Perceptual Sensitivity to the Changes in Facial Expressions: Individual Differences in Relation to Shyness and Adult Attachment

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Abstract：The present study examined individual differences in perceptual sensitivity to the changes in facial expressions in relation to adult attachment and shyness. Perceptual sensitivity was found not to differ as a function of attachment orientations as represented by the four attachment styles: fearful avoidant, preoccupied, dismissive avoidant, and secure. On the other hand, differences were found in perceptual sensitivity for the shy and not-shy groups; shy individuals were found to perceive changes in facial expressions less accurately. When attachment style, shyness and age variables were considered together, shyness no longer made an unique contribution to explain perceptual sensitivity, but avoidant attachment style and subject's age were found to be significant explanatory variables for perceptual sensitivity. The implications of these findings were discussed in light of the constructs of shyness, adult attachment and also the development of perceptual sensitivity with reference to experiences during young adulthood amongst the female population.

Keywords：perceptual sensitivity, signal detection theory, adult attachment, shyness, maternal sensitivity

Introduction

In the social world, an ability to recognise changes in other people's behaviours is vital to maintain interactions. Such sensitivity helps to understand other people in that changes in behaviour can be used to infer their intentions. Although a certain degree of sensitivity to social stimuli like facial expressions is advantageous, if this ability is too highly developed then it can prevent the formation of healthy social relationships. The purpose of this study is to investigate individual differences in sensitivity to changes in facial expressions in relation to personal qualities that may affect social interactions.

A line of research has investigated the sensitivity to social stimuli such as facial expression as a function of adult attachment. Niedenthal and colleagues (Niedenthal, Brauer, Halberstadt, & Innes-Ker, 2001; Niedenthal, Brauer, Robin, & Innes-Ker, 2002; Niedenthal, Halberstadt, Margolin, & Innes-Ker, 2000) found that those who hold a representation of insecure attachment relationships tended to process emotional facial expressions differently from those who hold a representation of secure attachment relationships. They categorised the attachment orientations based on Bennan, Clarak, and Shaver (1998) and compared these categorical groups to their ability to detect changes in emotional facial expressions. Amongst the four categories: fearful avoidant, preoccupied, dismissive avoidant, and secure, the fearful avoidant individuals identified the offset of changes in both happiness and anger expressions earlier, whereas the securely attached individuals and the preoccupied and dismissive individuals identified these changes at later stages.

More recently Dewitte and De Houwer (2008) not only confirmed the differences in processing facial expressions with regard to adult attachment styles but also indicated a possible explanation for finding such differences; people who are high in both anxiety and avoidance showed reduced attention to angry faces and also had a tendency towards shifting their attention away from happy faces. These findings suggest that personal disposition can predict how people process and respond to social stimuli.

Another line of research investigated the sensitivity of responding to emotional facial expressions with reference to shyness and social phobia. Though the findings are mixed, there are some predictions regarding the connection between shyness and perception of emotional facial expressions. One prediction is that shy individuals are more sensitive to information derived from facial expressions, especially the

negative affect.

Aron, Aron and Davies (2005) proposed a hypothetical model for a similar line of prediction. People who show higher levels of sensory-processing sensitivity tend to perceive negative affects more quickly and easily than those who show lower sensitivity; such perceived negative affectivity could eventually lead to the development of increased shyness. In support of this prediction, there was a finding that individuals with a generalized subtype of social anxiety disorder showed higher levels of sensory-processing sensitivity than individuals with a non-generalized subtype (Hofmann, & Bitran, 2007).

However, other studies (Hendarson, & Zimbardo, 2003) failed to find higher perceptual sensitivity in shy individuals than in not-shy individuals. Heuer, Lange, Isaac, Rinck, and Becker (2010) found similar results with people who are high socially anxious compared with those who are not high socially anxious. They suggest that perceptual sensitivity was not found at the onset of perceiving and decoding the social stimuli, but that high socially anxious people showed negative biases in interpreting a threat under the pressure of time. In this respect, high sensory sensitivity in perceiving facial expressions may lead to incorrect interpretations of facial affects, which in turn leads to another prediction: shy individuals were less likely to make correct judgments of any changes in facial expressions because they were highly bias to perceive facial affects negatively.

There was another area of research in which sensory sensitivity played an important part in forming early social relationships. According to a study conducted by Donovan, Leavitt, Taylor, and Broder (2007b) maternal sensory sensitivity to positive infant facial expression at 6 months of age predicted the maternal quality of responsive behaviors at 24 months, and sensory sensitivity to both the infants' positive and negative expressions was associated with later maternal affect. These findings indicate that sensory sensitivity influences not only one's cognitive aspect of perceiving the social environment that may impact on themselves but also influence how they interact with other people. In the case of maternal sensory sensitivity, the implications of these findings could be huge especially when their child is too young to influence a given social environment.

Thus far, it has been discussed that sensory sensitivity to facial affects are related to adult attachment orientation, shyness and social anxiety. Although these lines of studies have addressed their own research questions, adult attachment and shyness may share something in common; the two dimensions of anxiety and avoidance, in adult attachment could be a cause of or a consequence of being of a shy disposition. In order to try and clarify these relationships, this study examines sensory sensitivity in relation to both adult attachment and shyness. In addition, as maternal sensory sensitivity to infant facial expressions predict maternal responsive behaviour at later stages, it is important to clarify how this predictive relationship may be derived. Given the previous findings from adult attachment literature, it is possible that mothers' attachment relationships with significant others is likely to have some influence on maternal sensory sensitivity. The present study, using a methodology that measures maternal sensory sensitivity (Donovan *et al*., 2007b) aims to examine how sensitivity to infants' facial expressions relates to both adult attachment and shyness.

Method

The present study comprises the measurements of sensitivity to the detection of changes in facial expressions, shyness and adult attachment.

Participants

One hundred and two female university students participated in the study. The age of the students ranged from 18 to 25 (M = 20.0, SD = 1.4) who were in the first to the fourth year of education at university.

Material and procedures

Participants answered two sets of questionnaires, each comprising the shyness scales and the adult attachment scales, respectively. For the shyness measure, the Revised Cheek and Buss Shyness Scale (Melchior, & Cheek, 1990) was translated for the Japanese subjects. In adopting this scale, the Japanese translations were confirmed with a subsequent back translation process. The Revised Cheek and Buss Shyness Scale was reported to have an internal consistency reliability of 0.94 with a mean score of 51.8 and a standard deviation of 13.6.

For the adult attachment measure, the Japanese version of Experiences in Close Relationships devised by Nakao and Kato (2004) was used. This adult attachment scale was based on ECR (Brennan, Clark, and Shaver, 1998) and this original scale has been used widely with a modified version, such as ERC-R (Fraley, Waller, & Brennan, 2000) and translated to adopt different languages (Alonso-Arbiol,Balluerka, &

Shaver, 2007; Li, & Kato, 2006). The scale comprised two subscales: anxiety and avoidance. The internal consistency reliability was reported to be α= 0.90 for anxiety and α= 0.83 for the avoidance subscales. These two questionnaires were administered either before or after the change detection experiment.

The experiment was set-up to measure sensitivity for the detection of changes in facial expressions. In this experiment, each participant was asked to judge if two images of facial expressions were the same or different. The stimuli used for this experiment was made from facial expressions of a boy and a girl. Happy and sad images of each child were used to create 9 morphed images (Tiddeman, Burt, & Perrett, 2001). The middle variant of the morphed images for each child was used as a standard, which always appeared first for all trials in the tasks. In addition, five variants in either direction of happy or sad images and also the standard image for both children were presented as subsequent judgment stimuli[1] in the happy change detection and the sad change detection blocks, respectively. Each variant was presented twice and the standard was presented four times, comprising 28 trials in the task. The happy or sad versions of the task were administered in a counterbalanced way. For each participant, the sensitivity measure in the change detection task was derived from a total of 56 trials. The size of faces for both children was set to be approximately the same, which led to the image sizes of 850*866 pixels and 944*962 pixels, respectively.

A program, Super Lab 4, executed the stimuli presentation, which ran on a MacBookPro laptop computer with a 15-inch screen. A trial began with a blue screen cue that was presented for 1500 ms, which was followed by presenting the standard image for 2000 ms in a centre. This was followed by the presentation of a test stimulus at a horizontal distance of 200 pixels to the right or left from the centre until the participants responded by pressing one of the designated keys on the response box which was connected to the computer (4000 ms was set as a timeout for the test stimuli).

[1] Prior to the experiment, a pilot study was carried out to compute the proportion of correct responses. The proportion of same correct responses was 0.78 for the girl's image and 0.83 for the boy's image. The proportion of correct responses for five variants of the boy (happy: 0.05 ~ 0.95; sad: 0.14 ~ 0.86) and of the girl (happy: 0.19 ~ 0.62; sad: 0.14 ~ 0.89).

Results

Individual differences in adult attachment and shyness

In order to check the construct of and internal consistency reliability of the ECR for the Japanese version with the present sample, a confirmatory factor analysis with a two-factor model was carried out with a varimax rotation. The analysis corresponded to the previous study with high internal consistency reliabilities for the anxiety sub-scale:α= 0.93 and for the avoidance sub-scale:α= 0.82.

Another factor analysis was carried out to examine the construct of the shyness scale. The analysis confirmed that this scale corresponds with the factor model as the original version indicated. The internal consistency reliability was α= 0.89. The scores for the adult attachment sub-scales and for the shyness scale were computed and descriptive statistics are reported in Table 1. The attachment subscales did not correlate with each other (r = 0.092, p = 0.357), confirming that these factors are independent. On the other hand, both the anxiety and the avoidance subscales correlated significantly with the shyness measure (r = 0.460, p < 0.001; r = 0.363, p < 0.001, respectively).

Table 1. Means and standard deviations for the attachment sub-scales and shyness scale

	Anxiety	Avoidance	Shyness
M	2.93	2.88	3.25
SD	0.78	0.63	0.59
V	0.60	0.39	0.35

Perceptual sensitivity to change detection

Perceptual sensitivity measures were derived from the participants' responses in detecting if two images of facial expressions were the same or the different. Drawing on the Signal Detection Theory, hit [the proportion of correct identifications of changes in facial expressions when there is a change] and false alarm [the proportion of incorrect identifications of changes in facial expressions when there is no change] were utilized to calculate the sensitivity and bias measures. Before calculating the sensitivity measure *d'* and bias *c*, the proportion of correct responses for the happy and sad blocks were compared. A multivariate analysis of variances for the repeated measures of 2 emotional face × 2 response type for the proportion of correct responses were performed. There were main effects for the emotional face and response type: F (1, 101) = 7.40, p < 0.01 and F (1, 101)

= 227.6, $p < 0.001$; the happy block ($M = 0.65$, $SD = 0.011$) had a significantly lower response rate than the sad block ($M = 0.68$, $SD = 0.010$) and the different response ($M = 0.50$, $SD = 0.015$) was significantly lower than the same responses ($M = 0.84$, $SD = 0.012$). However there was no interaction between the emotion and response types: F (1, 101) = 0.09, ns. When the sensitivity d' and bias c were computed and compared both measures between the happy and sad blocks, there were no significant differences in these measures between the blocks: $df = 101$, $t = 1.59$, ns, $df = 101$, $t = .78$, ns. Therefore, sensitivity and bias were computed for the combined blocks. The means and standard deviations of the sensitivity and bias are shown in Table 2.

Table 2. The means and standard deviations for sensitivity and bias

	d'	c
M	1.24	1.25
SD	0.86	0.86
V	0.73	0.73

Perceptual sensitivity in relation to adult attachment and shyness

Perceptual sensitivity in change detection was examined in relation to the adult attachment. The participants were categorized into four attachment groups drawing on the score of the two attachment subscales, using their mean score as a cut-off point for each sub-scale. The means and standard deviations of sensitivity and bias measures for the high/low groups on the attachment sub-scales were given in Table 3.

An analysis of covariance (2 high/low anxiety groups × 2 high/low avoidance groups) with age as a covariate was performed for sensitivity and bias measures, respectively. Neither the sensitivity nor bias showed significant differences between high-low groups in the attachment sub-scale or the interaction between these groups.

Similarly for shyness, using the mean as a cut-off point in the shyness scores, high/low-shyness groups were created. An analysis of covariance for shyness as dependent variables with age as a covariate revealed that sensitivity scores were significantly higher for the low-shyness group than for the high-shyness group: $F_{d\,(1,\,99)} = 4.00$, $p = 0.048$, and bias scores showed a similar trend and approached a significant level $F_{c\,(1,\,99)} = 3.54$, $p = 0.063$.

So far the dependent variables were compared between the independent high/low groups that were derived from the shyness scores. In order to take into account both variables in explaining individual difference in perceptual sensitivity, multiple regression analyses were performed for the sensitivity and bias scores as criterion variables, and anxiety, avoidance, and shyness scores as well as age were used as explanatory variables. In addition, an interaction between anxiety and avoidance for the high/low groups was added to an equation as explanatory variables. The regression models appeared significant: $F_{d\,(5,\,96)} = 2.34$, $p = 0.03$, $F_{c\,(5,\,96)} = 2.36$, $p = 0.056$. The standardized coefficients of the explanatory variables are given in Table 4.

The results indicate that age was a significant contributor to explain perceptual sensitivity and bias, suggesting that as people age they become the better detecting changes in facial expressions. For the sensitivity measure, in addition to age, avoidance appeared to be a significant contributor, suggesting that a less avoidant person is more sensitive to detect changes

Table 3. The means and standard deviations for sensitivity and bias measures as a function of the high/low groups on the attachment sub-scales

	Anxiety		Avoidance		Shyness	
	Low (N = 52)	High (N = 50)	Low (N = 52)	High (N = 50)	Low (N = 49)	High (N = 53)
d'						
M	1.25	1.23	1.17	1.31	1.41	1.06
SD	0.91	0.81	0.76	0.94	0.98	0.66
c						
M	1.28	1.23	1.19	1.31	1.42	1.08
SD	0.93	0.78	0.79	0.91	0.99	0.65

in facial expressions. For the bias measure, similar trends were found albeit they were only approaching significant levels. Taken together, it is possible to say that both the sensitivity and bias measures were explained by age and avoidance variables; sensitivity increases, as one ages and is less avoidant to others.

Discussion

The present study examined perceptual sensitivity to detect changes in facial expressions in relation to adult attachment and shyness.

When perceptual sensitivity was examined in relation to adult attachment orientations: anxiety and avoidance dimensions respectively, there were no sensitivity differences between the high/low score groups for both attachment dimensions. This finding did not support the findings of previous studies, which found that both anxiety and avoidance measures appeared to differentiate perceptual sensitivity (Niedenthal *et al., 2002*) and a tendency to avert attention from negative facial expressions (Dewitte, & De Houwer, 2008). Although the present findings did not support the previous studies, some consideration can be made to explain the current results. It does not suggest that adult attachment orientation has no association with perceptual sensitivity. However, it is possible that what was measured in terms of sensitivity was different.

First, the present study asked subjects to judge if the change in facial expressions occurred in two still images presented in a sequential manner, whereas other studies employed more elaborate methodologies such as allowing the subjects to play the morphed movies to identify the onset and offset of the appearance of facial affects. In addition a study that employed a spatial cueing paradigm is still being debated for its reliability depending on the SOA: stimulus onset asynchrony (Cooper, Rowe, Penton-Voak, & Ludwig, 2009). For the present methodology in which subjects were asked to respond to 2 FAC tasks under a time constraint, it is unlikely that subjects needed to decode dynamic changes in facial expressions, which might not have reflected their interpersonal attitudes.

When the shyness measure was taken to indicate categorical difference in terms of high and low shyness, it was found that shy people appeared to be less sensitive to the detection of changes in facial expressions. This finding is not in line with some of the previous studies that found that high socially anxious people are more sensitive to the negativity of facial affects. However, as seen in Heuer, *at al* (2010), if high socially anxious people did not differ from non-anxious people in perceiving the onset of facial stimuli but differ in biases to interpret negative affects, then the present study could reasonably support Heuer *et al*. In the present study, shy people were found to be less sensitive in identifying the changes. It may be possible to interpret current findings based on Heuer *et al*. that shy people made more errors in the judgment of change detection of facial expressions because their biases were at work, which led them to made incorrect judgments.

The main objective of the present study was to investigate perceptual sensitivity in relation to both adult attachment and shyness. The main findings in this investigation suggest that perceptual sensitivity is related to age and the avoidance measure, indicating that people who scored less in the

Table 4. The standardized coefficients of the explanatory variables for the sensitivity and bias measures

	Sensitivity d'		Bias C	
	β		β	
age	0.265	**	0.289	**
shyness	-0.088		-0.124	
anxiety	-0.18		-0.095	
avoidance	-0.395	*	-0.261	
Lanx-Havo	0.405	*	0.344	+
Hanx-Lavo	0.194		0.163	
Hanx-Havo	0.553	**	0.398	+
R^2	0.15	*	0.13	+

** p<.01, * p<.05, + p<.1

avoidance subscale are more sensitive to detect changes in facial expressions.

Although attachment orientation itself did not differentiate perceptual sensitivity, when it was combined together with the shyness variable, attachment orientation appeared to be a significant factor in explaining the variability of perceptual sensitivity. The individuals who scored highly in the avoidance subscale were less sensitive to the detection of changes in facial expressions. The reason that the high avoidance individuals were less accurate on detecting changes may be due to the lower intensity of focused attention at the onset of processing the facial images at presentation. As the avoidant people tend to show less positive personal attitudes to interpersonal stimuli, it is possible that similar attitudes were persisted with the images of infant faces used in the experiment.

As for shyness, this measure no longer played a significant role in explaining perceptual sensitivity when this variable was entered together with attachment measures and age variables, despite the fact that when shyness was considered as a categorical measure, shy and not-shy subjects differed significantly in perceptual sensitivity. This inconsistency could be derived from the treatment of the shyness measure. Shyness as represented as a continuum measure could be different from a categorical measure. How the construct of shyness is considered may be important. Is shyness better explained as a continuum or as dichotomous? In the case of shyness, studies often used categories of clinical and non - clinical groups when comparing the dependent variables of interest. In the literature on shyness research, Kagan (1994) for example, strongly claimed that this characteristic is rooted in innate temperamental traits and this is considered to be a dichotomous variable. Although the current data only suggests a possible tendency that individuals who were relatively shy on the shyness scales were less perceptually sensitive. However, when shyness is considered as a continuum variable, shyness was not a significant variable that could explain perceptual sensitivity.

The current findings also suggest that age was a significant contributor in individual differences in perceptual sensitivity. Initially, age was not considered to be a major factor to differentiate perceptual sensitivity because little is known about the development of sensory sensitivity at the onset of young adulthood.

Most studies were carried out based on the assumption that age is not a significant factor that influences any outcome variables. However, as long as the perceptual sensitivity measured in the present methodology is concerned, from young adulthood onward, age is a significant contributor. This finding makes the Donovan at al.'s (Donovan, Leavitt, Taylor, & Broder, 2007a; Donovan *et al.*, 2007b) findings more interesting in that maternal sensory sensitivity may be differentiated depending on a quality of adult attachment and maternal age. This interpretation begs the question of whether maternal sensitivity could be nurtured. As seen from the current finding that sensitivity differed depending on age, it is possible to affirm the possibility of changes in female sensitivity. All females in this sample had no children at the time of the experiment. Thus, it is possible that regardless of the maternal experience, the older subjects were more sensitive to the detection of changes in faces. That also implies that maternal experience may also be an important factor to explain increasing sensitivity in general. When other variables such as maternal attachment relationships are taken into account, the relationships between perceptual sensitivity, age, and experiences present a more complex picture.

This study indicated a relationship between perceptual sensitivity and adult attachment and shyness. There are some limitations in these findings. This study used the methodology to measure perceptual sensitivity which was analogues to Donovan *et al* (2007a). This study exteuded the previous studies in that it addressed individual differences in the sensitivity measure with reference to adult attachment or shyness. Follow up examinations with a current methodology are necessary to replicate and extend the current findings to confirm that adult attachment and maybe shyness could explain the variability of perceptual sensitivity. A similar treatment is necessary to confirm a contribution fage. If the age variable is considered to be a major contributor, The experiences of processing social information in eveyday life, i.e. face-to-face interactions with their child, may increase female perceptual sensitivity.

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表情変化を認識する個人差の検討
：アタッチメントスタイルとシャイネスとの関連性から

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要　旨

本研究は、乳児の表情の変化を認識する敏感さについて、女子大学生のアタッチメントスタイルとシャイネス度との関連性から検討した。表情変化をとらえる敏感さは、アタッチメントの４スタイル間で大きな違いが認められなかった一方で、シャイネスの程度に関しては、シャイでないグループはシャイなグループに比べ、より敏感に表情変化を認識することが示された。さらに、これらと年齢と変数とし表情変化を認識する敏感性を説明する要因を検討したところ、アタッチメントスタイルにおいて回避型傾向が少なく、年齢が高い方が表情変化に敏感であることが認められた。

キーワード：表情変化、信号検出理論、アタッチメントスタイル、シャイネス