Upward socioeconomic status comparison temporarily hinders working memory: an exploratory study

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Abstract

Socioeconomic inequalities can be perpetrated by psychological mechanisms which negatively impact the cognitive resources of the more disadvantaged. When expecting to be evaluated against higher status peers, lower socioeconomic status individuals show a lower performance on a range of tasks, hypothesized to stem from a threat response. In the present study, we tested whether the same response can be triggered by the expectation of such an upward comparison regardless of objective resources. Right before a working memory task, participants were given a feedback about their relative socioeconomic status and were told their score was going to be compared to that of higher (or lower) socioeconomic status participants. While the overall performance was unaffected by the manipulation, a worse performance in participants in the upward comparison condition was found in the initial trials. Additionally, performance in the upward comparison group, but not in the downward one, was negatively correlated with trait anxiety. This result, together with the lack of a disparity in terms of objective resources between groups, suggests how threat mechanisms hindering performance do not only affect the more disadvantaged, but can be also triggered across the SES spectrum by the mere perception of inequalities under comparative settings.

Keywords: social comparison, socioeconomic status, working memory, threat, anxiety

Introduction

Even in academic contexts where social mobility is highly promoted, psychological mechanisms can act as barriers and negatively affect the more disadvantaged social classes. One of such mechanisms is known as stereotype threat, and it is described as the effect through which the negative stereotypes linked to the group one belongs to can influence behavior accordingly (Inzlicht & Schmader, 2011). One of the dimensions through which individuals can be grouped, which can in turn determine their social rank, is the socioeconomic status (SES), commonly defined as a combination of occupational prestige, level of education, and income of the individual or its family (e.g., Adler, Epel, Castellazzo, & Ickovics, 2000). When asked to report their SES prior to taking an academic test framed as diagnostic of intellectual ability, low SES students underperform relative to their higher SES peers (Croizet & Claire, 1998; John-Henderson, Rheinschmidt, Mendoza-Denton, & Francis, 2014; Spencer & Castano, 2007), and show reduced self-control and cardiovascular threat reactivity (Flores, Chavez, Bolger, & Casad, 2019). Although differences in executive functions and academic achievement between individuals of differing SES has been argued to represent a stable factor deriving from unequal early childhood exposure to enriched environments (Hackman et al., 2014; Rosen et al., 2020; Rosen, Sheridan, Sambrook, Meltzoff, & McLaughlin, 2018), the presence of an underperformance in lower SES can depend on the presence of specific circumstances triggering stereotype threat. In the case of a lower SES, most commonly associated with stereotypes of laziness, incompetence, and an overall lack of intelligence (Croizet & Claire, 1998; Hall, Zhao, & Shafir, 2014; Spencer & Castano, 2007), the threat response would be activated by a status reminder, resulting in an increased salience of group belonging, and the test framing. It was argued that both these elements are necessary to trigger such stereotype threat response, nevertheless, recent studies suggested that the same mechanisms can be also activated by a comparative context. John-Henderson and colleagues

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(2014) have shown that lower SES subjects show an increased inflammatory response, along with lower task scores, when expecting their performance on a verbal task to be compared to the one of higher SES peers. The authors argued that, even though the test was not framed as diagnostic of intellectual ability, the presence of an upward comparison is enough to place lower SES participants under a condition of greater threat of underperforming in general relative to their higher status comparison peers.

Analogous effects on cognitive performance were found by studies showing that even if the status of one's group is made relatively lower through a false feedback manipulation (i.e., acknowledging that the prestige of one's university department is ranked lower compared to others), executive functions can be temporarily compromised, arguably resembling the effects found in lower SES subjects under stereotype threat conditions (Guinote, Cotzia, Sandhu, & Siwa, 2015). However, Scheepers and Ellemers (2005) suggested that the mere awareness of one's group being relatively inferior in a particular domain can trigger a threat response to the value of one's social identity more in general. Unlike in the specific case of stereotype threat, social identity threat would emerge also when a group is temporarily disadvantaged during a comparison, even if the group and its relative status has been assigned arbitrarily. The same authors have shown how subjects who have just performed a task display a physiological threat response when placed in a second test situation if given a bogus feedback about their low performance on the first task and assigned to a group accordingly. Even though stereotype threat is often thought of as a specific case of social identity threat (Derks, Inzlicht, & Kang, 2008), in the case of a comparative context based on SES, it is difficult to rule out the contribution of stereotypes. In fact, the perceived inferiority of an upward, relative to a downward comparison group may still derive from the negative stereotypes linked to being associated with a lower SES, even though only at a contextual level. Nevertheless, both types of threat would imply the presence of the same underlying psychological mechanisms

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hindering performance. The aim of the present research was therefore to assess whether such mechanisms can extend beyond low SES individuals and be triggered regardless of actual resources by contextual SES-based comparisons.

The performance impairment derived from threat responses is commonly considered to stem from increases in anxiety, performance monitoring and negative thought suppression, which contribute putting an additional load on working memory. This load in would turn reduce the amount of resources available for other tasks (Schmader, Johns, & Forbes, 2008). By placing participants in a comparative context based on an arbitrarily attributed relative SES, we isolated the effect of the status comparison and tested whether working memory would be negatively affected by the hypothesized threat response, moderated by participants' levels of anxiety. Right before completing a 2-back task, a widely used test of working memory (for a review see Kane, Conway, Miura, & Colflesh, 2007), two groups were provided with false feedback about their SES relative to other participants and were told that their performance was going to be compared to the one of higher or lower SES subjects. Regardless of objective SES, we expected participants in the upward comparison condition to perform significantly worse compared to those in the downward comparison condition. To test whether the effect was driven only by the direction of the comparison and not also by one group feeling more economically disadvantaged following the manipulation (Bratanova, Loughnan, Klein, Claassen, & Wood, 2016), we asked participants to evaluate their economic resources at the end of the study. Given the positive relationship between the magnitude of stereotype threat effects and anxiety, we expected to find a worse performance in individuals reporting higher levels of trait anxiety, but only in the upward comparison condition. Last, to make sure participants understood the manipulation, and assess whether the two groups held different beliefs about the relationship between their cognitive abilities and SES, creating different

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expectations about their performance, they were asked to write down the factors they thought differentiated them from the other group at the end of the session.

Method

Participants

Fifty-two subjects (38 females, $M_{\text{age}} = 23.94$, $SD = 3.02$) were recruited from the local population and received monetary compensation for their participation. Sample size decision was based on a power analysis of previous research employing similar analyses to assess the effects of relative status feedback on executive functions (Guinote et al., 2015). The power analysis, conducted using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007), indicated that two groups of 26 participants would be required to reach a power of 80% to measure a medium-to-large effect size of $d = .7$. Due to computer malfunctions while testing the first three subjects, three additional subjects were recruited to reach the predetermined sample size. The study was approved by the Ethics Committee of the International School for Advanced Studies (SISSA).

Procedure

To assess participants' pre-experimental differences in working memory, and to familiarize with the main task, at the beginning of the experimental session participants completed a 1-back task. This task was followed by three questionnaires, two measuring anxiety, and a third demographic questionnaire aimed at assessing SES. Following the questionnaires, participants completed the practice trials of a 2-back task. After correctly completing a minimum of 10 out of 30 self-paced practice trials with trial by trial feedback, participants were randomly assigned to one of the two experimental conditions and received bogus feedback about their comparison position. They were told that, based on the data provided in the demographic questionnaire,

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their SES was either higher or lower than the participant average, and that their performance on the test, presented as measuring cognitive abilities, was going to be compared with the one of lower or higher SES subjects. Additionally, to make sure they read the manipulation, they were told that at the end of the task they would have been asked to indicate what they thought differentiated them from the comparison group. After reading this information on the screen, participants pressed one of the two response buttons to begin the 2-back task.

At the end of the session, participants wrote down their thoughts about what differentiated them from the group their performance was going to be compared, with beyond the economic factor. This allowed us to assess whether participants were still aware of the initially provided feedback. To test whether the manipulation influenced how they perceived their economic resources, subjects were also asked to answer three Likert scale questions.

Measures

A composite Anxiety index ($M = .00$, $SD = .88$, $\alpha = .73$) was obtained by averaging the standardized scores on the Trait Anxiety scale of the State-Trait Anxiety Inventory (T-Anxiety; Spielberger, Gorsuch, Lushene, Vagg, & Jacobs, 1983) and the Penn-State Worry Questionnaire (PSWQ; Meyer, Miller, Metzger, & Borkovec, 1990), $r(48) = .69$, $p < .001$. Because of the variance in anxiety of the two groups were significantly different on the Levene's test, $F(1, 48) = 10.41$, $p < .01$, the standardization of the variable was conducted independently within each Condition. We included the latter questionnaire based on previous findings reporting stereotype threat and performance to be more strongly mediated by the cognitive, rather than emotional, side of anxiety, that is, worry (Cadinu, Maass, Rosabianca, & Kiesner, 2005; Osborne, 2007).

A composite SES index was created based on the standardized scores of reported family income, self-perceived SES, and personal and parental level of education ($M = .00$, $SD = .64$,

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$\alpha = .64$). Self-perceived SES was measured with the Subjective Socioeconomic Status Scale (SSS; Adler, Epel, Castellazzo, & Ickovics, 2000). Personal and parental levels of education were reported on three 5-point scales. Income was measured through a 20-point scale, ranging from <5.000 € to >100.000 € in 5.000 € sections.

The 1-back task was programmed in Python using the PsychoPy library (Peirce, 2007), running on a desktop computer with Windows XP. During the task, a stream of white letters on a black background appeared one by one at the center of the screen. Participants were instructed to press a green-coded button whenever the letter on the screen matched one that preceded it (*target* trial), and to press a yellow-coded button whenever the letter on the screen was different from the one preceding it (*non-target* trial). After the presentation of an initial fixation cross for 1000 ms, each trial began with the presentation of a letter, which remained on the screen for 500 ms and was replaced by a blank screen. A time window of 2000 ms was then given to respond, after which the next trial began. Participants were told to just attend the first letter of the stream, and to start responding from the second one. Each participant completed a total of 160 trials in which the letter stimuli were drawn from a pool of 8 phonologically distinct letters (B, F, K, H, M, Q, R, X; adapted from Kane, Conway, Miura, & Colflesh, 2007). The letters were presented in a pseudo-randomized order, with twenty-five percent of the trials being target trials (i.e., the letter on the screen matched the one preceding it). All other trials were non-target trials, and each target trial was followed by a non-target trial, allowed to avoid having more than one target trial in a row. The test started with 30 self-paced practice trials in which participants received feedback about their accuracy after every trial. Following correct responses, the letter on the screen turned green, whereas following incorrect responses the letter turned red. No feedback was given during the main test. If a participant made more than 10 mistakes during the practice, instructions were given again verbally, and they were asked to take a second practice session ($n = 1$). The 2-back task was

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programmed to be as similar to the 1-back task, with the difference being the response criterion. Target trials were defined as those in which the letter on the screen matched the one preceding it by 2 trials. To reduce task difficulty and increase the control over the task parameters, there were never two same letters in a row (1-back lures). Participants were asked to attend the first two letters of the stream, and to respond from the third letter on.

Subjective economic resources were evaluated at the end of the session using a scale from 1 (scarce) to 9 (abundant), followed by two economic advantage and economic disadvantage scales ranging from 1 (completely disagree) to 7 (completely agree).

Analysis plan

Data were processed and analyzed in R (R Core Team, 2016). All data, scripts and analyses are available online (https://osf.io/n9826/?view_only=d920fdd01f6c456791172c382c8a152b). The main hypothesis was tested via Analysis of Covariance (ANCOVA), predicting performance on the 2-back task based on Condition and Anxiety while controlling for SES.

For exploratory purposes, given the lack of an effect on the overall performance, we assessed the time course of the expected accuracy disparities following the manipulation. To do so we used nonparametric permutation tests on single trials, treating accuracy in the trial progression as a time series. The series was first smoothed with an averaging filter of 3 trials to increase the signal-to-noise ratio, producing 158 averaged trials per subject. To conduct nonparametric permutation testing we used the ‘permuco’ package available in R (Frossard & Renaud, 2018). We computed the linear model’s F-statistic at each time point, using a threshold that corresponds to the 95th percentile of the parametric F distribution. Each model tested 2-back task accuracy based on Condition, SES, Anxiety and their interactions. Since we expected the group difference to be more pronounced in participants with higher levels of anxiety, the respective covariate was centered at its third quantile (50.5, as in Frossard and Renaud, 2018).

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We then determined the summed cluster mass above this threshold for the true data as well as for each of 5000 permutations. From the resulting null distribution, we obtained a p -value for the cluster mass statistic of the true data and tested this for significance ($\alpha = .05$).

Given the significant negative correlation between the self-reports of economic advantage and disadvantage, $r(48) = -.66, p < .001$, after inverting the latter score, a composite Perceived resources index was calculated from the standardized scores of these two measures (as in Bratanova et al., 2016; Study 1) together with the one of the subjective economic resources scale, ($M = .00, SD = .86, \alpha = .82$).

Results

Five participants were excluded from the analysis due to a computer malfunction ($n = 3$), and due to not having read the manipulation by being unable to answer the follow-up question ($n = 2$). We initially removed from the analysis one participant whose proportion of correct responses on the 2-back task differed from the sample average ($M = .87$, $SD = .10$) by more than two standard deviations. The final sample consisted of 50 participants (35 females, $M_{\text{age}} = 24.02$, $SD = 3.02$) equally split among the two groups. Independent samples t -tests revealed no differences between the two groups in terms of 1-back task accuracy, SES, and Anxiety (all $ps > .28$; see Table 1 for descriptive statistics).

		Upward	Downward
Performance	2-back task accuracy	87.45 (8.58)	88.48 (7.72)
	1-back task accuracy	95.40 (.04)	96.48 (.03)
SES	Income	6.20 (3.00)	6.36 (3.07)
	Subjective social status	5.56 (1.04)	5.16 (1.46)
	Education	1.56 (1.00)	1.84 (.80)
	Education (mother)	1.2 (.96)	1.56 (2.14)
	Education (father)	1.32 (.98)	1.28 (1.37)
Anxiety	STAI - T	41.68 (6.47)	45.32 (13.54)
	PSWQ	47.44 (10.75)	48.12 (15.50)

Table 1. Descriptive statistics of the variables related to performance, SES and anxiety for the upward and downward comparison groups. Values in parentheses indicate the SD.

The accuracy in the 2-back task of the upward comparison group ($M = 87.45\%$) was equal to the one of the downward comparison group ($M = 88.48\%$). This difference was not significant also when controlling for the included covariates, $F(1, 45) = .05$, $p = .83$. The interaction between condition and Anxiety was also not significant, $F(1, 46) = 2.48$, $p = .12$.

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The analysis of the time course of the hypothesized effect revealed a significant cluster of performance disparity encompassing the initial 7 smoothed trials of the task (cluster mass = 69.4, $p < .01$; see Figure 1).

Figure 1. Panel A: average difference in performance accuracy (%) between groups across trials following smoothing. Lower scores indicate a worse performance of the upward comparison group relative to the downward comparison group. Panel B: Fisher's statistic associated with each trial. Red dots represent trials presenting a significant difference between groups.

As shown in Figure 2, within these trials, the percentage of correct responses of the upward comparison group ($M = 79.1$, $SD = 25.7$) was significantly lower compared to the downward comparison group ($M = 90.2$, $SD = 9.8$), $F(1, 42) = 5.82$, $p = .02$.

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Figure 2. Average accuracy of the upward and downward comparison groups calculated on the overall performance (left panel) and in the initial 9 trials (right panel). Bars indicate ± 1 SE.

We then ran an additional test assessing whether Anxiety had a different effect on accuracy based on Condition in the trials underlying the time points that showed a significant difference in the permutation test (i.e., the first 9). The results revealed that the interaction between Condition and Anxiety was statistically significant, $F(1, 42) = 7.22$, $p = .01$. As depicted in Figure 3, the interaction was characterized by a significant negative correlation between the Anxiety score and the accuracy in the upward comparison group, $r(23) = -.47$, $p = .02$, without a significant relationship in the downward comparison one, $r(23) = .11$, $p = .61$.

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Figure 3. Correlation between accuracy in the initial trials of the 2-back task and the Anxiety score for the upward (left) and downward (right) comparison groups.

We also analyzed the Perceived economic resources after the manipulation, controlling for SES. The average scores of the upward comparison group ($M = .07$, $SD = 0.93$) did not differ significantly from the ones of the downward comparison one ($M = -.07$, $SD = .79$), $F(1,47) = .21$, $p = .65$.

Last, in the writing task, no significant differences emerged between the number of words used by the upward ($M = 16.40$, $SD = 18.50$) and downward comparison group ($M = 17.64$, $SD = 16.82$; $p > .05$), nor in the number of subjects mentioning cognitive disparities (upward = 4, downward = 3, $p > .05$).

Discussion

Social comparative contexts have been shown to influence people's cognitive abilities. The nature of this influence depends both on the direction of the comparison and the dimension on which it is based. In the present study, we tested whether an SES-based upward comparison during a cognitive task leads to detrimental effects on working memory performance. We investigated this specific effect of the comparison direction regardless of pre-existing differences in SES. Based on previous studies on stereotype threat and social status, suggesting upward comparisons to trigger threat responses, we expected participants with higher levels of trait anxiety, and thus more prone to experiencing negative worrying thoughts, to perform significantly worse on the task. Our results provide support to these hypotheses, although suggesting a reduced magnitude of the effect. Whereas we found no difference between groups when considering their performance on the overall task, participants in the upward comparison condition performed significantly worse in the trials immediately following the manipulation. Within these trials, we also found a significant relationship between working memory performance and anxiety, confirming the hypothesis by which higher levels of anxiety are associated with a worse performance under upward, but not downward comparison conditions.

Although we initially expected an underperformance of the upward comparison group to be present throughout the whole task, the effect emerging only during the first trials suggests that the duration of the threat response is relatively limited in time. One of the reasons for such pattern may be due to the difficulty of the task. As the greatest effects of threat responses on performance are expected to occur when one's abilities are pushed to their limit (Keller, 2007), it is likely that the task we administered may have not been difficult enough, and thus the effect lasted until participants got familiar with it. If this was the case, administering a more demanding test may lead to longer-lasting effects.

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Despite the manipulation including both a feedback of participants' relative SES and a comparison direction, the lack of a difference in the perceived economic resources at the end of the session makes us rule out the possibility that the effect was driven by one group feeling their economic resources to be scarcer (Bratanova et al., 2016; Mani, Mullainathan, Shafir, & Zhao, 2013). It is possible that the lack of an effect on the perceived economic resources was due to the differences addressed by our manipulation not being presented in exclusively economic terms. In fact, they rather referred to differences in the socioeconomic status derived from the administered questionnaire. If the effect was still driven by the induction of a temporary feeling of a lower status, it may have been more appropriate to administer a scale capturing the subjective social status a second time. Nevertheless, since the SSS scale asks participants to place themselves on a ladder representing the broader social context (Adler et al., 2000; Singh-Manoux, Adler, & Marmot, 2003), rather than the relative experimental one, the measure may have shown the same null difference.

The contextual nature of the assigned status, without the two groups differing based on their objective SES, suggests that the threat response may not derive from the activation of negative stereotypes associated with one's social group. However, it is still possible that the stereotypes commonly associated with a lower SES were temporarily assimilated by the upward comparison group, thus inducing a feeling of inferiority. Even though not made explicit by the manipulation, both the group salience and the test's diagnostic elements required to elicit a stereotype threat response may have still been present. The comparison itself, being based on SES, may have increased the salience of group belonging, although assigned only arbitrarily, but plausible to the eyes of the participants. The test diagnosticity element may be reflected in the expectation of the performance comparison between groups. Despite the lack of a stated test diagnosticity, the comparison may still put an additional pressure on the individual not to underperform relative to the other group, leading to the reported effects.

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In conclusion, the present findings suggest that an upward comparative context based on SES does hinder performance on a working memory task. The effect emerges when the relative status is defined contextually, and therefore does not depend on pre-existing socioeconomic resources. The resulting impairment, correlated with the level of trait anxiety, triggers a threat response which, in the present case, lasted only briefly after the appraisal of the relative status inequality and comparison. This indicates that, even when an individual does not belong to the lower SES population, threat responses may arise when a perceived SES inequality is present in the immediate social context. Even though the magnitude of the effect does not indicate a sustained hindering of working memory, it is possible that it may increase with the difficulty of the task. More broadly, the magnification of this effect may in part explain the disparities found on academic test scores, contributing to creating and maintaining a gap in academic success between people with lower and higher SES (Bradley & Corwyn, 2002). Beyond revealing whether the perception of status inequalities in comparative settings influences additional cognitive functions relevant in test settings, future research may focus on understanding how to best contrast the triggering of the underlying mechanisms, contributing to building increasingly effective interventions aimed at promoting social mobility and reducing inequalities.

Acknowledgments

T.S. would like to thank Dr. Miriam Vignando for constructive comments on an earlier version of this manuscript.

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