a egg timer that they needed to “smuggle” by carrying it inside of the computer bag and walking through the route without being detected by others (including the confederate and all the passersby), and (2) they were instructed to be completely deceptive during their conversation with the confederate. They were informed that failing to deceive would result in losing an extra reward (i.e., chocolates, blind to participants). This was done in order to introduce negative consequences. In fact, no detection was performed. In truth telling conditions, participants were not given the egg timer to conceal and they were asked to tell the truth during their conversation with the confederate. They were instructed to be as natural as possible. All the participants received the extra reward of chocolates at the end of the experiment.

Risk of deception detection was induced by altering the role played by the confederate. For higher risk conditions, the confederate played a formally dressed researcher, carrying a folder from the FBI academy. Participants in this condition were told that the confederate was a researcher from the FBI academy who was well trained to detect deceivers and would be looking for "smugglers" in the game. The confederate asked questions in an inquisitive manner about participants' identity and background information, their subject of study, their activity for the day, the length of time that they would be in the building, and the content of the bag. The questions for each round were different, except the overlapping questions about participants' identity and background information. Participants were instructed to tell complete lies or the truth (depending on their condition of veracity), regardless of what questions were asked. For lower risk conditions, the confederate played the role of a student visitor who was new to the university. She asked participants to have a chat, since she was waiting for a friend. She also showed curiosity about the content of the bag. The conversation involved similar topics asked by the FBI confederate, but in a friendly rather than inquisitive way. However, participants were told that the student confederate was not trying to spot smugglers.

Demand for self-regulation was enhanced by inducing self-focus. During the waiting period, participants were standing in front of a digital mirror in the waiting area (Fig. 1), and instructed to be well prepared for the task. For control groups, participants were standing in front of a digital screen displaying artwork, and were instructed simply to wait for the start signal from the experimenter. In all, each participant did both the deceptive and truth telling rounds and were randomly assigned to the four between-subject groups, each including one of the two conditions in the variables of high or low risk of detection and self-regulation demanded or control conditions.

D. Coding

Behavior data were collected via video recording, and the tapes were edited into video clips. There were 166 clips (each for one round of the behavioral task, with a length of 1 minute 16 seconds on average) in total that were then reviewed and coded using (1) Coding Scheme-A (Table I) developed based on the literature for nonverbal movements [1], [2] and (2) Coding Scheme-B (Table II) assessing the impression related to psychological processes of emotions, cognitive load, and attempted behavioral control. Four coders (Undergraduate and Masters students in social sciences at a UK university) trained for three hours and coded a 10% random sample of the video clips for inter-rater reliability (Cronbach's alpha for different sections of cues: eye section = 0.96, trunk section = 0.83, hand/arm section = 0.93, leg/feet section = 0.75, and impressions = 0.75). Following the acceptable inter-rater reliability, the remaining 90% of clips were coded by two of four coders. The numerical data for each clip were finalized by averaging the ratings. The coders were blind to the experimental conditions and hypotheses, and the clips were muted in order to exclude the noise of voices. Movements that were presented in fewer than 40% of the participant pool were excluded from coding as they were considered less frequent movements. The valid movements were presented in Table I.

TABLE I. CODING SCHEME-A (BODY MOVEMENT ITEMS)

Body Sections	Variable Name[a] (Movements)
Eye	**Eye contact; Eyes averted; Other eye movements**
Trunk	**Trunk sway;** Trunk lean towards; Trunk lean backwards
Hands/Arms	**Hands and arms; Hands only; Fidgeting; Hand(s) in pocket(s); Hands & objects;** Arms crossed; Hand holding
Legs/Feet	**Legs and/or feet**

[a]Body movements being included in the analysis were in Bold

TABLE II. CODING SCHEME-B (IMPRESSION ITEMS)

Underlying Psychological processes	Impression Items (Appears to be …)	Subcategories of Impressions[a]
Emotional process	Relaxed	Tense
	Tense	
	Pleased	Unpleased
	Unpleased	
	Friendly	Unfriendly
	Unfriendly	
Cognitive effort	Thinking hard	
Attempted Behavioral control	Formal	Formal
	Casual	
	Rigid in movements	Rigid
	Smooth in movements	
	Endeavoring to manipulate behavior	

[a]Created by grouping the items listed in the second column

Using the Coding Scheme-A, the coders coded the movements across the body sections. Firstly, they used two separate 7-point scales to code (1) frequency of movements ranging from 1 = exists to 7 = always (i.e., happens all the time in a given clip), and (2) duration of movements ranging from 1 = brief to 7 = whole session (i.e., lasts for the whole session in a given clip). Then they gave an overall rating on the proportion of a movement that appeared in the full session in one clip (according to the ratings of frequency and duration) using a 7-point scale ranging from 1= very briefly existed to 7= existed for the whole session. The overall rating was used in the final analyses. Missing values were coded as 0, so as to represent the absent status of movements. Using the Coding Scheme-B, the coders rated the impressions displayed by participants in each clip assessing 12 items, on a 7-point scale ranging from 0 = impression wasn't detected to 6 = to the greatest extent (e.g., the highest degree of tense). The individual impression items were grouped into subcategories of impressions with reverse coding of positive items (See Table II). The subcategories of impressions were found to be all significantly correlated to each other, and were then averaged into one item, called "negative and controlled impression" displayed by participants.

E. Data Analysis

Mixed Design tests of Analysis of Covariance (ANCOVA) were conducted separately for individual movements and the impression item. ANCOVA is built on the basis of Analysis of Variance (ANOVA), which compares means of dependent variables (i.e., the value measured for body movements and impression) from different groups (conditions of independent variables) of participants. On the basis of this, ANCOVA included covariates (e.g., variables systematically vary between conditions of independent variables) that are controlled for their possible impact on the findings through the tests that compare means [21]. The present study uses a mixed design, which contains one within-subject variable and two between-subject variables. Therefore, Mixed Design ANCOVA tests were conducted, which test both the main effect of veracity (i.e., within-subject variable) as well as the interaction effects of risk, self-regulation, and veracity. The latter interaction effects are the focus of the present study, as they may reveal the difference of dependent variables between deceivers and truth tellers across conditions of risk and/or self-regulation. Bonferroni corrections were employed to reduce the chance of Type I errors. Demographic information did not significantly influence any of the dependent variables, and thus was removed from the covariate battery. The Big Five Inventory scores were retained as covariates in the ANCOVAs for the dependent variables including ten body movements and one impression item. Cronbach's alpha for BFI scores are: Extraversion (Bfie) = 0.86, Agreeableness (Bfia) = 0.71, Conscientiousness (Bfic) = 0.79, Neuroticism (Bfin) = 0.76, and Openness (Bfio) = 0.72).

IV. RESULTS

A. Body Movements

Table III shows the results for the within-subject effects in the mixed design ANCOVA conducted for the ten body movements. By controlling BFI scores as covariates, significant interaction effects between veracity and risk of detection were found in "hand(s) in pocket(s)" $F(1, 74) = 4.57$, $p < 0.05$, $\eta p^2 = 0.06$. Amongst the five covariates, agreeableness produced a significant effect on the finding, $F(1, 74) = 7.28$, $p < 0.05$, $\eta p^2 = 0.09$. An explanation of the possible reasons was discussed in Section V-A. There was no significant main effect for veracity, suggesting regardless of the risk of detection and self-regulation variables, there was no significant difference in "hand(s) in pocket(s)" between deceiving and truth telling conditions. However, the veracity × risk of detection interaction reveals two significantly different patterns of "hand(s) in pocket(s)" movements in relation to risk of detection and veracity: in the higher risk of detection conditions, the amount of "hand(s) in pocket(s)" movements decreased from the deceiving (M = 4.13, SD = 3.23) to the truth telling condition (M = 3.29, SD = 2.92); this pattern is significantly different from that in lower risk conditions, where "hand(s) in pocket(s)" increased from the deceiving (M = 3.24, SD = 3.30) to the truth telling condition (M = 3.46, SD = 2.99) (see Fig. 2). These findings were predicted when the self-regulation was demanded; however, no significant effect of self-regulation emerged in our results. Further discussions are presented in Section V-A.

B. Impressions

The results for the between-subjects effects in the mixed design ANCOVA (Table III) also revealed that by controlling BFI scores as covariates, risk of detection has a strong effect in magnifying the "overall negative and controlled impression" (this item is created by taking the mean of all the subcategories of impressions) $F(1, 74) = 18.72$, $p < 0.001$, $\eta p^2 = 0.20$. Amongst the five covariates, extroversion had a significant effect on the finding, $F(1, 74) = 5.75$, $p < 0.05$, $\eta p^2 = 0.07$, as discussed in Section V-B. There was a greater degree of negative and controlled impression ratings associated with higher risk of detection levels (M = 2.51, SD = 0.38) versus the lower risk of detection levels (M = 2.14, SD = 0.37). These findings partially support our prediction that risk of deception detection can magnify impressions. However, this effect was found regardless of the veracity conditions. There was no effect of self-regulation on impressions. Further discussions are presented in Section V-B.

TABLE III. RESULTS FOR MIXED DESIGN ANCOVAS

Body Movement[a]		Impression[a]	
Within-subject Comparisons	***Hand(s) in pocket(s)***	***Between-subject Comparisons***	***Negative & controlled***
Veracity		Risk of detection	
F	0.41	*F*	18.72
Df	1, 74	*Df*	1, 74
P	0.53	*P*	0.00
ηp^2	0.01	ηp^2	0.20
Veracity × Risk of detection		Self-regulation	
F	4.57	*F*	1.46
Df	1, 74	*Df*	1, 74
P	0.04	*P*	0.23
ηp2	0.06	ηp^2	0.02
Veracity × Self-regulation		Risk of detection × Self-regulation	
F	2.31	*F*	2.02
Df	1, 74	*Df*	1, 74
P	0.13	*P*	0.16
ηp^2	0.03	ηp^2	0.03
Significant covariate[b] (Bfia)		Significant covariate[b] (Bfie)	
F	7.28	*F*	5.75
Df	1, 74	*Df*	1, 74
P	0.01	*P*	0.02
ηp^2	0.09	ηp^2	0.07

[a]Variables with nonsignificant findings were not listed (in attachments)
[b]Other covariates did not reach significant levels were not listed
ηp^2 = Partial eta square, effect size estimate

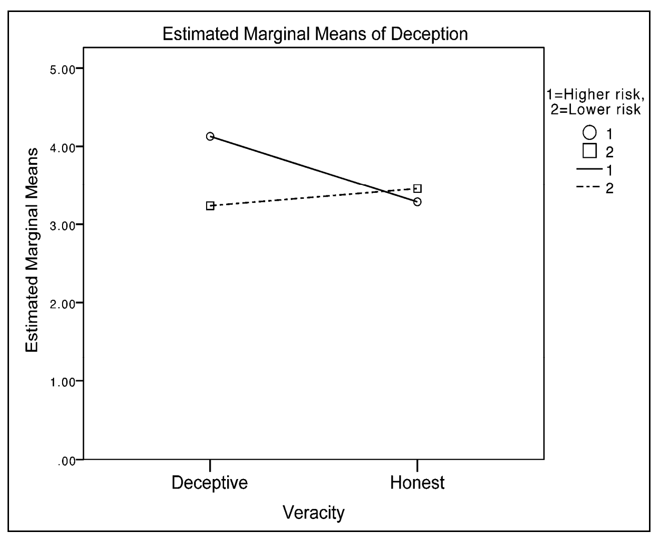

Figure 2. Plot of the veracity × risk of detection interaction.

The plot shows significantly different patterns of hand(s) in pocket(s) movements across deceiving and truth telling (honest) conditions between higher and lower risk of detection groups.

V. Discussion

A. Deception and Body Movements

The risk of deception detection does lead to differences in the amount of “hand(s) in pocket(s)” movements presented by the same person in deceiving vs. truth telling conditions. When the risk of deception detection is higher, people who are telling lies are more likely to put their hands in their pockets, compared with when they are telling truth. This pattern is significantly different in groups with a lower risk of detection (reversed pattern), suggesting that it is possible to discriminate between deceiving and truth telling in the same person by comparing the pattern of change in one’s “hand(s) in pocket(s)” under higher and lower risk of detection conditions. This finding also supports our proposition that risk of detection can alter deception behavior, as in the case of stakes [11]. Putting one’s “hand(s) in pocket(s)” is considered to be a sign of self-restrained behavior [22]. Increases in such behavior may be related to attempted behavioral control during deception. Amongst the five factors of personality, agreeableness was found to be significantly influencing the deception cue of “hand(s) in pocket(s)”. This might due to the fact that agreeableness has been found in relation to perception of risk [23] and interaction quality [24]. Because personality is not the focus of this study, the significant variables were controlled so as to prevent their impact on the findings. However, further studies may be conducted so as to test the relationship between personality and nonverbal cues of deception.

The finding regarding the different pattern of changes in the incidence of “hand(s) in pocket(s)” deception cue between higher and lower risk groups partially supports the prediction under self-regulation demanded condition. This suggests demands on self-regulation resulted in losing proper behavioral control (as a result of impaired self-regulation [16]). However, there was no significant difference found in the cue between self-regulation demanded and the control groups. One possible explanation is that by participating in the behavioral tasks in a public space (being watched by many passersby), participants already had higher levels of self-focus compared to if they had done the tasks in a private space, such as a laboratory. There may already be high demands on self-regulation in such a public space, which suppressed the manipulation of self-focus prior to the task. This may be further tested in future studies. Nonetheless, this finding indicates the possible contextual effect on deception behaviors and supports our view that deception studies should also be conducted in contexts out of the laboratory, since the contextual factors may influence the effects of experimental manipulations. We believe it is difficult to generalize the findings from one specific context broadly. It is more appropriate to explore deception behaviors in several specific contexts and use the findings for lie detection only in similar contexts. We also suggest that researchers compare deceptive behaviors with truth telling behaviors within the same person. This will reduce any unknown influence of individual differences in relation to deception behavior [2].

Most deception studies focus on identifying cues to deception yet it is also important to look for evidence revealing the underlying psychological processes (such as self-regulation) of such cues. While suggesting that the role of self-regulation may result in leakages of deception cues, we consider that their depletion may not only be reflected in individual cues. Desteno et al. [25] recently found that by combining individual body movements into one variable, deception can be distinguished from truth telling. However, combining the individual movements properly requires specific temporal information for each movement. The onset/offset of cues is an important criterion in determining which individual movements could be combined together to serve as a movement set. This information can be obtained by using video annotation applications and we encourage researchers in the field of computer vision to perform analysis on such information.

B. Deception and Overall Impressions

Risk of deception detection shows a strong effect on the overall negative and controlled impression displayed by individuals. Such an impression is considered a sign of negative emotion and over-control of behavior, which are related to psychological processes of deception [2]. This finding suggests that with a higher risk of detection, deceivers tend to demonstrate more negative affect and controlled behavior, as compared to when risk of detection is lower. This indicates that the risk of deception detection can lead to magnified impression cues in deceivers. However, as predicted, this effect also influences truth tellers, who presented a similar pattern to deceivers. These support the idea that the risk of deception detection has similar properties to the stakes of deceiving [11], [12]. Due to the strong effect of risk of detection on impressions displayed by both deceiving and truth telling individuals, we encourage researchers to pay as much attention to the risk of detection as to stakes in regards to how the risk of detection can influence nonverbal behaviors including body movements and impressions. The finding also suggests that the personality factor of extraversion significantly influences the impressions displayed by participants. Although it has been found that extraverts and introverts present different behavior when they lie [2], further studies may be conducted so as to explore any direct relationship between this personality factor and deception behavior.

C. Limitations and Further Studies

There are other methods to assess veracity, risk of detection, and the demands of self-regulation. For example, the demand of self-regulation can be increased by introducing additional self-regulatory tasks or questionnaires prior the deception task (e.g., in [26]). However, we did not use these tasks since we wished to use a realistic intervention (mirror) that introduces few artificial effects into the experiment. Nonetheless, it is also useful to test the effect of these factors on deception in different forms and settings. In addition, we administered subjective coding so as to assess cues that could be observed easily by human beings. However, we also recommend the automatic annotation of a broader range of behavioral cues to be performed, in order to assess more detailed deception behaviors that are not visible to the human eye.

We believe that the findings of this study will provide information concerning nonverbal deception behavior to researchers within the community of computer vision and multimodal interaction. More specifically, there are three main points that we want to highlight for researchers interested in this area.

First, the specific body movement of “hand(s) in pocket(s)” found in relation to deception may carry information about the mental status of individuals while deceiving. This nonverbal cue may be considered in future studies concerning the recognition, generation or automated detection of deception behavior. In addition, we found a negative and controlled impression has a strong relationship with the risk of deception detection. This suggests the significant influence of risk of deception detection on behavior concerning emotional communication. Although such an impression was not found in relation to deception, we still recommend that researchers who conduct automated detection of deception take into account the effect that risk may place on the overall negative and controlled impression cue. Second, the movement and impression cues found in this study reflected individuals’ reactions to another person during face-to-face interaction and/or their reaction to contextual factors (e.g., risk of detection). We believe our findings will provide information to researchers interested in generating or processing face-to-face interaction between human-human and human-artificial conversational partners. More specifically, we provided the information concerning the effect of the interaction on human beings and nonverbal behavior that is sensitive to contextual factors such as the risk of deception detection. We also support researchers who are working on developing visual perception system for deception detection or researchers generating deception behavior using robots, to take these findings into account. Further studies that test the effects of environmental factors (e.g., the degree of publicity) on deception behavior are also recommended.

Finally, the present study has assessed deception, including both the concealment of an object and lying. We suggest attempts to investigate deception involving multiple types and greater task complexity, as complex deception leads to greater cognitive load [4] than simple tasks (e.g., to reply ‘yes’ or ‘no’ to a simple question). We believe that extending the investigation to natural settings with complex task will be beneficial to further real world applications of experimental findings.

As DePaulo and Bond [6] suggested, the exploration of deception behavior should not be limited to a specific context or paradigm. There are diverse kinds of deceit, and also diverse contextual factors in the real world.

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