Extraversion predicts individual differences in face recognition

Jingguang Li,[1,†] Moqian Tian,[1,†] Huizhen Fang,[1] Miao Xu,[1] He Li[1] and Jia Liu[1,2,*]

[1]State Key Laboratory of Cognitive Neuroscience and Learning; Beijing Normal University; and [2]Graduate University of Chinese Academy of Sciences; Beijing, China

[†]These authors contributed equally to this work.

In daily life, one of the most common social tasks we perform is to recognize faces. However, the relation between face recognition ability and social activities is largely unknown. Here we ask whether individuals with better social skills are also better at recognizing faces. We found that extraverts who have better social skills correctly recognized more faces than introverts. However, this advantage was absent when extraverts were asked to recognize non-social stimuli (e.g., flowers). In particular, the underlying facet that makes extraverts better face recognizers is the gregariousness facet that measures the degree of inter-personal interaction. In addition, the link between extraversion and face recognition ability was independent of general cognitive abilities. These findings provide the first evidence that links face recognition ability to our daily activity in social communication, supporting the hypothesis that extraverts are better at decoding social information than introverts.

Introduction

The ability to interact effectively in social environments is essential to success in everyday life. Because faces are arguably the most important social stimuli, the ability to correctly recognize faces is vital for social interaction. Individuals with better social skills may spend more time on people, which helps get better at recognizing faces. Consistent with this hypothesis, a recent behavioral genetic study has demonstrated substantial environmental influence on face recognition along with the genetic factor.[1] On the other hand, deficits in face recognition, such as prosopagnosia (i.e., face blindness[2,3]), may lead individuals to suffer from psychosocial difficulties such as fear and avoidance of social situations.[4] However, little effort has been dedicated to directly testing the relation between social activities and face recognition ability. Here, we ask whether individuals with better social skills have better face recognition ability.

Extraversion is chosen as a measure of one's social skills. As one of the fundamental dimensions of personality, extraversion is often thought of as implying sociability that involves sensitivity to reward, positive emotions, sociability, assertiveness and high energy.[5] Consistent with this hypothesis, a study using a portable recording device reveals that extraverts are more talkative and social than introverts.[6] In fact, extraversion predicts effective cognitive-social functioning across a variety of domains from cognitive performance and social endeavors to social economic

status. For example, extraverts are better at decoding nonverbal social information than introverts.[7] In addition, extraversion reliably predicts social activities, such as alcohol consumption, popularity, parties attended, dating variety, exercise,[8] social support seeking,[9] marital satisfaction,[10] and job performance in sales and management positions.[11] Finally, extraversion is negatively correlated with social phobia[12] and suicidality.[13] In sum, extraverts are more socially skilled than introverts.

In this study, we examined whether extraversion predicts individual differences in face recognition. The accuracy in an immediate recognition memory task (i.e., the old/new task) on faces and flowers was used to calculate face-specific recognition ability, whereas the self-report score on extraversion dimension from the NEO Personality Inventory, Revised (NEO PI-R[14]) was used to measure social skills. General cognitive abilities (i.e., general intelligence or IQ) were measured by Raven's advanced progressive matrices (Raven APM[15]). Using both extreme selection analysis[16] and correlational analysis, we found that extraverts were better at recognizing faces than introverts, but not at recognizing non-social stimuli. Furthermore, the link between extraversion and face recognition ability was independent from IQ.

Results

The self-report scores on extraversion are shown in **Figure 1A**. The scores were normally distributed and there was no clear cut
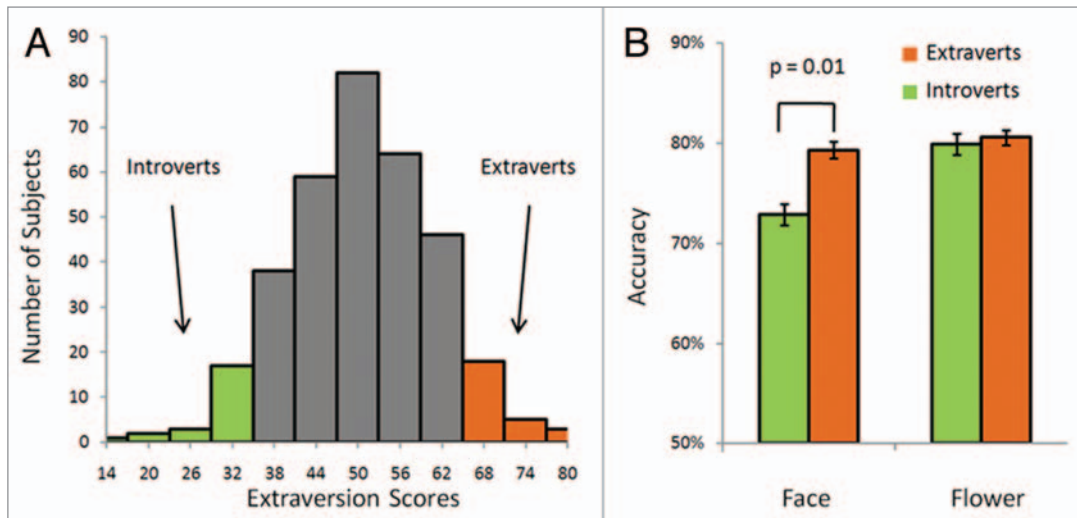
Figure 1. The relation between extraversion and face recognition ability. (A) Distribution of extraversion scores. The number of extraverts and introverts were 20 and 23 respectively, constituting approximately 12% of the total subjects tested. (B) The extraverts performed better at face recognition task, but not at flower recognition task, than introverts. The dissociation of Extraversion by object recognition suggests that the link between extraversion and face recognition is related to face-specific processing. Accuracy is shown on the y-axis and the error bar indicates standard error.

between extraverts and introverts. Therefore, instead of dividing the subjects using a median split along the extraversion dimension, here we used extreme selection approach[16] to select most representative extraverts and introverts whose scores lay at each end of the extraversion dimension. This approach has been proved successful in studies on genetics-related disorders as individuals at two extremes share least amount of genes. Therefore, instead of using the data of all subject tested, individuals drawn from the opposite ends of the extraversion distribution can maximize the statistical power by achieving the maximal possible phenotypic separation between introverts and extraverts. Individuals who scored above or below approximately 5% on each end were selected.

The accuracy in recognizing faces was significantly higher in the extraverts than introverts [$t(41) = 2.37$, $p = 0.01$; effect size: Cohen's $d = 0.26$] (**Fig. 1B**). However, there was no significant difference in recognizing flowers between the two groups [$t(41) = 0.26$, $p = 0.40$, Cohen's $d = 0.03$]. The dissociation of extraverts versus introverts in recognizing faces versus non-face objects suggests that only the processing of socially important stimuli (i.e., faces) is associated with individuals' social skills. In addition, the mean accuracy in recognizing faces of the whole subject population was between that of the introverts and the extraverts (population mean: 78%; introverts: 73%; extraverts: 79%), suggesting that the face recognition ability increases monotonically along the extraversion dimension. In fact, the extraversion score of the whole subject population was positively correlated with the face-specific recognition ability (FRA), indexed by the difference score between accuracy in recognizing faces versus flowers. This positive correlation was only found in the extraversion dimension ($r = 0.09$, $p = 0.06$), but not in other dimensions such as Conscientiousness, Neuroticism, Agreeableness and Openness to new experience (all $rs < 0.05$, all $ps > 0.2$).

Just as the FRA was more strongly associated with extraversion than other dimensions, it is likely that specific extraversion facets would better predict the FRA than other extraversion facets. For example, the gregariousness facet of extraversion reflects the inter-personal interaction (e.g., "I like to have a lot of people around me"), whereas the excitement-seeking facet reflects the energy level of activity (e.g., "I like to be where the action is"). We predicted that only facets that are involved in inter-personal interaction could predict the FRA. Consistent with this prediction, we found a positive correlation between the gregariousness facet and the FRA ($r = 0.10$, $p = 0.03$) (**Fig. 2A**), with a positive correlation between the gregariousness and face recognition ability ($r = 0.10$, $p = 0.04$), but not between the gregariousness and flower recognition ability ($r = -0.03$, $p = 0.63$). In addition, other extraversion facets such as warmth, excitement-seeking, assertiveness, activity and positive emotion, were not correlated with the FRA (all $rs < 0.07$, all $ps > 0.1$). Therefore, it is apparently the inter-personal interaction, but not the extraversion in general, that links to face-specific processing.

Previous studies have shown that extraverts are better at decoding non-verbal communication information than introverts,[7] and therefore the link between the gregariousness facet and the FRA may simply be derived from subjects' general ability in discriminating socially interesting stimuli. In other words, might the link be due to the possibility that they were both correlated with the general intelligence? As shown in our previous study, there was no positive correlation between the FRA and IQ (measured by Raven's APM) (**Fig. 2B**).[1] Moreover, although the extraversion score was positively correlated with IQ ($r = 0.11$, $p = 0.03$), consistent with previous findings,[21] the gregariousness facet was not ($r = 0.07$, $p = 0.11$) (**Fig. 2B**). The lack of a correlation of gregariousness facet with IQ is not a result of insufficient power, because other facets of extraversion, such as positive emotion facet, were positively correlated with IQ ($r = 0.15$, $p < 0.005$). Furthermore, with IQ controlled (i.e., regressed out), the partial correlation between gregariousness facet and the FRA remained
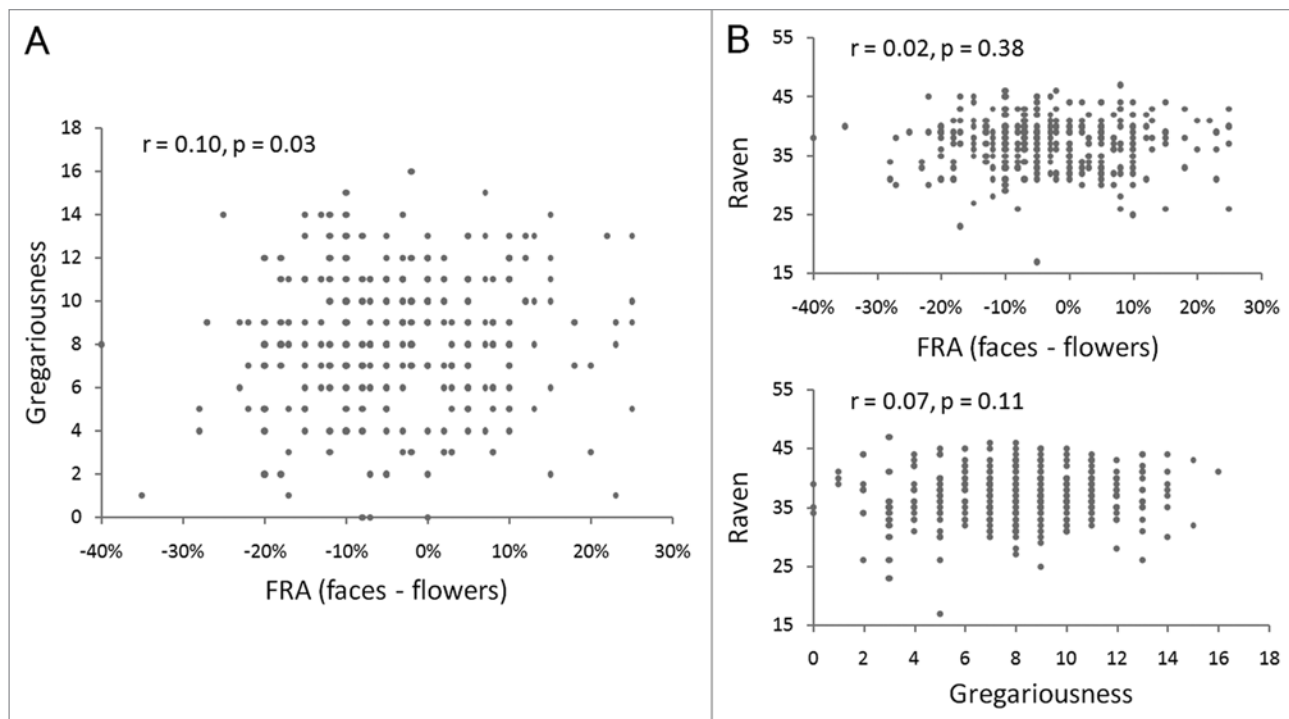
Figure 2. Gregariousness and face recognition ability. (A) Gregariousness is positively correlated with face-specific recognition ability (FRA, the difference score between accuracy in recognizing faces versus flowers). (B) Both gregariousness and FRA are not correlated with IQ measured by Raven APM.

positive (r = 0.10, p = 0.03). Therefore, the link between gregariousness facet and the FRA was independent of IQ.

Discussion

In this study, we examined the link between social skills and face recognition ability. We found that extraverts who show better social skills than introverts are also better at processing faces but not at processing non-face objects. More importantly, the underlying facet that makes extraverts a better face recognizer is mainly due to gregariousness facet, but not other facets of extraversion that do not rely heavily on interpersonal interaction. Finally, the link between inter-personal social activity (i.e., gregariousness) and face-specific recognition ability is independent of IQ. Our study provides the first evidence that links the face recognition ability and our daily activity in social communication.

It has been proposed for a long time that extraverts have certain abilities that are lacked in introverts, which make extraverts behave more socially than introverts.[22-24] Among them is the ability to decode non-verbal social information, as introverts are impaired in extracting relevant social, affective and evaluative cues from the inter-personal environment.[7] Our result is consistent with this hypothesis, showing that introverts were poorer in extracting social stimuli (i.e., faces), but their performance in recognizing non-social stimuli (i.e., flowers) was matched to extraverts. Further, we show that the processing of face information was linked to a specific facet of extraversion that relays heavily on inter personal communication. In other words, it is not

the extraversion in general but the inter personal interaction in particular that makes extraverts a better face recognizer.

However, the link between extraversion and face-specific recognition ability does not specify the causal relation between these two variables. It is possible that individuals who spend more time on inter personal interaction have more experiences with faces and/or are motivated to recognize faces. Therefore, the face recognition ability is improved because of the environmental influences. This hypothesis is consistent with our previous genetic study where we have demonstrated substantial environmental influence on face recognition.[1] On the other hand, individuals with poor face recognition ability (e.g., individuals with prosopagnosia or Autism) may become introverts after recurrent and sometimes traumatic social interaction difficulties caused by face recognition problems.[4] Finally, the link between extraversion and face recognition ability might be due to a third factor that modulates both of them. For example, the intranasal administration of a neuropeptide oxytocin not only improves the recognition of faces,[25] but also increases trustworthy behaviors.[26] In other words, because face recognition is highly interacted with daily social functions, it is possible that they might be evolutionarily co-developed and may have a shared neural and/or genetic basis. Future studies are needed to address casual link between extraversion and face recognition ability.

Method

Subjects. Three hundred and thirty-nine Chinese college students from Beijing Normal University participated in this study

(139 males, 200 females; age = 20.4 years, SD = 0. 9). All subjects had normal or corrected-to-normal visual acuity and received monetary compensation. Two subjects who did not participate in the Raven APM test were excluded from further analysis. The study was approved by the IRB of Beijing Normal University. Prior to testing, written informed consent was obtained from the subjects.

Procedure. The recognition task was conducted in computers with Matlab and the psychophysics toolbox.[17,18] The NEO PI-R scale and Raven APM test were paper-based. Each subject completed the NEO PI-R scale and Raven APM on the same day, and then the recognition task on a separate day.

NEO PI-R. NEO Personality Inventory Revised is a 240-item self-report inventory which permits differentiated measurement of each Big Five dimension along with six more specific facets per dimension.[14] The inventory has substantial internal consistency, temporal stability, and convergent and discriminant validity.[19] One hundred and twenty items were used in this study to reduce the length of testing while maintaining the reliability and validity of the inventory. The items were translated into Chinese for the ease of comprehension. Although the Chinese language does not clearly reproduce the English Big Five and several differences remain, previous studies have shown that the indigenous Chinese personality dimensions overlap considerably with the Big Five dimensions.[20] The internal consistency (Cronbach's alpha) for each subscale ranged from 0.75 to 0.89. The extraversion dimension is based on 24 items scored from 1 (least agreeable) to 5 (most agreeable).

Raven APM. Raven advanced progressive matrices contains 48 multiple-choice items of abstract reasoning where subjects are asked to identify the missing segment required to complete a larger pattern.[21] Because the subjects were highly homogeneous, the raw score of the test was used as a measure for general cognitive abilities.

Recognition task. Forty face images and forty flower images were used in the task. The face images were gray scale adult Chinese faces, with external contour (a roughly oval shape with hair on the top and sides) removed. The face images were selected from an in-house adult Chinese face database. Flowers were gray-scale pictures of daily flowers with leaves and background removed. There were two blocks in this task: a face block and a flower block. Each block consisted of one study and one test segment. In the study segment, 20 images of each object category were shown for 1 sec per image with an inter-stimulus interval of 0.5 sec, and the 20 images were cycled through twice. In the test segment, 10 studied images were shown twice, randomly intermixed with 20 new images from the same category. On presentation of each image, subjects were instructed to determine whether the image had been shown in the study segment. The split-half reliability for face recognition and flower recognition was 0.53 and 0.55 respectively.

Data analysis. We limited our comprehensive analyses to extraversion dimension given the established link between extraversion and social skills, and our lack of hypotheses about the link between face recognition ability and the remaining dimensions. That is, we hypothesized that extraversion, but not the other personality dimensions, would predict individual differences in face recognition. One-tailed t-test and correlational analysis were used on the basis of our directional hypothesis that individuals scoring higher in extraversion show a better ability in recognizing faces.

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