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# The role of trait anxiety and emotional information in the perception of biological motion

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Anxious individuals are known to process socially-relevant stimuli in an aberrant way, in both higher cognitive level and low level perceptual processing. While the majority of previous studies have investigated the influence of anxiety on processing of nonverbal social cues using face stimuli, we employed point-light biological motion (BM) as main stimulus, noting that processing of bodily movements is also important. Through two different tasks, detection from noise and emotion recognition, the current study examined whether the level of trait anxiety has an influence on BM detection, whether emotional valence (anger, happiness, and neutral) of the stimuli could modulate the anxiety effect, and whether accuracy pattern for explicit emotion recognition from BM is consistent with the influence of implicit emotion processing in the detection task. The results showed that the detection performances of high-anxiety group were poorer than those of low-anxiety group when the stimuli were emotionally neutral. In contrast, the performances of the two groups were comparable for emotional stimuli in both detection and emotion recognition tasks. The results imply that high level of trait anxiety is associated with decreased ability to process BM, which can be compensated if the stimuli convey emotional information.

*Key words : Anxiety, Biological motion, Perception, Emotion*

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Appropriate interpretation and utilization of social cues in the surroundings may be one of the most crucial abilities in everyday life. Failure to demonstrate such abilities is considered as a common impairment in several psychopathological groups. Among other major mental disorders showing social dysfunction, such as schizophrenia and autism spectrum disorder, anxiety disorders-characterized by feelings of anxiety and fear (American Psychiatric Association, 2013)-are also noted to exhibit altered social perception and cognition (Hezel & McNally, 2014; Plana, Lovoie, Battaglia, & Achim, 2013; Tibi-Elhanany & Shamay-Tsoory, 2011).

Although atypical processing in individuals with high level of trait anxiety is observed in general attention (Bishop, 2009) and cognitive control tasks (Paulus, 2015), it becomes more notable when the tasks require processing of socially-relevant information (see review: Clark & McManus, 2002; Hirsch & Clark, 2004). For example, highly-anxious individuals exhibit tendency to allocate more attention to threatening cues (Bar-Haim, Lamy, Pergamin, Bakermans-Kranenburg, & van Ijzendoorn, 2007; Mogg & Bradley, 2002; Gamble & Rapee, 2010) and to show bias in emotional processing (Attwood et al., 2017; Demenescu et al., 2011). Above all, it has been consistently reported that anxiety may have a negative impact on processing face stimuli in various tasks of perception and memory (Attwood, Penton-Voak, Burton, & Munafò, 2013; Davis et al., 2011; Mueller, Bailis, & Goldstein, 1979). Hence, individuals with high level of anxiety could have impaired function, or at least show distinctive performance pattern, in processing socially-relevant stimuli, not only in higher cognitive level such as recognizing emotion from the stimuli but also in low level perceptual processing.

Those studies that investigated influence of anxiety on socio-emotional processing for non-verbal social cues mainly used face stimuli (Attwood et al., 2013; Bradley et al, 1999; Button et al., 2013; Davis et al., 2011; Mueller, Bailis, & Goldstein, 1979). It is undeniably true that faces and facial expressions provide crucial as well as subtle information for precise social perception and cognition. However, considering that gaze aversion or avoidance is reportedly a central component of altered social functioning in people with anxiety disorder, especially those with social anxiety (Moukheiber et al., 2010), the results from past studies using faces as main stimuli may pose a limitation. It is plausible that individuals with high level of anxiety might have failed to process information from others' eyes, the most resourceful region of face, partially attributed to the high tendency of gaze aversion. However, face is not the only source of non-verbal social cues; body gestures and movements also provide quite socially-relevant, informative cues for social perception (Aviezer, Trope, & Todorov, 2012; Gunes & Piccardi, 2007). In fact, perceiving more global signals such as body gestures is important as well for successful social functioning. In real situation, for example, rapid and precise perception of body movements and gestures from relatively long distance would be necessary for initial response. Furthermore, like faces, body movements and gestures also can contain micro and subtle signals that do affect accuracy for detecting human motion from noise as evidenced by a recent study (Lee & Kim, 2017a). Thus, it is worth investigating whether people with high level of anxiety would experience altered perception for more global human action signals as well, not just for human faces and facial expressions.

In the present study, we used point-light(PL) display of biological motion(BM) (Johansson, 1973) as our main stimulus to examine the research question addressed above. Various human actions can be depicted by PL BM with only minimal number of simple markers (e.g., dots) located on head, torso, and major joints of the body. Although PL BM is not as detailed as faces in terms of physical cues, it can still convey rich social information in addition to plain motion information, including gender (Dittrich, Troscianko, Lea, & Morgan, 1996; Loula, Prasad, Harber, & Shiffrar, 2005; MacArthur & Baron, 1983), intention, mood, and emotion (Atkinson, Dittrich, Gemmell, & Young, 2004; Clarke, Bradshaw, Field, Hampson, & Rose, 2005; Manera, Schouten, Becchio, Bara, & Verfaillie, 2010; see also review by Blake & Shiffrar, 2007). Furthermore, patients exhibiting dysfunction in social cognition are reported to be impaired not only in perceiving social information (e.g., emotion) from BM but also in lower level perceptual processing of BM stimuli, such as discriminating BM from non-BM foils. Hence, it is recently suggested that BM processing itself is “a hallmark of social cognition (Pavlova, 2012).” Previous studies on schizophrenia and autism spectrum disorder, mental disorders that are clearly associated with reduced social functioning (Bellack, Morrison, Wixted, & Mueser, 1990), consistently reported findings that these groups exhibited selective impairments in BM perception (Blake, Turner, Smoski, Pozdol, & Stone, 2003; Kim, Norton, McBain, Ongur, & Chen, 2013; Nackaerts et al., 2012), in line with the suggestion by Pavlova (2012). Another study conducted by Kim and colleagues on obsessive-compulsive disorder (OCD), formerly categorized as a subtype of anxiety disorders, reported similar results: the OCD patients likewise showed impairments in processing BM (Kim, Blake, Park, Shin, Kang, & Kwon, 2008). The results imply that the relation between anxiety and social cognition can be reflected in BM perception performance. However, to our knowledge, there has been no follow-up study that focused on whether anxiety level is related with BM processing ability.

Mental disorder is usually associated with complicated patterns of behavioral outcomes. Patients with schizophrenia, for example, is impaired not only in perceptual processing of visual stimuli but also in retrieving socially-meaningful information from the stimuli so that whether or not they can benefit from rich social information provided by BM stimuli in a working memory task depends on the number of to-be-processed items, unlike healthy controls (Lee & Kim, 2017b). Sometimes, therefore, it is not easy to find whether a specific abnormal behavior is attributed to a distinctive underlying mechanism or it is just a facial manifestation of generalized deficits. Anxiety disorders are also associated with a wide range of affected behaviors and cognition. Considering the challenge, comparisons between high- and low-anxious individuals within normal range, instead of clinical population, would provide more sensitive measure of the effect of anxiety on BM perception. Therefore, we targeted individuals with different levels of trait anxiety in non-clinical group.

To summarize, we aimed to investigate whether high level of trait anxiety would have impact on BM perception, with the three specific research purposes as follows. First, we examined whether participants with high level of trait anxiety would have more difficulty in detecting BM from noise compared to those with low level of trait anxiety. Second, we scrutinized the possibility that the emotional valence of the BM stimuli would modulate anxiety effect on BM detection performance. Third, we investigated whether there is any evidence that accuracy for explicit emotion recognition from BM stimuli is affected by anxiety level in order to verify that interactions between anxiety level and emotions observed in BM detection task, if any, were attributable to differences in emotion recognition ability from BM stimuli across groups. We conducted two different tasks to address the research questions: detection from noise task and emotion recognition task. In the first task, we used PL BM stimuli with three different types of emotion (anger, happiness, and neutral) for a motion-noise paradigm (Kim et al., 2013; Lee & Kim, 2017a). The second task required the participants to explicitly process emotional information conveyed by BM. We hypothesized that 1) participants with high level of anxiety would be poor in discriminating BM from non-BM foils, which would result in lower performance in detection task in comparison with low-anxiety group; 2) the compromised detection performance of high-anxiety group would be recovered for emotional BM, especially those depicting anger, as individuals with higher anxiety are reported to have processing biases for emotional stimuli; 3) recognition accuracy for a particular emotion (i.e., anger) would be relatively higher in high-anxiety group, consistently with the results from the detection task.

## Methods

**Participants** A total of 108 non-clinical individuals (39 males and 69 females) completed Korean version of the trait section of the Spielberger State-Trait Anxiety Inventory (STAI)(Kim & Shin, 1978; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1970). Among those, individuals who scored above the 75th percentile (raw score of 52 or above) were assigned to high-trait anxiety group (23 participants; 6 males and 17 females) while those who scored below the 25th percentile (raw score of 37 or below) were assigned to low-trait anxiety group (25 participants; 10 males and 15 females). Mean trait-anxiety scores for high- and low-anxiety group were 56.96 (S.D. = 2.90) and 33.72 (S.D. = 3.01), respectively. Mean age of the participants was 22.91 (S.D. = 5.39) for high- and 23.20 (S.D. = 3.70) for low-anxiety group. All participants had normal or corrected-to-normal visual acuity and gave written informed consents. The study protocol was approved by the Institutional Review Board of Duksung Women's University.

**Stimuli** PL displays of BM stimuli were created by modifying motion-capture library by Ma, Paterson, and Pollick (2006) using Biomotion Toolbox (van Boxtel & Lu, 2013). Each BM stimulus was composed of 12 dots, indicating head, hip, shoulders, elbows, wrists, knees, and ankles, and depicting a walking motion in 3 different emotions (angry, happy, and neutral), facing 90° left. Frame rate of the stimuli was 20 frames/s, and the stimuli were designed to demonstrate 1 cycle of walking (i.e., 2 steps) in 1s. We selected 6 walkers, giving 2 to each emotion type, based on the preliminary emotion rating test. Mean rating scores of the walkers in each emotion type differed significantly in terms of conveyed emotion [$F(2,144) = 23.90$, $p < .001$; post hoc test showed significant differences among all three emotions, $p < .01$]. Details regarding the rating test can be found in our previous study (Lee & Kim, 2017a). In addition, mirror-reversed motions (i.e., facing 90° right) were generated for each of the 6 original stimuli to obtain a total of 12 different BM set.

Non-BM stimuli to be displayed as the

counterpart of BM stimuli in non-BM trials were generated following a recently-developed spatially-scrambling rule (Kim, Jung, Lee, & Blake, 2015) called pairwise shuffled motion (PSM). PSM stimuli are generated by pairing adjacent 2 dots that are destined to create local pendular trajectories of human limb segments, such as a pair of a wrist and an elbow or a knee and an ankle, and by swapping those pairs with some restrictions, instead of randomizing the starting positions of every dot within the display area. The stimuli created through this method hold advantages over traditional scrambled motion: PSM can maintain local motion and distributions of each dot in space more similar to those of original BM, compared with randomly-scrambled motion. PSM stimuli differed from BM stimuli in global form while local motion information was generally preserved, and thus required intensive global processing to discriminate BM from PSM and detect target from the noise.

**Procedure** The experiment was conducted in a dimly-lit, quiet environment. The stimuli were generated within MATLAB (Mathworks Inc, Natick, MA) using Psychophysics Toolbox (Brainard, 1997; Pelli, 1997) and displayed on an iMac screen (Apple Inc., Cupertino, CA). Viewing distance was 57cm, and the head movement was restricted by a chinrest. Each task was provided with a short preceding practice session. All participants conducted the BM detection task first and then carried out the emotion recognition task. If the emotion recognition task was administered first, the participants could presume that emotional valence of the stimulus was one of the variables during the BM detection task. Therefore, we fixed the order of the tasks to prevent such confounding effect, regardless of some risks of the order effect.

*Detection from noise task.* In each trial, PL animation of BM or PSM was displayed for 1s with a number of noise dots within a virtual area subtended 10 × 10° (Figure 1(a)). Noise dots were generated from motion information of the dots defining the BM or PSM sequences presented together on each trial, and the starting point of them were randomly positioned among the display area. The number of the noise dots was adjusted according to QUEST mean value (Watson & Pelli, 1983) calculated separately for all six conditions (BM and PSM for each of three emotion types) after each trial, ranging from 0 to 300. The mean size of the PLs was 4 (width) × 7 (height)°, and they were always slightly off-centered. Participants were instructed to report whether they detected a human figure among noise or not by pressing designated keys after each stimulus was followed

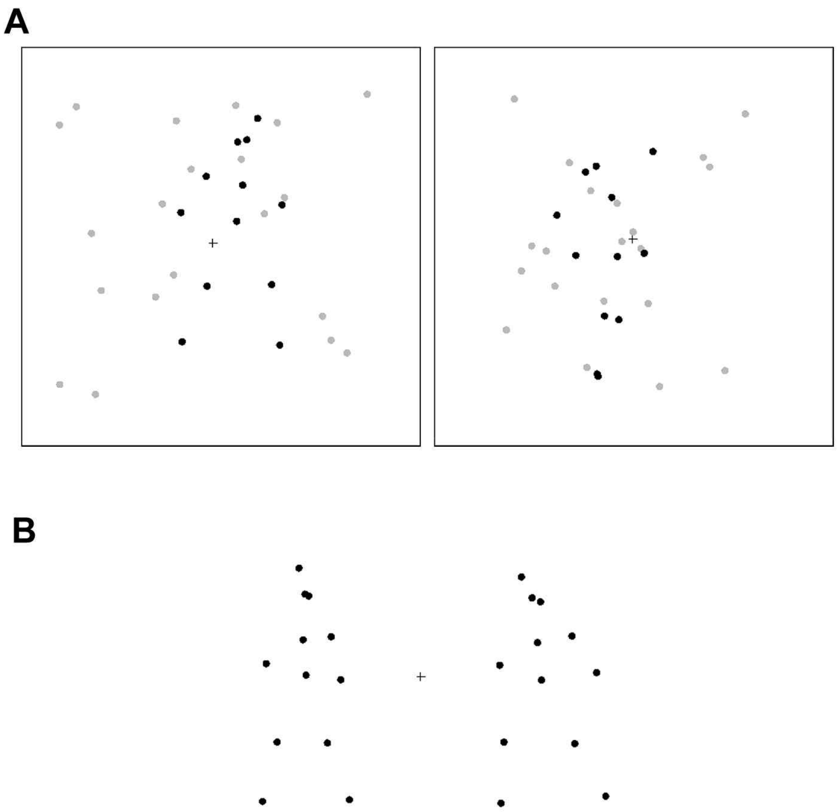


Figure 1. Illustrations of experimental displays. (A) Stimuli used in task 1 are shown in separate boxes. Dots constructing BM (left) and PSM (right) stimuli (drawn in black) are presented with noise dots (drawn in gray). Note that the noise dots were in the same color as the target in the actual task display. (B) An example display of task 2 is shown. The task was to report relative emotional state of the figure on right in comparison with the figure on the left.

by a blank screen with a fixation cross at the center. The stimuli for the six conditions were presented in equal number of trials, with the presentation order being randomized. The total number of trials was 312.

*Emotion recognition task.* Two different BM walkers were presented simultaneously at each side of the central fixation cross, distanced from each other by the visual angle of $10^{o}$ (Figure 1(b)). Participants were instructed to report the relative emotional state of figure on the right in comparison with the one on the left by pressing designated keys. Response choices were one of the three alternatives: angrier, happier, or emotionally the same. Figure on the left were in one of the three emotions (angry, happy, neutral), while figure on the right were either angry or happy walkers. The total number of trials was 176.

**Analyses** Outlier exclusion Before analyses, we checked if any participant's data included extreme values (i.e., outliers). If a participant's data had an outlier in any of the six conditions, the entire data from the participant were excluded from further analyses. Outliers were determined according to the threshold values following the outlier labeling rule (Hoaglin, Iglewicz, & Tukey, 1986) with the multiplying factor k of 1.5. The rule suggests to set the lower and the upper bound to cut off outliers based on the interquartile range, therefore the bounds are less influenced by the performance of outliers, in comparison with the traditional 2-standard- deviation rule. In order to calculate the lower and upper bounds following the rule, we first subtracted the lower quartile from the upper quartile, then multiplied the value by the factor k. Lastly, we added the value from the previous calculation to the upper quartile to set the upper bound or subtracted it from the lower quartile to set the lower bound. Threshold values exceeding the bounds were considered as outliers.

*Detection from noise task.* The QUEST mean values of the number of noise dots to detect the target stimuli with 75% accuracy were measured separately for each condition (3 emotion types each for BM and PSM conditions, resulting in 6 different conditions) as the detection threshold. The threshold values were then used for 2 (group) × 3 (emotion) × 2 (stimulus type) three -way repeated measures ANOVA. Correlations between trait-anxiety score and threshold values were also analyzed.

*Emotion recognition task.* Because the instruction was to report *relative emotional state* of the figure on the *right* in comparison with the figure on the *left*, accuracy was measured in terms of the correct recognition of the emotion conveyed by BM on the right. The accuracy for the trials when happy walker on the right was compared with angry walker on the left was considered the recognition performance for happy BM; the accuracy for the trials when angry walker on the right was presented with happy walker on the left was considered the recognition performance for angry BM. The trials when each side of the walkers depicted the same emotion type and when the BM on the right was compared with neutral walker on the left were not included in the analysis due to disproportionate physical feature differences between the two stimuli. That is, when two walkers depicting the same emotion are presented together to be compared, it is likely that the participants judge the stimuli relying on the similar characteristic motion instead of conveyed emotion; likewise, when emotional stimuli are presented with neutral walker, participants are prone to make judgments based on the physical differences (i.e., dissimilar motion speed) among the stimuli, not necessarily on the emotion per se. More detailed information regarding procedure and logic for the analyses could be found in Lee and Kim (2017a).

## Results

Data from 8 participants (6 from high-anxiety and 2 from low-anxiety) were excluded according to the outlier exclusion criteria mentioned in Methods, and then data from 17 participants in high-anxiety and 23 participants in low-anxiety were further analyzed and discussed.

**Detection threshold values** Although the three-way repeated-measures ANOVA (group × emotion × stimulus type) revealed negligible main effects of both emotion [$F(2,76) = 1.66$, $p = .20$] and group [$F(1,38) = 1.31$, $p = .26$], significant interaction effect between emotion and group was observed [$F(2,76) = 5.56$, $p < .01$]. More specifically, the group difference emerged in detecting emotionally neutral stimuli [BM: $t(38) = 2.26$, $p < .05$; PSM: $t(24.7) = 2.25$, $p < .05$], while no significant differences were

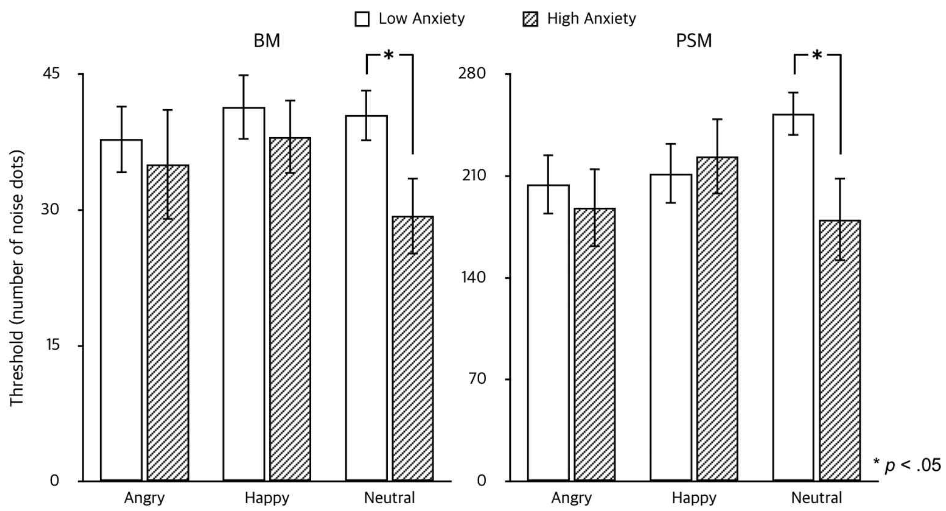


Figure 2. Main results of task 1. The threshold values of BM (left) and PSM (right) in low- and high-anxiety groups are shown with error bars indicating standard errors. Note that the range of vertical axis is different in BM and PSM conditions in order to reflect disparate variabilities in these two conditions.

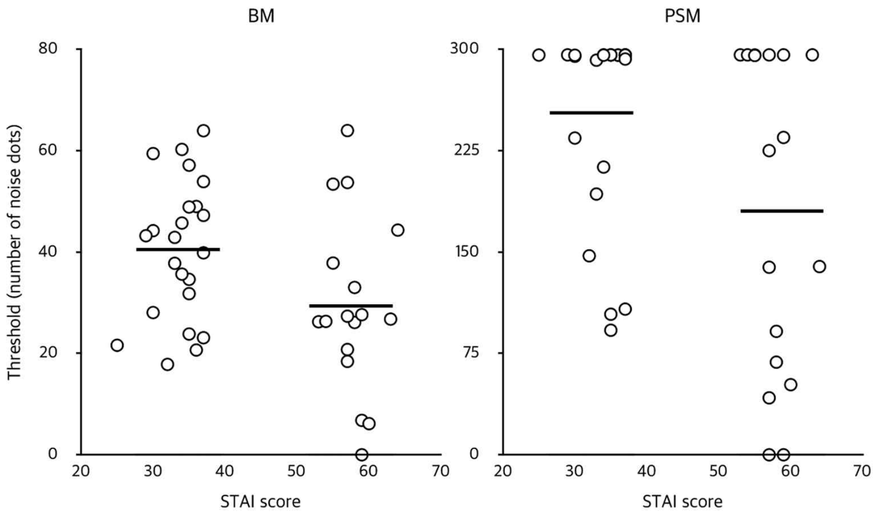


Figure 3. Individual data plot for non-emotional stimuli. Thick lines indicate mean values of each group. Note that the range of vertical axis is different in BM and PSM conditions due to different variabilities in these conditions.

found in detecting emotional stimuli [angry BM: $t(38) = .41$, $p = .68$; happy BM: $t(38) = .60$, $p = .55$; angry PSM: $t(38) = .48$, $p = .63$; happy PSM: $t(38) = .36$, $p = .72$] (Figure 2). In other words, high-anxiety group performed much worse in both detecting BM (i.e., BM trials) and successfully rejecting non-BM (i.e., PSM trials) compared with low-anxiety group only for non-emotional stimuli; the detection performance of high-anxiety group was comparable to that of low-anxiety group for both angry and happy stimuli. The association between higher level of anxiety and lower level of noise mask for successful detection in neutral stimuli is also clearly shown in individual data plot (Figure 3). The three-way interaction effect also reached significance level [$F(2, 76) = 3.56$, $p < .05$] as the different pattern between groups depending on emotional versus neutral stimuli were more robust in PSM condition. No other interaction effects reached significance level [stimulus type × group: $F(1,38) = .48$, $p = .49$; emotion × stimulus type: $F(2,76) = 1.30$, $p = .28$].

Main effect of stimulus type was also significant [$F(1,38) = 144.97$, $p < .001$]. The number of noise dots denoting detection threshold was higher for PSM trials compared with BM trials. This could be expected due to the disparate nature of the two conditions. The instruction was to “detect BM” for both trials, and PSM condition measured the ability to *not* *detect BM*-comparable to the concept of a correct rejection/false alarm in signal detection, considering that BM was a target-while BM condition measured the ability to *detect BM*. Hence, not detecting BM correctly in PSM trials resulted in an increment in the number of noise dots, engendering increasingly lower likelihood of detecting BM in PSM trials and, thus, incomparably higher threshold.

**Accuracy for emotion recognition** In order to scrutinize whether the two groups-individuals with low and high level of anxiety-do or do not differ in perceiving emotions explicitly, we analyzed accuracy for recognizing emotions. Consistent with the analyses on detection threshold values, no group difference was found in recognizing emotions from BM [$F(1, 38) = 1.12$; $p = .30$], indicating that high-anxiety group did not perform poorer in emotion recognition task in comparison with low-anxiety group. Neither main effect for emotion [$F(1, 38) = .19$, $p = .67$] nor interaction effect between group and emotion [$F(1, 38) = .39$, $p = .54$] were found. Both groups generally performed to a similar level recognizing anger and happiness from BM as it can be seen from Figure 4, and we did not find evidence that high-anxiety group perform particularly better or poorer in recognizing anger compared to low-anxiety group.

## Discussion

In the present study, we investigated the perception of BM with and without emotional

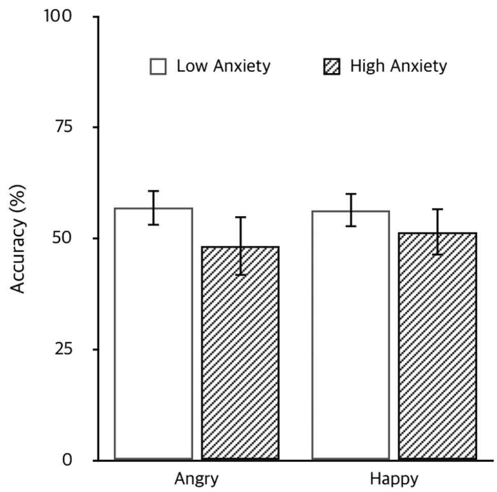


Figure 4. Results of task 2. Mean accuracy (%) to recognize emotion from target BM. Error bars represent standard errors.

information in individuals with low and high trait anxiety to answer the research questions of whether people with higher level of anxiety would have more difficulty detecting BM and whether the anxiety level and emotional information within the stimuli would interact with each other during the detection process. Overall, we found supporting evidence for our hypotheses: individuals with higher level of anxiety performed worse in the BM detection task than people with low anxiety, requiring smaller amount of noise for successful detection. In addition, such performance difference between the groups was observed only when the stimuli were emotionally neutral; the difference disappeared when the stimuli contained emotional information (anger and happiness in this study). We would like to discuss the results more in detail in the following paragraphs.

When BM was emotionally neutral, high-anxiety group seemed to have more difficulty in detecting BM from noise compared with low-anxiety group. In addition, high-anxiety group had relatively greater tendency to inaccurately report seeing BM from noise when actually PSM was embedded in noise instead (i.e., *false-alarm like* response), resulting in lower detection threshold for PSM trials. Such response tendency is shown well not only in group average data (Figure 2), but also in individual data plot (Figure 3). These results suggest that trait anxiety level possibly regulates ability of processing motion signals of BM, especially when the stimuli do not have specific emotional information.

Although perceptual characteristics of high- and low-anxiety group were the main findings of the current study, it would be necessary to consider possible relationship with social dysfunction for further interpretation. While impaired BM perception in mental disorders with social dysfunction (e.g., schizophrenia and autism) has been paid attention in last decade (Blake et al., 2003; Kim et al., 2005; 2011; Singh, Pineda, & Cadenhead, 2011), relations with anxiety level have remained little examined. One study a decade ago (Kim et al., 2008) revealed that individuals with OCD exhibited deficient BM perception while their ability to perceive other types of motion was relatively intact. In this study, OCD patients showed poor performance in a detection task parallel to the one used in the present study as well as in a simple discrimination task. Therefore, the findings from the present study may expand the results from the previous study by showing that the perceptual ability could be affected by anxiety level even in non-clinical group, not just in diagnosed clinical population.

Because many of past research have reported problems of general attention and its allocation in anxious individuals (Bar-Haim et al., 2007;

Bishop, 2009; Mogg & Bradley, 2002; Gamble & Rapee, 2010), one may argue that the significant group difference observed in the current study could have been a consequence of such general attentional deficits in high-anxiety group rather than of a BM-specific impairment. Indeed, there are numerous literature as of present supporting attentional control theory, which assumes that anxiety induces greater influence of stimulus-driven (bottom-up) process and less efficiency of goal-directed attentional control (Berggren & Derakshan, 2013; Eysenck, Derakshan, Santos, & Calvo, 2007). According to these previous studies, individuals with high level of anxiety are prone to be distracted or to show enhanced attentional capture by salient noise stimuli, in association with altered neural processing for inhibitory control. Considering that the main task in the current study engaged intense amount of noise, it may be possible that poor performance of high-anxiety group in BM detection task reflects greater susceptibility to noise distractors in comparison with low-anxiety group. However, because the group difference only existed in non-emotional stimulus conditions in the current study, and because the general attentional deficits induced by anxiety level should be more robust for emotionally strong stimuli according to previous studies, this speculation is less likely. Nonetheless, it would be worth adopting a discrimination paradigm in which BM and non-BM stimuli can be compared without noise in the future study.

Interestingly, while higher level of anxiety seems to be related with lower sensitivity in distinguishing emotionally neutral BM from non-BM, the group differences were no longer observed when the stimuli were conveying emotion, either angry or happy. We speculate that the emotional information embedded in the BM stimuli presumably worked as a supplementary cue in BM processing, and facilitated perception in high-anxiety group. Previous study examining effects of emotion on the perception of BM also reported that the detection performance varied depending on the emotional valence conveyed by BM (Lee & Kim, 2017a). In order to support the speculation, it is necessary to prove that the ability to recognize emotion from BM stimuli in the two anxiety groups do not differ. In fact, this is what we observed from our second task, the emotion recognition task. Indeed, high- and low-anxiety groups did not show differences in the accuracy for recognizing both anger and happiness from BM. Taken together, the low- and high-anxiety groups showed discrepancy in detecting BM without emotional information; but high-anxiety group no more exhibited poorer performance compared with low-anxiety group as long as emotion, from which both groups can find similar degree of informational value, is included in the stimuli.

It is questionable as to what could have caused analogous accuracies for recognizing emotion from BM in both groups. Individuals with anxiety disorder or high level of anxiety are often considered to show bias for more efficient processing for threat-related stimuli, such as fearful and angry faces (Ashwin et al., 2012; Byrne & Eysenck, 1995; Surcinelli, Codispoti, Montebarocci, Rossi, & Baldaro, 2006). On the other hand, we did not find any trace of evidence that individuals with higher level of trait anxiety are associated with enhanced processing for a particular emotion in comparison with those with lower level of anxiety. We provide a couple of speculations to explain the inconsistency. First, it should be noted that PL display of BM is relatively unfamiliar stimulus to participants in experimental environment compared to face stimulus. Unlike widely-used faces, PL display of BM is constructed with minimal physical cues, preserving only necessary motion information, and thus may seem quite different from the appearance of human body in real life. Although PL BM is reported to be efficient in conveying emotional information, and the stimulus set we adopted is confirmed through preliminary rating test before the main tasks in terms of adequately depicting each emotion, it may still be possible that the intensity of emotions perceived from BM is much weaker in comparison to that from faces. Hence, the intensity of anger depicted by BM might have been too weak to lead to enhanced processing in high-anxiety group. Another point to note is that the present study is not the only study that did not observe such bias. Findings by Cooper, Rowe, and Penton-Voak (2008) suggest that trait anxiety may not affect either accuracy or speed of the recognition of threat-related emotions when viewing facial expressions as well. The authors propose that the bias favoring threat-related emotions might be highly dependent upon experimental methodology. The surmises require further investigations.

The present study has a limitation in the relatively small and unequal sample size for the two groups participated in the experiment. Replications with larger sample size and more power would be needed to support the findings.

In sum, the present study confirmed previous findings on impaired perception of socio-emotional stimuli in people with elevated anxiety by showing lowered performance in BM detection task in high-anxiety group. Not only confirming, our results expand previous findings in terms of using a relatively new kind of socially-relevant stimulus (i.e., BM) in this area: our results showed that deficient perceptual processing for social stimuli in anxious individuals exist across detailed facial expressions and more global motion signals. Comparable detection performance between high-and low-anxiety groups in emotional stimulus conditions suggest that emotional information contained in the stimuli could provide additional cue to high-anxious individuals to restore their decreased perceptual ability. Taken together, the results imply that perceptual process should be considered as well as attentional biases to understand altered social functioning in people with high level of trait anxiety. Future studies on diagnosed patients (e.g., social anxiety disorder) would be desirable for replication of the present results.

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# 생물형운동 지각에서 특성불안과 정서관련 정보의 역할

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불안수준이 높은 사람들은 상위 인지 및 하위 지각 처리 수준 모두에서 불안수준이 높지 않은 사람들에 비해 사회적 정보를 다른 방식으로 처리하는 것으로 알려져 있다. 불안에 관한 대부분의 선행연구들은 주로 얼굴 자극을 사용하여 비언어성 사회적 단서 처리에 미치는 불안의 영향을 조사해왔다. 본 연구에서는 얼굴의 표정 뿐 아니라 신체 운동 역시 사회적 정보 처리에 매우 중요한 단서임을 고려하여 점광 생물형운동(point-light biological motion)을 주 자극으로 이용하였고, 탐지 과제 및 정서 재인 과제의 두 가지 과제를 통하여 특성불안의 수준이 생물형운동의 탐지에 영향을 미치는 지의 여부와, 자극에 내포된 정서가(분노, 행복 및 중립)가 불안의 효과를 조절하는지의 여부를 조사하였다. 또한 정서재인과제에서의 외현적 정서 재인의 정확도가 탐지과제에서의 암묵적 정서처리와 일관되는지를 알아보았다. 실험 결과, 중립정서를 내포한 생물형운동자극에 대해 불안수준이 높은 집단의 탐지과제 수행은 불안수준이 낮은 집단에 비해 저조한 것으로 나타났다. 대조적으로, 자극에 정서(분노 및 행복)가 내포된 경우, 탐지 과제 및 정서 재인 과제 모두에서 두 집단의 수행이 비슷하였다. 이 결과들은 높은 수준의 특성 불안이 생물형운동 지각 처리의 저하와 관련되어 있음을 보여주며, 자극에 정서 정보가 더해질 경우 불안에 의한 지각적 처리의 저하 효과는 약화 내지 사라질 수 있음을 시사한다.

주제어 : 불안, 생물형운동, 지각, 정서