

# Regret and disappointment in autism spectrum disorders

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# Accepted Manuscript

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## Regret and disappointment in ASD: The matter of thinking versus feeling

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In their recent study, Zalla et al (2014) explore how regret and disappointment are affected in autism spectrum disorders (ASDs). The study is motivated by previous indications of ASD comorbidity with emotion processing deficits, as well as suggestions that the mechanisms important for social cognition (typically thought to be affected in ASDs) may also underlie a variety of self-reflective cognitive and emotional processes. Zalla et al advance this field of research by specifically testing emotional responses and choice behaviour of ASDs in an entirely private decision-making context. By so doing, they raise the possibility that emotional processing deficits in ASDs may not depend on social cognition, since experiences of regret are caused by, and influence only, the chooser themselves. Moreover, by studying regret and disappointment specifically, as opposed to responses to negative events more generally, they highlight the possibility that particular deficits exist in the processing of counterfactual emotions, i.e. those that rely on comparisons between what *is* and what *might have been* but which vary in their attributions of personal responsibility.

The study finds that individuals with ASDs lack the ability to distinguish between experiences of regret and disappointment, though they show a preserved behavioural impact of these emotions on later choice. Zalla and colleagues interpret these findings as reflecting a “failure to overtly integrate self-relevant emotional information with inferential reasoning processes” in ASDs. Critically, they stress that these deficits can manifest even when these emotions are entirely self-reflective – i.e. in decision contexts that do not rely on social cognition. They discuss these findings in relation to alexithymia-like diminished emotional awareness, but with covert impacts of emotional arousal on behaviour. These findings raise a number of intriguing questions which, if answered, may add greatly to our understanding of the deficits associated with ASDs and of the mechanisms underlying healthy processing of counterfactual emotions.

Despite Zalla et al’s focus on an emotional processing deficit, we question whether these findings could yet be explained by a purely social cognition account. In order to experience both regret and disappointment, one must be able to generate alternative (i.e. counterfactual) states of the world, and to take the perspective of the fictive versions of ourselves that experience these alternative states. While the ability to take the perspective of others has long been thought to be affected in ASDs, less is known about the ability to take the perspective of fictive/counterfactual versions of oneself. However, there is evidence that ASDs develop and deploy counterfactual inference abilities in an atypical way (Grant, Riggs & Boucher, 2004; Begeer et al 2009).

Is it possible that the ability for counterfactual thinking is itself impaired in the ASDs? Zalla et al addressed this issue by measuring performance on Roese and Olson’s Counterfactual Inference Test. Finding no differences between controls and ASDs on this measure, Zalla et al conclude that

their ASD participants show intact counterfactual inference abilities. Still, we may question whether this is the best test of counterfactual inference in ASDs, given that the test a) relies on an ability to judge the mental states of other people, and b) asks the individual to judge the emotional responses of others. That ASDs did not differ from healthy controls is, of course, important. However, even the controls scored an average of only 2 out of 4 on this test (chance responding would be 1.32), suggesting that neither the controls nor the ASDs consistently made counterfactual inferences according to this measure.

Moreover, preserved counterfactual inference does not, of course, imply that typical emotional responses to such inferences will also be preserved. Previous studies have found developmental delays in the emotional response to counterfactual inference, compared to the ability to make inference itself (Amsel & Smalley 2000; Burns, Riggs, & Beck, 2012), suggesting that it is possible for the counterfactual inference to be intact but for the emotional response to be absent. An ability to experience these emotions can also be separated from the ability to interpret and express such feelings appropriately. The latter are thought to be the key impairments in alexithymia, and ASD individuals score higher on self-report measures of alexithymia than do healthy controls (Hill, Berthoz & Frith 2004; Berthoz & Hill 2005).

Zalla et al also themselves recognise that regret and disappointment differ most saliently in the attributions of responsibility associated with each. While regret depends on the realisation that one should have made a different choice, thereby invoking feelings of self-blame, disappointment depends only on the outcome being worse than was expected (therefore being situationally/externally caused). Is it possible, then, that impaired discrimination of these two emotions reflects impairments in attributions of responsibility more generally? By some accounts, the representation of mental states (and their causal relationships with externally observed events) is necessary for emotional awareness, both of one's own emotional state and that of others (Hill, Berthoz & Frith 2004). "Shared network" hypotheses also advise that the ability to represent the emotional states of others shares the same neural mechanisms as those responsible for processing one's own emotional state (Singer et al 2009; and see Nicolle et al 2012). Other studies have also shown reduced ability to distinguish between self-relevant and other-relevant information in the ventromedial prefrontal cortex of ASDs (Lombardo, 2010). Since regret depends entirely on our ability to mentally construct and take the perspective of our fictive self, *and* to attribute blame internally, any failure to appropriately attribute internal blame for the outcome of one's own decisions (or external causes for the outcomes of events for which we are not responsible) may render regret and disappointment indistinguishable. As discussed above, it is important to remember that regret and disappointment both rely on taking the perspective of our fictive self. Therefore, the

key factor in their discrimination, and perhaps the one most affected in ASDs, is more likely to be in the ability to appropriately attribute responsibility (i.e. internal versus external), or in the ability to distinguish between within-choice and between-choice counterfactual alternatives, rather than in the ability to mentally generate and take the perspective of fictive self specifically.

Since such a social-cognition account implies that regret and disappointment would remain indistinguishable at the level of the induced feeling itself, it also predicts impairments at the behavioural impacts of these emotions. This is not in keeping with Zalla et al's findings, however. Assuming that the disappointment-inducing and regret-inducing trials were entirely uncorrelated in the design of Zalla et al's experiment, their data suggest that their independent behavioural impacts are preserved (i.e. ASDs were able to learn to avoid choices, based on past experience, that were most likely to induce regret) and, therefore, that the emotions must be distinguishable at some level. The preserved behavioural impacts of regret and disappointment clearly indicate that the deficit cannot be explained by a failure to process between-choice information or to make between-choice counterfactual comparisons. Note that local processing theories of ASDs (e.g. Happé & Frith, 2006) may have predicted a failure to process unobtained outcomes, due to a disproportionate focus on the chosen gamble. In this case the necessary condition for regret to be experienced would be removed, but Zalla et al's finding of preserved behavioural impact shows this cannot be the problem.

Another important finding in demonstrating preserved discrimination of within-choice and between-choice counterfactual emotions, at least at some level, is that Zalla et al's ASD individuals experienced greater levels of joy than relief. This finding is intriguing, since it points to a possible asymmetry between discrimination of counterfactual emotions in the positive and negative domains. Such asymmetries are often observed in studies of reward-driven decision-making in healthy participants, yet there the findings are typically that "losses loom larger than gains" (Kahneman & Tversky, 1979). Particular aversion to losses in the controls may explain their lack of difference between the positive emotions. While it is yet unclear why ASDs report stronger feelings of joy than relief (and this effect is the inverse of what is typically expected from regret theory), one possibility is that ASDs may place a greater emphasis on outcomes of the chosen gambles, than those of the unchosen gambles, but only in the positive domain.

Zalla et al found impaired discrimination of regret and disappointment by self-report measures, but without any clear deficits in the behavioural impacts of these emotions. These results may also hint that the impairment is not in the induced emotional response itself, but rather in the ability to appropriately identify, discriminate and/or report on them, with the behavioural impact of the response perhaps able to sidestep these reflective interpretations. However, it is also possible that the intact counterfactual inferences can directly affect behaviour in the absence of any

counterfactual emotional response (note that this does not rule out the possibility that unspecific negative responses are still induced by the inference). Moreover, studies have shown that alexithymic individuals *do* display behavioural differences from controls on reward-based and risky decision-making (Bibby & Ferguson, 2011; Ferguson et al, 2009), meaning that Zalla et al's findings are not consistent with other studies of the diminished emotional awareness associated with alexithymia. Since Zalla et al measured only general emotional responses in their self-report scales, rather than tapping into reports of regret and disappointment directly or measuring physiological arousal, it remains unclear at which stage in the emotional processing stream (i.e. from counterfactual inference to induction of the emotional feeling, identification and report on that feeling, and finally to the behavioural impact) regret and disappointment will fail to be discriminated in ASDs.

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