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Faces presenting sadness enhance self-control abilities in gifted adolescents

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Abstract

Self-regulation skills refer to processes allowing emotional and cognitive adaptation of the individual. Some gifted adolescents are known for their imbalance between high intellectual abilities and low emotional skills. Thus, this study aimed at examining the interplay between emotion and cognition in gifted and non-gifted adolescents. A Stop Signal task, a response inhibition task including neutral, happy or sad faces as signal triggering inhibition, was administered to 19 gifted and 20 typically-developing male adolescents (12 to 18 years old). Gifted adolescents showed lower response inhibition abilities than non-gifted adolescents in the neutral and happy face conditions. Sad faces in gifted adolescents were associated with higher response inhibition compared to happy condition. In typically-developing adolescents, emotional information (happy or sad faces) was related to lower response inhibition compared to neutral face condition. This study highlights that gifted adolescents present different self-regulation skills than their typically-developing peers.

Keywords: response inhibition; self-regulation; emotion; giftedness; adolescence

Statement of Contribution

What is already known on this subject?

- Some gifted adolescents present higher intellectual abilities alongside with lower socio-emotional skills
- Self-regulation skills refer to processes allowing emotional and cognitive adaptation
- Self-regulation skills might help to understand gifted adolescents, but remain scarcely studied

What does this study adds?

- Task-relevant emotional information impaired cognitive control in typically-developing adolescents
- Gifted adolescents are able to use sad faces to enhance their cognitive control abilities

Faces presenting sadness enhance self-control abilities in gifted adolescents

"Gifted" individuals have higher intellectual capacities than their typically-developing peers. However, some gifted adolescents are vulnerable to behavioral and social maladjustment (e.g., Silvermann, 1993) as well as school difficulties (Siaud-Facchin, 2012), suggesting self-regulation difficulties (e.g., Chung, Yun, Kim, Jang, & Jeong, 2011). Self-regulation skills refer to processes allowing emotional and cognitive adaptation of the individuals to face the ever-changing environment or to achieve goals (Nigg, 2017). Due to the strong predictive value of self-regulation skills for academic performance (e.g., Nota, Soresi, & Zimmerman, 2004), it is of primary importance to better understand these skills in gifted adolescents.

One way to study self-regulation skills is to study the complex interplay between emotion and cognition. In particular, according to Pessoa's model (Pessoa, 2009, 2011), based mainly on studies with typically-developed adults, emotional information is preferentially processed than neutral information, recruiting part of the limited shared pool of attentional resources available for processing information and thus planned goal-directed actions (i.e., self-regulation skills). In particular, Pessoa's model predicts that if the emotional information is relevant for the ongoing action, emotion would enhance the efficiency of the effortful cognitive processes (Pessoa, Padmala, Kenzer, & Bauer, 2012). However, the intensity of the emotional information is important (more than the valence, Verbruggen & De Houwer, 2007). Indeed, only emotional information of mild intensity (compared to high-arousal stimuli like threat of shock) was observed to enhance performance when the task is relevant (Pessoa et al., 2012).

The anterior cingulate cortex (ACC), part of the prefrontal cortex, sustains these processes and is not fully developed at adolescence (Diamond, 2002). Due to this brain immaturity, the balance between emotional information and cognitive processes is not at its optimal level in adolescents. However, to the best of our knowledge, the potential positive influence of emotional information has never been tested neither in typically-developing adolescents nor in gifted adolescents, which is aimed by the current study. Previous studies showed that emotions may enhance cognitive control when they are congruent with the ongoing task (Pessoa et al., 2012). Additionally, some gifted youths are known for their higher sensitivity towards emotional information (due to overexcitability; Dabrowski, 1967). Thus, we hypothesized that emotion will enhance cognitive control abilities and that this effect might be stronger in gifted adolescents.

Material and Methods

Participants

Nineteen boys (i.e., only boys to reduce heterogeneity of the sample and according to sex differences in emotion processing; see Kret & De Gelder, 2012) gifted adolescents, followed in a public hospital for school difficulties, aged from 12 to 18 years (M = 15.13; SD = 2.10) were included in this study. Inclusion criteria were: (1) an intellectual quotient (IQ; Wechsler, 1996) higher than 125, (2) having typical cognitive and affective giftedness features (i.e., lively wit and quick thinking, very observant, alert, perceptive, and intuitive), and (3) not presenting diagnosed psychiatric disorders. The two last criteria were assessed by senior psychiatrists at the local public hospital.

Twenty-four age-matched male adolescents (M = 15.96; SD = 1.32) from a comparable socio-economic background were recruited. The exclusion criterion consisted of scores higher than the normal range (i.e., percentile 95) on the Colored Progressive Matrices (Raven, Court, & Raven, 1998). Four adolescents were excluded due to this reason, resulting in a sample of 20 non-gifted controls.

All participants, and their caretakers for adolescents younger than 14, gave their informed consent, and the procedure was approved by the local ethics committee. Despite the fact that socio-economic background was not explicitly assessed, the two groups should not strongly differ in this respect, because both were recruited during the same period and in the same geographic area in Switzerland.

The Stop Signal task

The Stop Signal task was adapted from Pessoa and colleagues (2012), and consisted in a choice reaction time task (Figure 1). A “go” trial began with a fixation cross randomly appearing on the computer screen for 500 to 1000 ms before the appearance of the first stimulus. The stimuli were either blue or yellow circles that participants had to categorize based on color by pressing keys. The stimulus presentation ended either by the participant’s response or 1500 ms after onset, and was followed by the presentation of another stimulus. In some trials (“stop” trials, 25% of the trials), the trial began like a “go” trial with the presentation of a colored circle, but after a delay (stop signal delay, SSD), a stop signal triggered response inhibition processes. The stop signal was either a neutral, happy or sad face appearing within the circle. The faces were the same young adult faces presenting each type of emotion (retrieved from MacBrain Face Stimulus Set). The SSD was initially set at 250 ms and was dynamically adjusted (±50 ms) depending on the participant’s success at inhibiting the ongoing response in the preceding “stop” trial which allows estimating the Stop Signal Reaction Time (SSRT), which refers to the response latencies of the inhibition processes. Higher SSRT is related to lower motor response inhibition abilities (Logan & Cowan, 1984). The task encompassed a training block consisting of 10 trials with 2 “stop” trials, and then 6 test blocks of 48 trials each, 12 (25%) of which had a stop signal, resulting in 72 “stop” trials (24 trials for each condition).

We computed from the go trials the overall success rate, the mean reaction time (MRT) and the standard deviation (SD) of the MRT. To assess response inhibition abilities, we computed the SSRT for each type of stop signal (neutral, happy and sad face). To do so, the reaction time distributions for "go" trials were rank-ordered, and the n^{th} RT (excluding RTs of more than 2.5 standard deviations) was determined. The n^{th} RT represents the percentage of failed inhibitions of the ongoing responses (probability of responding). Then, to obtain the SSRT, the mean SSD was subtracted from this n^{th} RT (Logan & Cowan, 1984).

Results

Gaussian-distributed data allowed parametric statistical tests. One gifted adolescent was excluded from analyses because of extreme data in the three SSRT measures. Table 1 reports the descriptive data. The t-tests revealed no significant differences between groups on measures MRT, SD of MRT and accuracy measured from the "go" trials, *ps* > .445.

A 2 (groups: gifted vs. control) by 3 (types of stop signal: neutral, happy and sad) ANOVA on SSRT (i.e., response inhibition abilities) revealed a marginal effect of group, $F(1, 36) = 2.91$, $p < .10$, partial η^2=.075, but a significant main effect of the type of stop signal, $F(2, 72) = 6.14$, $p < .01$, partial η^2=.146, as well as a significant interaction, $F(2, 72) = 4.84$, $p \leq .01$, partial η^2=.119 (Figure 2). Post-hoc tests conducted with Least Square Differences corrections revealed that, the control group had shorter SSRT (i.e., higher response inhibition) in the neutral (p =.030) and in the happy conditions (p =.041), but not in the sad one (p =.509). Additionally, in the control group, the neutral stop signal significantly resulted in lower SSRT (i.e., higher inhibition capacity) than both the happy (p =.003) and sad stop signals (p =.001), which did not differ from each other (p =.867). By contrast, in gifted adolescents, although the SSRT in happy and sad signal condition did not differ from the one in neutral signal condition (*ps* ≥.138), the sad signal resulted in shorter SSRT (i.e., better inhibition abilities) compared to happy signal (*p* =.009).

Discussion

The present study examined the self-regulation skills in gifted adolescents, by testing the interplay between planned motor response inhibition and emotions. Results revealed that (1) gifted adolescents present lower response inhibition abilities in presence of neutral faces or happy emotions, and (2) that although emotional material impaired response inhibition in the non-gifted adolescents, sad faces were related to higher response inhibition abilities in gifted adolescents.

Based mainly on studies with adults, Pessoa's model (Pessoa, 2009, 2011) posited that cognition and emotion both contribute to ongoing behaviors through a sharing of mental resources conceived as a limited pool of attention. Emotions might positively or negatively affect effortful cognitive control (e.g., response inhibition) depending on the relevance of the emotional information for the ongoing behaviors. However, as the prefrontal cortex, sustaining the integration between emotion and cognition, is not fully mature at adolescence (Diamond, 2002), we observed that non-gifted adolescents did not benefit from emotional information to enhance their abilities to inhibit a response.

By contrast, how can we understand that sad emotions were related to comparable response inhibition abilities of gifted adolescents and typically-developing adolescents? A functional and neuroscience perspective might help us to understand this result. First, sad emotions are related to avoidance behaviors whereas happy emotions lead to approach behaviors. Second, gifted adolescents present a higher functioning of prefrontal cortex (Geake, 2009), which provide better top-down control of the behavior, allowing higher self-regulation skills. Thus, gifted adolescents were able to use faces presenting sadness to enhance their abilities to inhibit planned motor response. However, we are aware of the exploratory nature of this study, and that the small sample size and the involvement of boys only may reduce the generalizability of the results. As a consequence, future studies should aim at extending the present findings. Beside the change in the sample, future work should also test whether such effects are age-dependent by examining children. Moreover, we might hypothesize that the impact of negative emotions is the same in other cognitive control abilities, such as inhibition of distracting abilities, proactive and reactive adjustments or error monitoring, leading to new series of experiments.

The current study showed that cognitive control abilities of gifted youths were enhanced by the induction of negative emotions, which might perhaps be linked to the mood-congruent effect (Murphy et al., 1999). Indeed, individuals have cognitive bias, which makes processing faster when information is congruent with their mood. Such effect can be observed in depressive individuals who processed negative stimuli faster (Murphy et al., 1999). Thus, we might suggest that gifted adolescents with socio-emotional problems (as it is the case for the present sample) might have a bias towards the processing of negative emotions, which might explain the observed differences for the negatively valenced faces. This opens a new window of reflection about the education of gifted individuals by integrating emotional dimensions in their training. Additionally, future researches should examine the link between the mood of gifted youths and emotional influence on cognitive control abilities. For instance, by examining the relationship between the level of depression or anxiety of gifted participants and the influence of negative emotions on cognitive control abilities.

To conclude, the present study is the first one to examine the impact of task-relevant emotion in the Stop Signal task at adolescence. Although emotions impact self-regulation skills, this was different in gifted male adolescents compared to typically-developing peers. Besides highlighting the specificity of the gifted population, the present study reveals the particular status of emotional information in gifted individuals' cognition.

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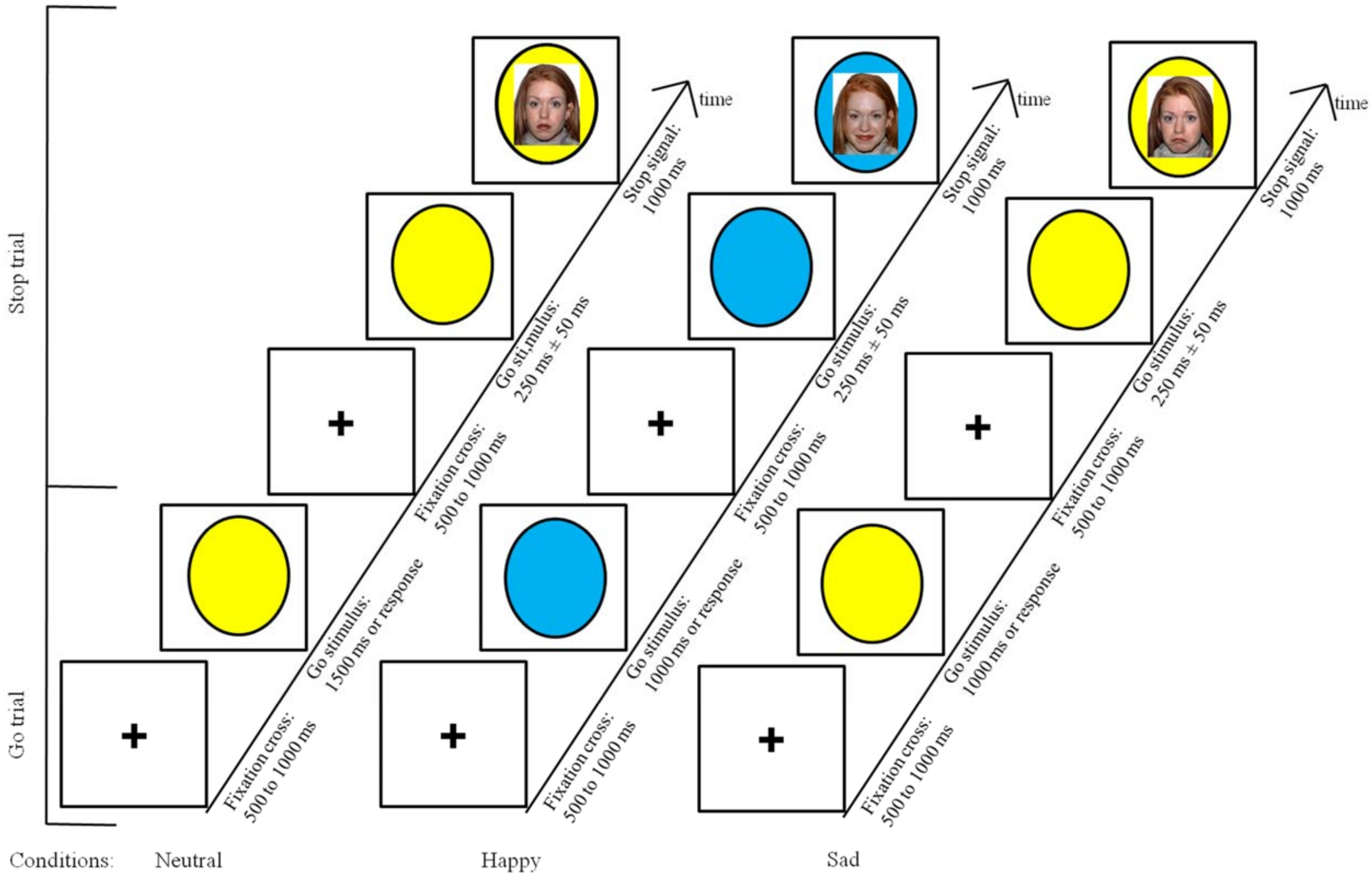
Table 1. Descriptive data from the Stop Signal task

	Control (n = 20)		Gifted (n = 18)	
	Mean	SD	Mean	SD
MRT	794	228	768	234
SD of MRT	257	58	242	59
Success rate	92	5	91	7
SSRT neutral	45	205	180	159
SSRT happy	115	163	216	127
SSRT sad	111	219	153	161

Note: MRT: mean reaction time in ms; SD of MRT: standard deviation of mean reaction time; ACC: accuracy in percentage; SSRT: Stop signal reaction time in ms.

Figure 1. Illustration of the Stop Signal task



Note. For color illustration see the online version. Adapted from Urben, Camos, Habersaat, Constanty, and Stéphan (In press).

Figure 2. Mean Stop Signal Reaction Time (SSRT) in ms (±standard errors) as a function of the group and the type of stop signal in the Stop Signal task.