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## Cognitive Processing

# "AVOIDING OR APPROACHING EYES"? INTROVERSION/EXTRAVERSION AFFECTS THE GAZE-CUEING EFFECT

--Manuscript Draft--

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| <b>Abstract:</b>                                     | <p>We investigated whether the extra-/introversion personality dimension can influence processing of others' eye gaze direction and emotional facial expression during a target detection task. On the basis of previous evidence showing that self-reported trait anxiety can affect gaze-cueing with emotional faces, we also verified whether trait anxiety can modulate the influence of intro-/extraversion on behavioral performance. Fearful, happy, angry or neutral faces, with either direct or averted gaze, were presented before the target appeared in spatial locations congruent or incongruent with stimuli's eye gaze direction. Results showed a significant influence of intra-/extraversion dimension on gaze-cueing effect for angry, happy and neutral faces with averted gaze. Introverts did not show the gaze congruency effect when viewing angry expressions, but did so with happy and neutral faces; extraverts showed the opposite pattern. Importantly, the influence of intro-extraversion on gaze-cueing was not mediated by trait anxiety. These findings demonstrated that personality differences can shape processing of interactions between relevant social signals.</p> |

**“AVOIDING OR APPROACHING EYES”? INTROVERSION/EXTRAVERSION  
AFFECTS THE GAZE-CUEING EFFECT**

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## **Abstract**

We investigated whether the extra-/introversion personality dimension can influence processing of others' eye gaze direction and emotional facial expression during a target detection task. On the basis of previous evidence showing that self-reported trait anxiety can affect gaze-cueing with emotional faces, we also verified whether trait anxiety can modulate the influence of intro-/extraversion on behavioral performance. Fearful, happy, angry or neutral faces, with either direct or averted gaze, were presented before the target appeared in spatial locations congruent or incongruent with stimuli's eye gaze direction. Results showed a significant influence of intra-/extraversion dimension on gaze-cueing effect for angry, happy and neutral faces with averted gaze. Introverts did not show the gaze congruency effect when viewing angry expressions, but did so with happy and neutral faces; extraverts showed the opposite pattern. Importantly, the influence of intro-/extraversion on gaze-cueing was not mediated by trait anxiety. These findings demonstrated that personality differences can shape processing of interactions between relevant social signals.

**Key words:** emotional facial expressions, gaze-cueing, personality, introversion and extraversion, attention.

## Introduction

Eye gaze and facial expressions provide fundamental information about others' intentions and emotional states, and have unquestionable adaptive value. Several behavioral studies investigated the effect of combined processing of facial expressions and gaze direction by means of the gaze-cueing paradigm. In the classical version of the paradigm, subjects are required to detect a target appearing unpredictably either to the left or the right of a neutral face with direct or averted gaze (for a review see Frischen et al. 2007). Normal subjects typically show faster detection times when targets are in the location consistent with gaze direction (congruency effect), thus demonstrating that observed eye gaze cues spatial attention (Frischen et al. 2007).

When the gaze-cueing paradigm is performed with face cues showing emotional expressions, mixed results have been obtained. Hietanen and Leppänen (2003) did not find any influence of the emotional facial expression on the gaze-cueing effect. In contrast, Putman et al. (2006) reported a combined effect of gaze direction and facial expression on spatial attention using dynamic stimuli, with stronger gaze-cueing effects for faces changing expression from neutral to fearful than from neutral to happy; however, the strength of the cueing effect was significantly correlated to participants' levels of anxiety. Two more studies have confirmed that the interactive effect of gaze direction and facial expression is largely modulated by trait anxiety. Actually, orienting of attention toward the gaze direction of the face-cue proved to be enhanced by fearful expressions, but only in subjects with high levels of trait anxiety (Fox et al. 2007; Mathews et al. 2003). Therefore, the mixed pattern of results on the gaze-cueing effect in the context of an emotional facial expression can be partially ascribed to the level of observers' trait anxiety (Frischen et al. 2007; Fox et al. 2007).

Another factor contributing to variability in the magnitude of the gaze-cueing effect is the tendency to avoid eye contact (Frischen et al. 2007). Bayliss et al. (2005) reported a poor congruency effect in normal subjects scoring high on a measure of the autistic spectrum. These findings fit well with data showing that in autistic children eye fixation is associated with an

overarousal in limbic regions such as amygdala; the attempt to reduce overarousal triggered by eye gaze might lead autistic children to avoid eye fixation (Dalton et al. 2005). Subjects with social phobia too are inclined to avoid eye region when scanning faces (Horley et al. 2003), likely to reduce exaggerated emotional responsiveness to social stimuli. Similarly to autistic children, social phobics show increased amygdala activation when viewing angry faces (Stein et al. 2002). In particular, individuals with social phobia show overarousal when processing threat-related emotional faces, as demonstrated by both hyperscanning of face stimuli (hypervigilance) and reduced eye fixation (eyes avoidance) (Horley et al. 2004; Moukheiber et al. 2010), but as far as we know this clinical population has not been investigated on the emotional gaze-cueing paradigm.

No direct investigations are available on the possible role of personality differences in processing eye gaze and emotional facial expressions. Different lines of evidence underline the existence of a strong link between social phobia and the personality trait of introversion. Some authors have shown that introversion is a major component of social phobia (Janowsky et al. 2000). On the other hand, it has been demonstrated that overarousal elicited by social stimuli is shared by introverts (Eysenck 1967) and social phobics (Horley et al. 2004; Moukheiber et al. 2010).

On the basis of the above considerations, in the present study we tested the hypothesis that personality differences along the intro-/extraversion dimension can affect attentional orienting induced by gaze direction combined with emotional facial expressions. Provided that introversion is related to high levels of arousal to social signals (Eysenck 1967), and consistent with evidence on social phobia (Horley et al. 2004; Moukheiber et al. 2010; Stein et al. 2002), we expected that introverts would not show the gaze congruency effect in presence of threatening, and in particular angry, facial stimuli relative to non-threatening (happy and neutral) expressions. Importantly, since previous research showed that the gaze-cueing effect with emotional expressions can interact with trait anxiety (Frischen et al. 2007; Fox et al. 2007; Mathews et al. 2003), in the present experiment we also assessed self-reported levels of trait anxiety to explore the possible relationships between anxiety and intro-/extraversion in modulation of the gaze-cueing effect.

## **Method**

### *Participants*

One hundred twenty undergraduate students (75 females; mean age: 24.3; range: 18-40) participated to the study.

All participants were assessed on the Introversion/Extraversion (IE) scale of the Italian version of the Big Five Questionnaire (BFQ; Caprara et al. 1993). According to the normative data, a IE score of 45 or less corresponds to high “introversion”, a IE score of 55 or more corresponds to high “extraversion”. To ensure reliable assessment of the IE dimension, we excluded from the study subjects ( $n=36$ ) who achieved a score  $<44$  and  $>56$  on the validation scale “Lie”. This scale comprises 12 items (e.g.: “I have never told a lie” or “I have always gotten along with everyone”) designed to detect the subject’s tendency to offer a distorted profile of her/his own person, either in a positive or a negative way (Caprara et al. 1993). The final sample comprised 84 subjects (49 females) with a mean score on the Introversion/Extraversion scale of 49.3 ( $SD=12.3$ , range= 21-84).

The participants were also assessed on the State-Trait Anxiety Inventory (STAI; Spielberg 1983): scores of 45 or above correspond to high levels of trait anxiety, whereas scores of 35 or below correspond to low levels of trait anxiety (Spielberg 1983; see also Richards and French 1991; Schwerdtfeger 2006). Mean score on STAI-T in our sample was 51.7 ( $SD=11.01$ , range= 29-79).

### *Stimuli and Procedure*

Cueing stimuli were derived from photographs of one male face displaying happy, fearful, angry or neutral expression, selected from Ekman and Friesen’s set (1976). Facial expressions of one actor only were presented to prevent unwarranted effects of variations in identity of face stimuli (Ganel et al. 2005). Hair and non-facial areas were removed so that only the central face area was visible. In the 4 original pictures the gaze was directed straight ahead; to simulate a leftward or rightward gaze

we digitally modified each photograph by positioning both pupils to the far left or far right. Photographs were presented in central position and subtended a vertical visual angle of 7°. The stimulus for the target detection task consisted in a black asterisk, positioned 5° to the left or the right of the midpoint of the screen. Trials consisted of a fixation cross at the center of the screen (1000 ms), followed by a face looking straight ahead (900 ms) and then by the same photograph with either direct or averted gaze, to simulate a gaze shift toward the left or the right. The target asterisk appeared either 300 ms or 700 ms after the second face presentation, unpredictably on the left or the right of the picture, to prevent stimulus predictability (e.g., Fox et al. 2007). Subject were required to press the space bar of the computer keyboard as soon as they detected the asterisk; face cues and targets remained on the screen until response completion. It was emphasized that gaze direction or facial expressions did not predict the target location.

Participants seated 50 cm away from a 17-in. computer screen, with their head positioned on a chinrest. Stimulus presentation and data collection were controlled by a PC using Cedrus SuperLab v.4. A practice block of 12 trials was completed before two blocks of 192 experimental trials. The experimental trials consisted of combinations of four emotional expressions (neutral, happy, angry, or fearful), two target positions (left or right), three gaze directions (straight ahead, left, or right), and two stimulus-onset asynchronies (300 ms or 700 ms). Each combination was repeated four times, the entire experiment comprising 128 direct gaze trials and 256 averted gaze trials (128 congruent and 128 incongruent), presented in a random order. To discourage anticipatory responses, we added 36 “catch” trials, in which faces were not followed by the target asterisk. Participants were instructed not to respond; catch trials ended 2000 ms after the onset of the face stimulus.

### *Statistical analyses*

In order to test the starting hypothesis that intro-/extraversion could affect participants' behavior on the gaze-cueing task, and to investigate the possible mediation/modulation effect of trait anxiety, we performed mediational analyses according to the method proposed by Baron and Kenny (1986).

For these purposes, regression analyses were conducted with the behavioral performance as a dependent variable, intra-/extraversion as the independent variable and trait anxiety as the mediator. Thus, trait anxiety was first regressed on intra-/extraversion (path A); second, behavioral performance was regressed on intra-/extraversion (path C); and third, behavioral performance was regressed on both intra-/extraversion and trait anxiety (path B; see Figure 1). Two conditions must be met in the third equation (path B) if a mediator effect of anxiety is present: i) the mediator is a significant predictor of the outcome variable, and ii) the direct relationship of the independent variable to the outcome variable is less significant than it is in the second equation (path C; Baron and Kenny 1986).

Independently from meditational analysis, following previous studies (Fox et al. 2007; Mathews et al. 2003) we specifically investigated possible relationships between trait anxiety and behavioral performance by means of separate regression analyses.

All the above analyses were performed on averted gaze and direct gaze conditions separately (Fox et al. 2007; Mathews et al. 2003). As regards gaze averted trials, the congruency effect was computed for each of the four facial expressions (angry, fearful, happy and neutral) by subtracting the mean reaction times on congruent trials from the mean reaction time on incongruent trials; with respect to direct gaze trials, mean reaction times were calculated separately for each emotion and then entered into regression analyses.

--- Please insert Figure 1 about here ---

## Results

As a first step of our meditational analyses, the regression equation assessing path A showed that intro-/extraversion significantly correlated with trait anxiety,  $Beta = -.469$ ,  $p = .0001$  (Figure 2).

The following steps (paths B and C) were computed on the congruency effect in averted gaze trials separately for the four expressions. As regards angry expression, regression analysis assessing

**path C** showed that intro-/extraversion significantly affected the congruency effect,  $Beta = .338, p = .002$  (Figure 2), whereas regression equation for **path B** did not show any mediator effect: the mediator did not significantly predict the congruency effect,  $Beta = .128, p = .278$ , and the variance in congruency effect explained by intro-/extraversion,  $Beta = .399, p = .001$ , was not reduced with respect to the **path C**. As regards fearful expression, regression analysis assessing **path C** showed that intro-/extraversion did not significantly affect the congruency effect,  $Beta = -.094, p = .393$ .

Although there was no significant direct association between the independent variable and the outcome variable, we searched for direct relationships between trait anxiety and performance. This were the case, one could infer that, for fearful faces, the gaze-cueing effect was specifically influenced by trait anxiety (and not by intro-/extraversion). Results of the regression analysis showed, instead, that trait anxiety did not significantly predict the congruency effect,  $Beta = .017, p = .881$ . With respect to happy expression, regression equation for **path C** showed a significant effect of intro-/extraversion on the congruency effect,  $Beta = -.242, p = .027$  (Figure 2), whereas regression equation on **path B** did not show any mediator effect: the mediator significantly predicted the congruency effect,  $Beta = -.312, p = .009$ , but the variance explained by intro-/extraversion,  $Beta = .388, p = .001$ , was not reduced with respect to the **path C**. The regression equation assessing the relationship between trait anxiety and gaze-cueing effect with happy faces did not reveal any significant effect,  $Beta = -.130, p = .239$ . Finally, as regards neutral expression, regression equation for **path C** showed a significant effect of intro-/extraversion on the congruency effect,  $Beta = -.281, p = .010$  (Figure 2), whereas regression equation on **path B** did not show any mediator effect: the mediator did not significantly predict the congruency effect,  $Beta = -.219, p = .068$ , and the variance explained by intro-/extraversion,  $Beta = .383, p = .002$ , was not reduced with respect to the **path C**. The regression equation testing for possible influence of trait anxiety on the gaze-cueing effect with neutral faces did not provide significant results,  $Beta = -.039, p = .727$ .

--- Please insert Figure 2 about here ---

Mediation analyses were then computed on the mean reaction times for direct gaze trials.

Results from regression equations assessing **path C** showed that intro-/extraversion did not significantly affect reaction times for any facial expression (angry: Beta = .045,  $p = .683$ ; fear: Beta = .136,  $p = .217$ ; happy: Beta = -.145,  $p = .188$ ; neutral: Beta = -.105,  $p = .344$ ). **The regression analysis assessing whether trait anxiety could significantly influence processing of emotional faces with direct gaze showed that trait anxiety significantly affected reaction times for happy, Beta = .275,  $p = .011$ , and neutral faces, Beta = .248,  $p = .023$  (Figure 3), whereas it did not significantly influence reaction times for angry, Beta = .009,  $p = .937$ , and fearful expressions, Beta = -.032,  $p = .773$ .**

--- Please insert Figure 3 ---

## Discussion

The present results demonstrated that **on the averted gaze trials** introvert individuals did not show the congruency effect when peripheral targets were preceded by face-cues displaying angry expressions, whereas they showed the congruency effect when eye gaze was combined with happy or neutral expressions; the opposite was true for extraverts. Mediation analyses provided evidence that although intro-/extraversion was significantly related to self-reported levels of trait anxiety, the influence of personality on the gaze-cueing effect was not mediated by anxiety. **Moreover, analyses on direct gaze trials showed that the higher the trait anxiety the slower the reaction times when processing happy or neutral expressions; intro-/extraversion, instead, never affected behavioral performance.**

Several authors (Fox et al. 2007; Putman et al. 2006) have demonstrated that high levels of trait anxiety enhance gaze congruency effect to fearful with respect to neutral, happy and angry facial expressions. Actually, in Fox et al.'s study (2007) in the averted gaze conditions fearful expressions

increased attentional orienting response in high-anxious subjects, while angry expressions inhibited it. The present study demonstrated that higher levels of introversion were associated to reduced orienting to eye gaze for angry expressions, whereas lower levels of introversion favored the congruency effect, independently from anxiety. Different findings have been obtained for fearful expressions, where we did not observe any influence of personality or anxiety. On this basis, we could suggest that differences in personality traits can define the subjective representation of threatening expressions in a highly specific way, with introversion being related to eye avoidance in interaction with other's angry faces.

Neurofunctional studies showed that amygdala activation is stronger for presentation of unambiguous threats, as in the case of angry faces with straight gaze, directed toward the observer, and of fearful faces with averted gaze, directed away from the observer, towards a possible threat in the environment (Adams and Kleck 2003; Hadjikhani et al. 2008; N'Diaye et al. 2009). Such findings would suggest that specific neural structures are strongly activated when the combination of eye gaze direction and facial expressions give rise to unambiguous, self-relevant threats (e.g., Cristinzio et al. 2010). In apparent contrast with these data, Adams et al. (2003) showed that angry faces coupled with averted gaze and fearful faces coupled with direct gaze (ambiguous threat) elicited stronger amygdala activations than angry faces coupled with direct gaze and fearful faces coupled with averted gaze (unambiguous threat). The present results would reconcile these apparent divergences by suggesting that the concept of self-relevance and ambiguity of threat cannot be rigidly represented by defined combinations of facial expressions and gaze direction but rather can be conceived by more flexible categories of stimuli shaped by individual differences.

In this context, the hypothesis that emotion processing is influenced by appraisal of self-relevance assigned to a stimulus (i.e., self-relevance hypothesis) would predict different behavioral responses as a function of idiosyncratic representations of threat (Sander et al. 2003). As reported above, subjects with high trait anxiety **would be** particularly prone to experience anxiety to cues subjectively signaling threats (fearful faces with averted gaze and angry faces with direct gaze),

although they do not experience others' eyes as a specific self-relevant threat, as demonstrated by the presence of the gaze-cueing effect (Fox et al. 2007). On the contrary, subjects with excessive concerns that others could evaluate them negatively (i.e., individuals with high levels of introversion; Janowsky et al. 2000), experience others' eyes as highly self-relevant stimuli, likely the most threat-inducing feature in social situations (Öhman 1986). The present results allowed to clarify that others' gaze is not always threatening for introverts but represents threat only in the context of angry facial expressions. Otherwise, others' gaze could be "self-irrelevant", as in the case of fearful expressions, or could be even reassuring, as in the case of averted gaze combined with happy and neutral expressions. The present data strictly fit evidence on social phobia (Horley et al. 2004; Moukheiber et al. 2010; Stein et al. 2002) and are consistent with the self-relevance hypothesis: since others' eyes may represent a powerful signal of danger for introverts individuals, they would (likely implicitly) try to avoid interaction with eye gaze in the attempt to reduce threat-related overarousal, but only when gaze is combined with angry expressions. On the contrary, introverts are encouraged in eye contact when other's gaze is combined with positive or neutral expressions. This introversion-related representation of self-relevant social stimuli was reversed in extraverts who, instead, showed the congruency effect when processing angry faces and did not show the effect when processing happy or neutral faces, fitting evidence from a neuroimaging study by Canli et al. (2002) who demonstrated high amygdala activation to happy faces in extraversion; the authors suggested that this brain response could account for the sociable interactive style of extraverts.

The present findings on the gaze-cueing effect in averted gaze trials demonstrated that the influence of intro-/extraversion on processing of social signals was independent from the role of trait anxiety. Regressions analyses on direct gaze trials confirmed that personality traits and anxiety exerted independent effects. Actually, higher trait anxiety was related to slower reaction times for happy and neutral expressions, whereas intro-/extraversion never affected performance. It is worth mentioning that the present findings of slower responses in high trait anxiety participants with

respect to low trait anxiety subjects are in keeping with the general pattern of results reported by Fox et al. (2007; Fig. 4), although we did not replicate the specific effects of the different emotional facial expressions on performance (significantly slower responses with angry expressions in high trait anxiety subjects) described by Fox et al. (2007). The relationships between trait anxiety and processing of emotional facial expressions with direct gaze warrants further investigation, also in consideration that other authors reported slower responses in anxious individuals to centrally located fearful faces with direct gaze (e.g., Mathews et al. 2003).

In line with previous literature on social cognition, in the present experiment we used photographs of potentially threatening expressions (e.g., fearful and angry) but no real threat was actually present in our laboratory. In real life, management of threat-related situations could give rise to different patterns of interaction between personality and anxiety in processing others' eye gaze and emotional faces. This issue can be tackled with only by experimental paradigms allowing to reproduce more dynamic "real life" situations (see, Mumenthaler and Sander 2012).

In conclusion, we found here that individual differences in specific personality dimensions can affect processing of social signals such as eye gaze and emotional facial expressions. Mediation analyses demonstrated that the influence of intro-/extraversion on gaze-cueing was not modulated by trait anxiety. In line with the self-relevance model of emotional processing, the present findings underline the role of individual differences in studies on cognitive and neurofunctional mechanisms of social cognition. More precisely, the present data would suggest that self-relevance cannot be rigidly defined by specific combinations between facial expressions and gaze direction, but rather have to be represented in a more flexible way taking into account individual differences in personality traits.

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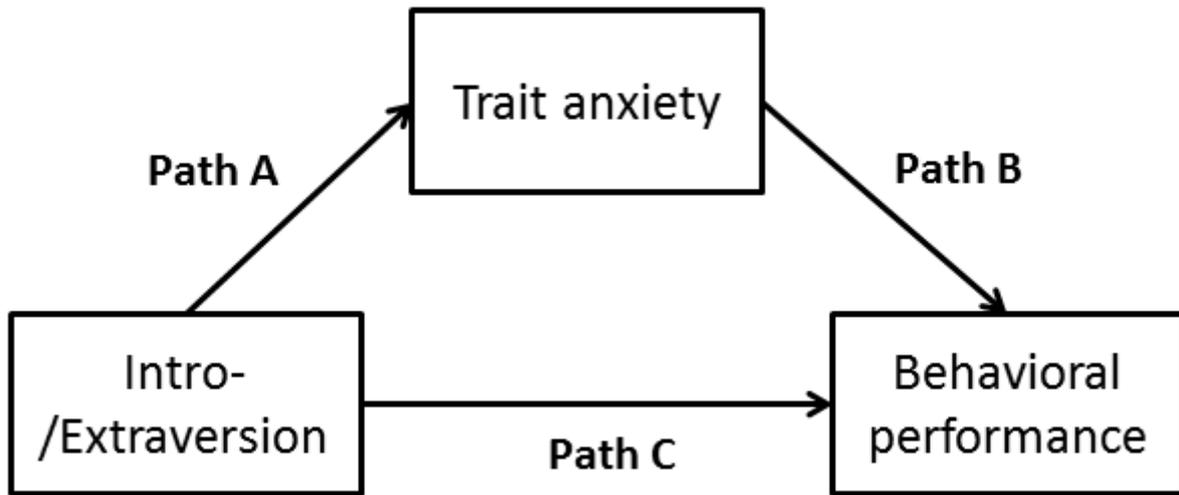
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## Figure legends

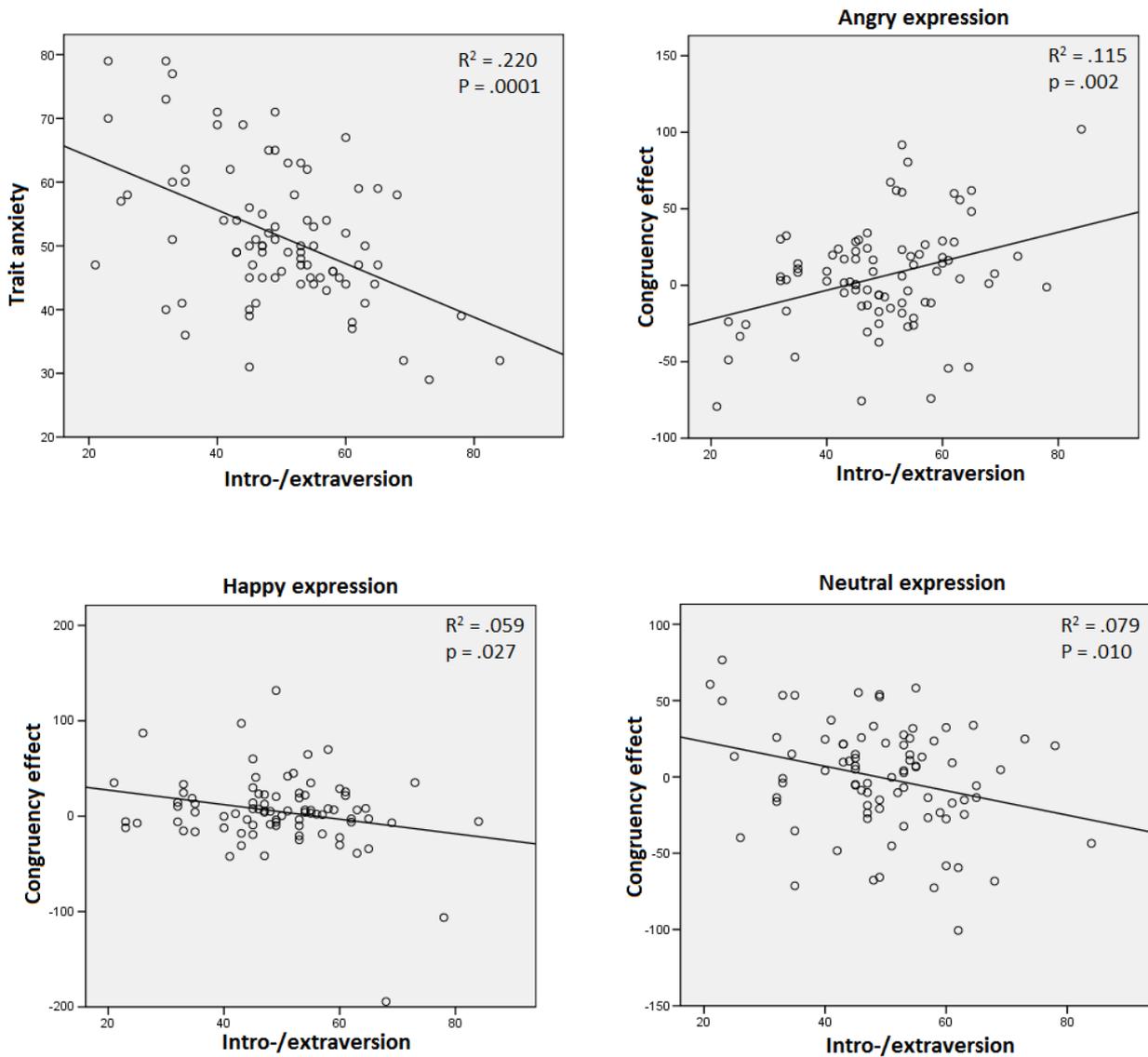
**Figure 1.** Model of mediational analysis with the behavioral performance as a dependent variable, intra-/extraversion as the independent variable and trait anxiety as the mediator.

**Figure 2.** Regression plots of intro-/extraversion with trait anxiety (top left panel) and with the congruency effect (computed by subtracting mean reaction times on congruent trials from the reaction time on incongruent trials) for angry (top right panel), happy (bottom left panel) and neutral (bottom right panel) facial expressions with averted gaze.

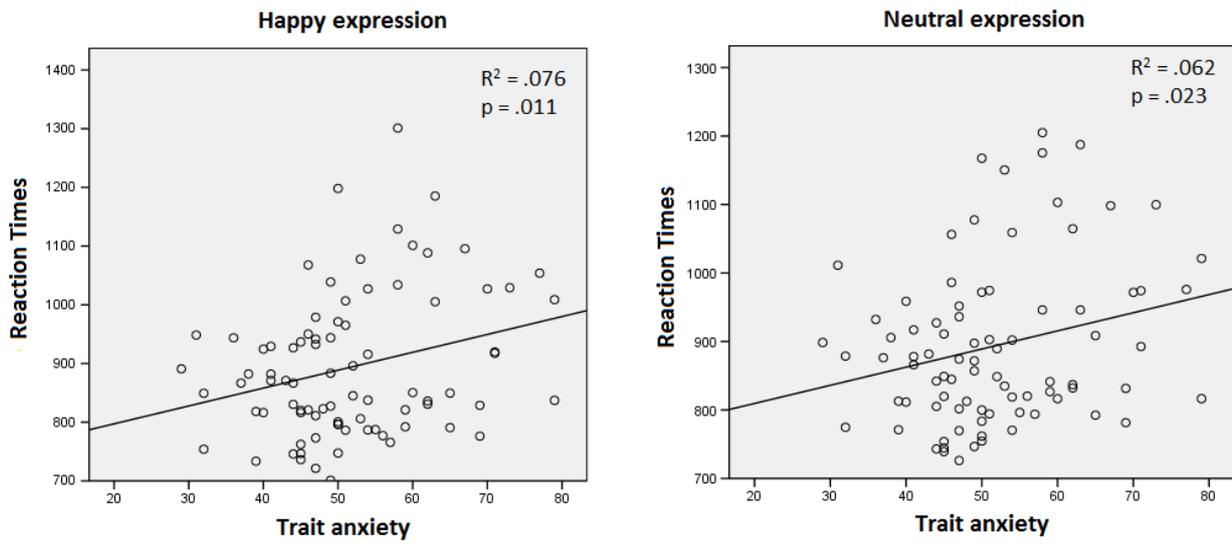
**Figure 3.** Regression plots of trait anxiety with reaction times for happy (left panel) and neutral (right panel) facial expressions with direct gaze.



**Figure 1.** Model of mediational analysis with the behavioral performance as a dependent variable, intra-/extraversion as the independent variable and trait anxiety as the mediator.



**Figure 2.** Regression plots of intro-/extraversion with state-trait anxiety (top left panel) and with the congruency effect (computed by subtracting mean reaction times on congruent trials from the reaction time on incongruent trials) for angry (top right panel), happy (bottom left panel) and neutral (bottom right panel) facial expressions with averted gaze.



**Figure 3.** Regression plots of trait anxiety with reaction times for happy (left panel) and neutral (right panel) facial expressions with direct gaze.

## Cognitive Processing

# "AVOIDING OR APPROACHING EYES"? INTROVERSION/EXTRAVERSION AFFECTS THE GAZE-CUEING EFFECT

--Manuscript Draft--

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| <b>Abstract:</b>                                     | <p>We investigated whether the extra-/introversion personality dimension can influence processing of others' eye gaze direction and emotional facial expression during a target detection task. On the basis of previous evidence showing that self-reported trait anxiety can affect gaze-cueing with emotional faces, we also verified whether trait anxiety can modulate the influence of intro-/extraversion on behavioral performance. Fearful, happy, angry or neutral faces, with either direct or averted gaze, were presented before the target appeared in spatial locations congruent or incongruent with stimuli's eye gaze direction. Results showed a significant influence of intra-/extraversion dimension on gaze-cueing effect for angry, happy and neutral faces with averted gaze. Introverts did not show the gaze congruency effect when viewing angry expressions, but did so with happy and neutral faces; extraverts showed the opposite pattern. Importantly, the influence of intro-extraversion on gaze-cueing was not mediated by trait anxiety. These findings demonstrated that personality differences can shape processing of interactions between relevant social signals.</p> |