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Hemispheric asymmetry and deception detection

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Previous research has indicated a possible right hemisphere advantage in deception detection including a possible left ear advantage in decoding deceptive statements. In this study, 32 undergraduate students listened to 112 true and false statements presented unilaterally to both the left and right ears. The participants responded using their left or right hand, indicating whether the statements they heard were true or false. It was found that there was a significant ($p < .004$) advantage for the left ear in detecting whether a statement was true or false. These findings replicate and extend previous research indicating a left ear/right hemisphere advantage in deception detection.

Frank and Ekman (1997) suggested that deception detection is a two-step process. First, the detector has to recognise that a cue deviates from the norm or that an emotion expressed does not match the words being spoken. Following this, the detector has to interpret the cue or cues accurately. DePaulo and Rosenthal (1979) found that when people were able to detect deceptive cues they were not necessarily able to identify what the deception was concealing.

Accuracy in deception detection has been defined by primarily negative findings. For example, it has been shown that confidence in one's detection ability is not related to accuracy (Ekman & O'Sullivan, 1991). Further, it has been demonstrated that using cues that involve eye contact (DePaulo et al., 2003), nonfacial body characteristics, or simply one's intuition does not improve deception detection accuracy (Porter, Campbell, Stapleton, & Birt, 2002). In addition, it has been shown that many features of speech are also poor indicators of deception, including hesitations, the number of words spoken (Ekman, O'Sullivan, Friesen, & Scherer, 1991) and speech content (Porter et al., 2002).

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Those participants who are accurate at detecting deception have reported the use of more cues and a larger variety of signals than those who are not as accurate, including both verbal and nonverbal indicators (Anderson, DePaulo, Ansfield, Tickle, & Green, 1999; Ekman & O'Sullivan, 1991; Ekman et al., 1991; Porter et al., 2002). A meta-analysis performed by DePaulo et al. (2003) demonstrated that those who engaged in deception were generally more tense and had greater pupil dilation. Deceivers also made more negative statements and provided fewer details than truth tellers. It has been found that cues such as the flow of the story, control over one's voice, and the sincerity of one's voice seem to aid in deception detection (Anderson et al., 1999; DePaulo et al., 2003). Fabbro, Gran, and Bava (1993) suggested that emotions might be more easily recognised through the voice due to dryness in the mouth and larynx, quickened breath, and muscle tremors in the vocal tract. It was suggested that this may be the reason that the fundamental frequency of one's voice increases when giving a false statement (DePaulo et al., 2003; Ekman & O'Sullivan, 1991; Fabbro et al., 1993). Despite accuracy cues, it is rare that deception-detection accuracy is ever greater than chance (see DePaulo et al., 2003).

While there has been much research performed on the neurological correlates of the production of deception (e.g., Ganis, Kosslyn, Stose, Thompson, & Yurgelun-Todd, 2003; Langleben et al., 2002; Lee et al., 2002; Modell, Mountz, & Ford, 1992; Spence et al., 2001), there has been little research performed on the brain correlates of deception detection. Correlative evidence has been reported indicating that left-handed participants (compared to right-handed participants) are superior at deception detection (Porter et al., 2002), which suggests a possible right hemisphere advantage. More direct evidence of hemispheric differences in deception detection has been gathered. For example, there is evidence that suggests those with right hemisphere damage (RHD) are impaired on tasks of deception detection when compared to those with left hemisphere damage (LHD) or no damage (Stuss, Gallup, & Alexander, 2001). For example, Stuss and colleagues (2001) demonstrated that RHD was significantly correlated with the number of errors made on deception detection tasks. Winner, Brownell, Happe, Blum and Pincus (1998) investigated the ability of RHD patients to tell if a statement was either a lie or a joke. They found that RHD patients were significantly more impaired than the control group when distinguishing between a lie and a joke. Etcoff, Ekman, Magee, and Frank (2000) investigated the deception-detection abilities of patients with LHD and RHD and a control group. They found that those with LHD were significantly more accurate than either the RHD patients or the control group. In fact, the LHD patients were the only group that performed better than chance.

Kimura (1967) suggested that ear advantages in dichotic listening tasks reflect an underlying brain hemispheric dominance. Since her initial finding, there have been numerous indications that ear advantage is both reliable and valid (Bulman-Fleming & Bryden, 1994; Mohr, Heim, Pulvermüller, &

Rockstroh, 2001; Stirling, Cavil, & Wilkinson, 2000; Voyer, 1998; Voyer & Rodgers, 2002). A meta-analysis performed by Voyer (1998) showed that in general, auditory laterality tasks were at least as reliable and valid as other indices of hemispheric laterality, if not more so (see also Voyer & Rodgers, 2002). These studies and others support the use of ear advantage as an indicator of hemispheric processing biases (Alho et al., 1999; Alho et al., 2003; Bulman-Fleming & Bryden, 1994; Mohr et al., 2001; Stirling et al., 2000; Voyer, 1998; Voyer & Rodgers, 2002; but see Teng, 1981 for counter-evidence).

Fabbro et al. (1993) used an auditory laterality task to investigate hemispheric differences in deception detection. They presented participants with true and false statements to either the left or right ear through headphones. They asked participants to judge whether the statements were true or false. They found that there was a significant left ear advantage (LEA) when recognising true statements. They speculated that the lateralised difference was due to hemispheric differences. Specifically, it was hypothesised that the right hemisphere was significantly better at the detection of statement veracity than the left. The authors suggested the observed right hemisphere advantage was due to the superiority of the right hemisphere in processing the emotionality and prosody of another's voice.

To further examine the findings of Fabbro et al. (1993), we tested the LEA hypothesis in terms of deception detection. Statements (truthful and deceptive) were presented unilaterally to the left and right ears of the participants. The participants were asked to determine the veracity of each statement. If Fabbro et al.'s hypothesis is correct, there should be a significant LEA indicating a right hemisphere superiority in detecting statement veracity.

METHOD

Participants

A total of 32 students (28 females and 4 males) enrolled in psychology classes from Montclair State University volunteered to participate. Of these participants, 87% reported being right-handed as indicated by the Edinburgh Handedness Inventory (Oldfield, 1971). The remaining participants were classified as left-handed. Instructors gave extra credit to all students who volunteered. All participants were treated within the ethical guidelines of the American Psychological Association.

Apparatus and materials

All 32 participants were presented with 112 pre-recorded statements. The participants were asked to determine which statements were true and which statements were false. The statements were digitised and presented via Superlab Version 2.0 (Cedrus Corporation, Phoenix, AZ). Participants listened to the statements on Maxell headphones. To respond, participants used a computer keyboard marked with red and green tape. Keys, ''z'' and ''/'' were marked with red tape and keys ''x'' and ''.'' were marked with green tape. The different keys were pressed, depending on the type of sentence (i.e., true or false) that the participants thought was presented. All participants filled out a survey that included demographics. All testing occurred on a Dell Pentium based computer with a 17″ colour, flat screen monitor.

Procedure

Prior to the experiment, a total of 112 true and false statements were recorded. Of these statements, 56 were recorded by a male and 56 were recorded by a female. Both actors were untrained. To make the statements as naturalistic as possible, actual true and false statements were generated by the actors prior to recording them. They involved personal characteristics of the actors and of their same-sexed best friend. Therefore, half of the statements began with ''One thing I like about myself is . . .'' and the other half began with ''One thing I like about my best friend is . . .''. Three examples include ''One thing I like about myself is my hair/my sense of humour/my work ethic''. All of the statements were between 2 and 4 seconds, with the average length being 2.6 seconds.

Participants were seated in a separate room with a desk and a computer, where they were given an informed consent form and a survey. After these were completed, they were given oral and written instructions. The participants were informed that they would listen to the statements in four sets. Two sets of 28 statements were presented to the left ear and to the right ear. For each ear, the right hand was used to respond for one set and the left hand for the other set. The order of the four combinations was randomly determined for each participant. After each statement, the phrase ''Was that statement true or false?'' appeared centred on the screen. If the participant believed the statement was true, he or she was to respond by striking the key marked green, and if they believed the statement was false, he or she was to respond by striking the key marked red. The participants were asked to answer as quickly and as accurately as possible. After the participant finished all four sets of statements, they were told the nature of the study.

RESULTS

There were no significant differences between the right- and left-handers across any of the measures (ps > .05). Because of this, these groups were combined and their data pooled. The overall accuracy was 58.87% and the average reaction time was 983.23 ms (SE = 214.87). Using a single-df t-test, accuracy was found to be significantly greater than chance, $t(31) = 10.27$, $p < .001$, $\eta^2 = .77$. The data were analysed using a 2 × 2 × 2 ANOVA (Truth/Lie × Left Ear/Right Ear × Left Hand/Right Hand). There were no significant interactions (all ps >

.05). There was also no main effect for Hand ($p > .05$). However, both main effects for Truth/Lie and Left/Right Ear were significant. The participants were significantly more accurate in response to the true statements ($M = 73.49\%$, $SE = 2.61$) than to the false statements ($M = 44.25\%$, $SE = 2.49$); $F(1, 31) = 37.08$, $p < .001$; $\eta^2 = .55$. This may have been a result of ''over-responding'' with true responses (see below).

In terms of our main hypothesis, there was a significant main effect for Ear, $F(1, 31) = 9.43$, $p < .004$; $\eta^2 = .23$. Participants were significantly more accurate when statements were played through the left ear ($M = 61.33\%$, $SE = 1.26$) than the right ear ($M = 56.41\%$, $SE = 1.09$). These data suggested a general right hemisphere advantage in deception detection. Interestingly, there was no correlation between right ear and left ear performance in terms of accuracy but there was a significant correlation in terms of reaction time between the ears, $r(30) = .67$, $p < .001$; $r^2 = .45$. These data indicated that accuracy of one ear is not a significant predictor of the other ear, and this may be interpreted as independence in performance on a cognitive level. A correlation in reaction times between the ears may indicate a possible motor relationship between the ears irrespective of cognitive performance.

Reaction time was also examined employing a Truth/Lie $\times$ Left Ear/Right Ear $\times$ Left Hand/Right Hand ANOVA. The only significant main effect or interaction found was a main effect for Lie/Truth statement, $F(1, 31) = 7.22$, $p < .01$; $\eta^2 = .19$, with the Lie statements ($M = 1049.13$, $SE = 97.65$) being responded to more slowly than the Truthful statements ($M = 913.60$, $SE = 70.11$).

We also examined the possibility that certain participants were over-responding. For example, if a participant gave all true responses, s/he would be correct for all the true statements and incorrect for all the false statements. To test this possibility, we examined individual participant responses. Two participants were identified as ''over-responders'' using an outlier analysis (Tabachnick & Fidell, 2001, p. 67). One of them provided significantly more ''yes'' responses and the other significantly more ''no'' responses ($ps < .05$). When the data were re-analysed, similar results were obtained. There was a significant main effect for Ear ($p < .007$) and Truth/Lie ($p < .001$), but no significant interactions. Therefore, the results were likely not a result of response bias.

DISCUSSION

A significant left ear advantage was found, such that statements presented to the left ear were more accurately categorised in terms of deception. In our experiment, participants were more likely to attribute truthfulness overall.

There is evidence that deception detection is mediated via the right hemisphere, which support these results. Stuss et al. (2001) found a significant correlation between damage to the right medial frontal areas, the right anterior cingulate, and the number of errors made when detecting deceit. This evidence suggests that the right hemisphere plays an important role in deception detection. Neuroimaging evidence is much less clear in determining specific brain regions involved in deception and deception detection (Lo, Choong, & Tan, 2003; Spence et al., 2001), although there appears to be a possible right hemisphere advantage (Ganis et al., 2003)

There has also been evidence that there is an LEA when subjects are presented with emotional stimuli, suggesting a right hemisphere advantage for processing emotions (Bulman-Fleming & Bryden, 1994; Stirling et al., 2000). It could be interpreted that the results of the current experiment may be due to the processing of the statements' emotionality. However, this possibility was tested experimentally by playing the statements backwards, and under these conditions no LEA was observed (Malcolm & Keenan, 2003).

While it might be thought that ear presentation is not a true indicator of laterality, there is strong evidence to suggest otherwise. Recent neuroimaging studies using PET show a tendency for greater contralateral activation during selective listening tasks (e.g., greater RH activity when the left ear was attended to). This was demonstrated with both tones and continuous speech (Alho et al., 1999; Alho et al., 2003). These data indicate that attending to an auditory source presented selectively to one ear results in selective contralateral hemispheric activation.

Porter et al. (2002) reported that left-handed participants were superior at deception detection compared to right-handed subjects. While there were no handedness differences in our sample, the low number of left-handers in our study makes this comparison somewhat suspect. Although not specifically related, we did examine lateralised hand response differences. The hand that was employed did not appear to have an impact on deception detection. One possibility in explaining our negative results is that our paradigm was not sufficiently sensitive to hand effects. It is possible that hand advantage in terms of hemispheric processing may be an early-occurring phenomenon (<300 ms). If so, our study would not have detected any hand effects. A design that employs a more rapid stimulus (see Barnacz, Johnson, Constantino, & Keenan, 2004) may be more sensitive to hand differences.

Similarly, our design was likely not sensitive to reaction time differences. However, it is of interest that true statements were responded to earlier than false statements. Further research will need to be performed to determine if there is a hemispheric difference related to this phenomenon. In addition, future research should be conducted to determine the specific nature of the effects, controlling for nonverbal cueing such as emotionality.

In conclusion, there was a left ear advantage when detecting statement veracity. Participants were significantly more accurate in determining the truthfulness of a statement when hearing it through the left ear. These data support the hypothesis that the right hemisphere is involved in detecting deceit. Further, they extend the literature on the possibility of using ear advantage as a gauge of hemispheric involvement.

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