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Can verbal instructions aimed at being more reflective reduce threat-induced impulsivity?

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Short title: Reflective control over impulsivity

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Abstract

Whether reflective processes can control impulsive processes is of both theoretical and applied interest. Interventions targeting reflective processes have been suggested to change how individuals react to emotional stimuli, but it is unclear under which conditions behavioural measures of impulsivity can be demonstrably influenced. In the current study, participants were given repeated instructions (varied between-subjects) related to reappraisal, visualization, or loving-kindness meditation, or a baseline condition. Participants then performed blocks of an emotional Go/Nogo task known to evoke threat-induced impulsivity on both reaction time and accuracy contrasts. Effects of instructions were tested on these contrasts. Results showed no significant effects of instructions. Further, the null model was supported by Akaike's Information Criterion and by Bayes Factors. The results thus contribute to knowledge on the nature of reflective-to-impulsive influence, by demonstrating an absence of an effect for the current instruction method and the current measure of impulsive processing.

Keywords

Reflective; reappraisal; visualization; loving-kindness; impulsivity.

Dual-process models posit that our behaviour is determined by two different cognitive systems, one termed automatic, impulsive, or System 1 and the other controlled, reflective or System 2 (Bargh, 1994; Evans, 2008; Schneider & Shiffrin, 1977; Shiffrin & Schneider, 1977). While specific models differ, the overall concept is that the impulsive system is responsible for fast, involuntary, stimulus-driven and emotional processes, which are developed via long-term conditioning and training, while the reflective system allows for impulsive responses to be voluntarily inhibited and replaced by behaviour based on relatively complex, rational, voluntary, effortful, and flexible cognition. In some models, the systems work independently or even in competition, while other points of view criticize this division (Keren, 2013; Keren & Schul, 2009) and may emphasize unimodels or the holistic, time-dependence of learning-dependent processes underlying (motor or cognitive) response selection (Cunningham et al., 2007; Gladwin, 2022; Gladwin et al., 2011; Gladwin & Figner, 2014; Kruglanski, 2013). Over the various formulations of dual-process models, however, a core issue remains whether, how, and to what extent reflective processes can influence automatic processes.

Multiple kinds of reflective processes have been argued to permit such control, three of which were the focus of the current study. One such process is strategic reappraisal of stimuli and experiences. Reappraisal refers to a cognitive tactic in which an emotional event is reflectively processed in such a way as to achieve a desired emotional response, which can effectively improve emotion regulation (Cutuli, 2014; Foti & Hajcak, 2008; Gross & John, 2003; Powers & LaBar, 2019; Stover et al., 2024; Webb et al., 2012) and change biases in self-reported metacognitive beliefs (Ikani et al., 2022). For instance, the impact of criticism could be reduced by reinterpreting it as a sign of the bad intentions of the antagonist rather than the individual's own inferiority. A second reflective process that may allow control over automatic processes is mental imagery, or visualization. This refers to the controlled generation of mental experiences; for instance, one could visualize successfully navigating a difficult conversation. Mental imagery has been shown to be an effective strategy for enhancing the development of (motor) skills in multiple domains and thus appears able to affect automatic processes (Driskell et al., 1994; Feltz & Landers, 1983; Fridland, 2021; Guillot et al., 2009; Hanakawa et al., 2008; Jeannerod, 1994). Imaginal retraining has also been tested in the context of addiction, with promising first results involving reduced craving for alcohol (Moritz et al., 2019). Finally, loving-kindness meditation can be understood as this kind of reflective process. This centrally concerns consciously generating kind intentions towards people (Zeng et al., 2015), aimed at achieving "a mental state of unselfish and unconditional kindness towards all beings" (Hofmann et al., 2011). The practice of this kind of mediation appears to increase positive emotions (Zeng et al., 2015) and to improve mental health and wellbeing (Galante et al., 2014; Hofmann et al., 2011). This suggests that loving-kindness meditation could be an example of a causal effect of reflective processes, involving conscious, deliberate intentions and self-regulation (Bishop et al., 2004), on the automatic emotional processes that habitually underlie wellbeing in daily life.

The aim of the current study was to test whether verbal instructions to use reflective processes associated with improved self-control could affect behavioural effects due to threat-induced impulsivity, an important type of limitation of self-regulation (Hartikainen et al., 2012; Nieuwenhuys et al., 2012; Schutter et al., 2008; Verbruggen & De Houwer, 2007). The study concerned immediate effects, i.e., effects that are evoked by a certain type of reflective processing as it occurs, rather than effects that accumulate after longer-term practice. These two types of effect are of independent interest, but findings on immediate effects would provide an indication of whether and which longer-term effects might be expected, or of possible causal mechanisms. Use of a behavioural measure that reflects a certain kind of impulsive, emotion-drive process avoids some limitations of self-report on impulsivity, such as expectancy or social desirability (Zeng et al., 2015). If a reflective intervention changes how individuals self-report on such processes, e.g., because there is some

incentive to emphasize positive feelings, the suggested interpretation could be invalid; the intervention causes a kind of failure of measurement invariance rather than the suggested self-reported effect. This is not to suggest there are no questions about the validity of implicit measures (Blanton et al., 2009; Dear et al., 2011; Meissel et al., 2021). However, effects of impulsivity on simple biases in task performance would provide relatively direct evidence that automatic processes have been influenced. We therefore used an emotional Go/Nogo task (Bruin et al., 2001; Sagliano et al., 2021; Schulz et al., 2007) involving neutral and angry faces, known to provide strong baseline effects reflecting threat-induced impulsive responding, in terms of both faster responses when responding to angry versus neutral faces and more false positives when responding to angry versus neutral faces (Gladwin et al., 2019). We hypothesized that instructions aimed at increasing reflective control over automatic reactions to threat can reduce this kind of threat-induced impulsivity. The instructions were provided at the start of each block and involved reappraisal via reinterpretation of negative expressions; visualization of remaining calm; generation of a loving-kindness state; or a neutral baseline.

Methods

Participants

Participants were 299 healthy adults (130 female, 169 male; mean age 42 years, *SD* = 10), recruited via online student participant pools. An additional 17 participants were excluded for very low accuracy (below 60%) on the task indicating problems with understanding or motivation. Participants received £5 for participation. The sample size was sufficient for 96% power for a one-way ANOVA comparing four instruction-groups on a given dependent variable, assuming a medium effect size for the immediate effect of the instructions. All participants provided informed consent and the study was approved by the University of Greenwich Research Ethics Committee.

Questionnaires

Questionnaires asked for participants' age and sex. The Patient Health Questionnaire-4, PHQ4 was presented, which uses two items each to efficiently assess anxiety (Cronbach's alpha = 0.89) and depression (Cronbach's alpha = 0.80) symptoms (Kroenke et al., 2009). For a subset of 205 participants, a final awareness-check question at the end of the experiment asked participants to select the reflective instruction they received, out of the four possible instruction-conditions.

Task-relevant Emotional Go/Nogo Task (TEG/NT)

The TEG/NT was based on a previously studied emotional Go/Nogo task, known to evoke threat-induced impulsive responses on both RT and accuracy measures (Gladwin et al., 2019). Core features of the task, as argued for in more detail in the original paper, were task-relevant stimuli and 50-50 percentages for Go and Nogo trials. The task consisted of 10 blocks of 48 trials each. Each of the 10 blocks started with an Instructions phase, presented for 15s. There were four types of instructions, one of which was selected at random per participant and then kept consistent for that participant over the whole task. The Null instruction was "For 15s, please look at the fixation cross below." The Reappraisal instruction was "For 15s, think of a reason someone could act angry but really be upset or afraid" The Visualized Calm instruction was "For 15s, visualize yourself, as vividly as possible, staying calm when confronted with an angry person". The Loving-Kindness instruction was "For 15s, imagine someone you love a lot and send them your heartfelt good wishes. You might say in your mind: may you be happy, may you be healthy, may you live with love and ease."

Following the instructions, the Go/Nogo task instructions were presented, which informed the participant of the correct responses on the task for the upcoming block. There were two block types,

"Angry=Go" and "Neutral=Go". Participants were either instructed to press the space bar if an angry face was presented, and not to respond if a neutral face was presented (Angry=Go), or they received instructions with the reverse mapping (Neutral=Go). Instructions alternated over blocks, with the first block's instructions selected at random per participant. Instructions were presented onscreen for 2s initially, after which text was added to the screen informing participants that they could press the spacebar to start the block.

Trials started with a fixation cross presented for 250, 300, or 350 ms, with equal probabilities. Subsequently, a face was presented for a 600 ms response window, selected from a subset of 42 images from the Karolinska Directed Emotional Faces set (Lundqvist et al., 1998). The face was selected at random under the restriction that the same face was never immediately repeated. The face had either an angry or a neutral expression, with equal probabilities per trial. Depending on the block instructions, participants had to press a space bar or not depending on the emotional expression. If a response was required but not given within the response window, the text "Too late" was presented in red for 400 ms. If a false positive response was given, the text "Incorrect" was presented in red for 400 ms. Otherwise, the screen remained empty for 400 ms.

Procedure

The experiment consisted of a single session of around 30 min. Participants filled in the questionnaires and performed the emotional Go/Nogo task with the instructions. Finally, for a subset of participants, the awareness check was presented.

Preprocessing and statistical analyses

The first four trials per block were removed, due to potential general effects of initiating a new block and to allow participants to adjust to the new task instructions. Trials following an error were removed to avoid post-error interference. Effects of Instruction conditions were tested using a one-way ANOVA. Within-subject t-tests were used to test contrasts representing the effect of emotional expression on RT (Angry=Go versus Neutral=Go blocks, for Go trials) and on accuracy (Go versus No-go trials in Angry=Go blocks versus Go versus No-go trials in Neutral=Go blocks). The preprocessing and these tests were performed in Matlab (The Mathworks, 2015).

Additionally, model comparison using Akaike's Information Criterion was used to test whether a model representing the absence of an effect was preferred over a model allowing for group differences (Burnham et al., 2011). This was done by running the analysis as a linear model with three indicator variables for each of the three active Instruction conditions, against the null condition as the baseline, and constraining the coefficients representing differences between conditions to be zero. The analyses were run for two dependent variables: the contrast for the effect of emotional expression on RT on Go trials, and the contrast for the effect of emotional expression on Go versus Nogo accuracy. The R toolbox teg_regr_test was used for this (Gladwin, 2021). Finally, Bayes factors were computed for the null effect for the ANOVA, using the anovaBF function of the BayesFactor toolbox (Morey et al., 2021) and JASP (JASP Team, 2018).

Data and scripts are available online at 10.6084/m9.figshare.19758805.

Results

The number of participants per instruction-condition was 73 for Null; 65 for Reinterpretation; 85 for Visualization; and 76 for Loving-kindness. The mean PHQ4 scores were 3.41 (*SD* = 1.69) and 3.27 (*SD* = 1.57) for anxiety and depression symptoms, respectively. The percentage of participants who correctly identified their instruction-condition in the awareness check was 94%.

Table 1 shows the performance data, for block type (Angry=Go versus Neutral=Go) and trial type (Go versus No-go). The within-subject effects representing threat-induced impulsivity were significant for both RT and accuracy. RT on Go trials was faster in the Angry=Go blocks than in Neutral=Go blocks, $F(1, 298) = 164.5$, $p < .0005$, eta_p^2 = 0.356. For accuracy, the Go versus Nogo contrast was more positive in Angry=Go blocks than in Neutral=Go blocks, $F(1, 298) = 57.83$, $p < .0005$, eta_p^2 = 0.163; that is, participants tended to give relatively many false positive responses to angry faces.

Table 1. Reaction times and accuracies

	RT on Go trials		Accuracy			
	Neutral=Go, Angry=No-go	Angry=Go, Neutral=No-go	Neutral=Go, Angry=No-go		Angry=Go, Neutral=No-go	
			No-go	Go	No-go	Go
Mean [ms]	473.25	458.60	0.77	0.83	0.87	0.87
SD	33.33	32.19	0.11	0.11	0.082	0.085

Table 2 shows the results per Instruction condition. There were no significant effects of the Instruction condition on the RT or accuracy contrasts representing threat-related biases. In the model comparison analyses, the AIC was better (i.e., lower) for the null models for both the RT and accuracy contrasts than for the models with free parameters for effects of the Instruction conditions. Aligned with this, the Bayes factor for the null versus alternative hypothesis was 19.50 for the RT contrast and 10.17 for the accuracy contrast, interpreted as strong evidence for the null (van Doorn et al., 2021).

Table 2. Contrasts per Instruction condition

Instruction	RT contrast	Accuracy contrast
Baseline	-15.41 (18.89)	-.055 (0.15)
Reappraisal	-17.74 (18.83)	-.037 (0.13)
Visualization	-12.57 (18.56)	-.082 (0.12)
Loving-kindness	-13.64 (22.51)	-.056 (0.14)

Note: The table shows the mean contrast score with standard deviations in parentheses. The contrasts are as follows. For RT (on Go trials): Angry=Go - Neutral=Go blocks. For accuracy: ((Go - No-go trials) in Angry=Go blocks) – ((Go - No-go trials) in Neutral=Go blocks). In both cases, more negative contrast scores are in line with more impulsive responding to Angry faces.

Discussion

The current study tested whether a range of reflective instructions - reappraisal, visualization, and loving-kindness - could influence an automatic process related to social threat. Effects were tested on threat-induced impulsivity as measured via RT and accuracy effects on an emotional Go/Nogo task. The task was known to provide strong baseline behavioural effects, which was needed for there to be a measurable impulsive effect in the first place for the instructions to potentially decrease. No significant effects of instructions were found, and evidence for the null hypothesis was provided by the AIC and by Bayes Factors.

The results thus failed to show the hypothesized immediate effects of simple instructions aimed at evoking reflective processes thought to increase emotion regulation, on a behavioural measure of

impulsivity evoked by social threat stimuli process. Clearly, inferences beyond this must be tentative. However, if, counterfactually, a result had been found for one or more of the instruction types, this would have been taken as evidence for reflective control over automatic processes along the lines of the theoretical framework associated with the instruction. The finding of there being no such effect, even if limited, should therefore provide at least some evidence in the direction of an absence of an effect. That is, these null findings serve as a building block for understanding what type of influences and interventions can and cannot be expected to have effects. For example, if simply providing verbal instructions does not immediately lead to a reduction in threat-induced impulsivity, which ingredients would need to be added for an effect to be found? It is certainly possible that long-term effects could differ from immediate effects (Zeng et al., 2015), but this raises the question what the mechanism would be, if not a more persistent version of an acute effect evoked by the intervention. Although no effects of instructions were found, the within-subject effects did replicate previous results using the same emotional Go/Nogo task (Gladwin et al., 2019). These concerned both RT and accuracy effects, in line with an evolutionarily adaptive lowered threshold for responding to threatening stimuli or with impaired response inhibition (Hartikainen, 2021); similar effects using task-relevant Go/Nogo tasks have been found in different contexts (Sagliano et al., 2021).

Assuming that the current results are not false negatives, why could there be an absence of influence of these reflective manipulations on impulsivity? Existing literature, as reviewed in the introduction, did suggest that interventions targeting the reflective system in these ways should be able to improve its ability to control the impulsive system, in terms of dual-system theory (Kahneman, 2011). From the perspective of models of impulsivity focused on temporal dynamics of competing processes (Boucher et al., 2007; Gladwin & Figner, 2014; Verbruggen & Logan, 2008), it may be the case that in the current task, impulsive responses were executed before the instructed reflective control processes had a chance to intervene. It could also be the case that the meaning of angry faces is encoded in a distributed neural representation (Masson, 1995; Mikolov et al., 2013) that inherently includes impulsive responding or disinhibition. This would translate into an automatic association (Gladwin, 2022), that would keep exerting an influence unless the long-term memory representation were fundamentally reconfigured. Finally, as noted above, the current Go/Nogo task strongly evoked the expected impulsivity. Strong, systematic effects are methodologically essential for studies such as the current one. They may, on the other hand, be relatively difficult to modify for the same reason they are robust. Thus, the specific behavioural measure or type of automatic process involved in the current study could have been particularly insensitive to the manipulation. Nevertheless, for effects of reflective activities in daily life to be considered plausible, it would appear desirable to be able to demonstrate behavioural effects on this kind of impulsive responding due to social threat.

The above interpretations of the current null findings suggest some possible lines of future research into reflective influences on impulsivity. First, it could be helpful to consider the threat-induced impulsive response as Pavlovian, i.e., a hardwired, simple, and fast unconditioned response due to a conditioned association involving the visual stimuli. Then methods to improve reflective or willed control could be taken from the literature on conditioning, Pavlovian-Instrumental Transfer, etc (Burghoorn et al., 2025; Dayan et al., 2006). One possibility is that a “counter-Pavlovian” response is needed, e.g., involving freezing, to create time for effects involving reflective control to occur. Second, the reflective intervention could be made more specific to the stimuli and behaviours involved in the task. E.g., participants could be asked to visualize correct non-responses to angry faces. If this is the case, it would suggest the problem of failures to control impulsivity might lie in the generalisation of reflective control. Third, even if interventions such as reappraisal can change the long-term memory patterns containing the meaning of angry faces, this may require significantly

longer training periods, during which the role of reflective processes is to mediate changes in association rather than to exert control directly. Finally, we briefly note that in situations in which the aim is to reduce impulsive behaviour, rather than to specifically study reflective-impulsive interactions as in the current study, it may be more effective to use interventions designed to target automatic processes, such as Cognitive Bias Modification (Clarke et al., 2014; Cristea, Kok, et al., 2015; Cristea, Mogoaşe, et al., 2015; Gladwin et al., 2017; Houben & Jansen, 2011; Kruijt & Carlbring, 2018). There may even then be an important role for reflective processes, however, such as motivation (van Deursen et al., 2015) or declarative memory function (Loijen et al., 2025).

A limitation of the study concerns the convenience sample. Participants were not selected based on motivation to change, which could be a necessary component even for interventions targeting automatic processes (Gladwin et al., 2017; Wiers & Gladwin, 2016). The online nature of the study is also a limitation, although we note that online measurements can be reliable and valid and provide a useful alternative method to lab-based studies (Chetverikov & Upravitelev, 2016; van Ballegooijen et al., 2016). On the set of used reflective instructions, this was limited in not being an exhaustive set of possible instructions; a pragmatic choice of relevant and varied instructions was made which was unavoidably somewhat subjective. Finally, we do not have a direct measure of whether participants conscientiously followed the instructions or how much effort they exerted; however, the awareness check does show that the participants were paying enough attention to identify the presented instructions, which were repeated frequently and were consistent per participant. This does not guarantee they tried to follow them; however, some doubt would remain even if participants had been explicitly asked to report on their effort and it does appear from the accuracy and reaction times that participants were making a good faith effort to perform well.

In conclusion, the current instructions, concerning reappraisal, visualization, and loving-kindness, did not have an immediate effect on threat-induced impulsivity. Future work will need to demonstrate whether a different combination of the features of the intervention, the evoked reflective process, or the behavioural measure does show the hypothesized type of effect, or whether the current findings reflect a limitation of reflective control and these attempts to improve it.

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Disclosure of interest

The authors report there are no competing interests to declare.

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