

# **The relationship between sense of agency and borderline personality disorder traits in the general population**

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## **Ethics declarations**

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### Conflict of Interest

The author has no conflict of interest to declare.

### Ethical Approval

This research was approved by the Goldsmiths Research Ethics Committee

## **Data availability statement**

The datasets generated and analysed during the current study are available in the OSF repository: <https://osf.io/j5dsh/>

## **Abstract**

It has been claimed that Borderline Personality Disorder (BPD) is associated with impaired self-other discrimination, a core feature of which is the sense of agency (the feeling that one's actions are one's own). At present the evidence related to sense of agency in BPD is limited and inconsistent. Here we examine this further by assessing the relationship between sense of agency and BPD traits in the general population. We used intentional binding to quantify sense of agency. Intentional binding refers to the subjective compression of time between and action and its effect when we feel in control of that action. We also used this measure to quantify temporal sensitivity and its relation to BPD traits. We found that sense of agency was weaker and temporal sensitivity was poorer in those with higher BPD traits.

## **Key words**

Agency; Borderline personality disorder; Traits; Consciousness; Intentional binding; Volition; Time perception; Self-other

## Introduction

Borderline personality disorder (BPD) is characterised by interpersonal, affective and identity instability (American Psychiatric Association, 2013). Different proposals have been made concerning the underlying neurocognitive disturbance responsible for BPD psychopathology (e.g., excessive aggression: (Kernberg, 1967; emotion dysregulation, Linehan, 1993). Here we focus on the more recent proposal that impaired self-other distinction is at the core of BPD (Bender & Skodol, 2007; De Meulemeester et al., 2021; Neustadter et al., 2021). On this view, the clinical phenomena associated with BPD are cognitive, affective, and behavioural manifestations of a more fundamental difficulty in distinguishing self from other (De Meulemeester et al., 2021). When it comes to self-other distinction, there are two core aspects: sense of body ownership (“this body is my own”), and sense of agency (“this action is my own”). The present paper focuses on sense of agency and how individual differences in this are related to the severity of BPD-like traits in the general population.

There are implicit and explicit aspects of sense of agency (Synofzik et al., 2008; Moore, 2016). Implicit sense of agency refers to the background (pre-reflective) feeling of controlling our actions, whereas explicit sense of agency refers to higher-level attributions of agency we make (“that was me”). These aspects of sense of agency require different measures (Moore, 2016). Explicit measures directly probe aspects of an individual’s conscious experience of agency in a particular situation. Implicit measures capture a correlate of voluntary action and use that to infer something about the agentic experience (crucially, participants are not directly asked about their agentic experience). One implicit measure is sensory attenuation (Blakemore et al., 1998), which relies on changes in the perceived intensity of self-generated stimuli – the perceived intensity of a stimulus is reduced when it is under voluntary control. Another implicit measure is intentional binding (Haggard et al., 2002; Moore & Obhi, 2012), which relies on changes in time perception associated with voluntary action – actions and outcomes are perceived as closer together in time when they are under voluntary control.

In existing research there is inconsistency in terms of observed changes in implicit sense of agency in BPD. Colle et al. (2020), using a sensory attenuation paradigm, found reduced implicit sense of agency in participants with a diagnosis of BPD relative to controls. Mild electrical stimulation of the hand was either self-generated by pressing a button or other-generated (the experimenter pressed the button). They found that the typical reduction in perceived intensity of self-generated stimulation was *absent* in the BPD sample, suggesting a reduced sense of agency.

On the other hand, Möller et al. (2020), using the intentional binding paradigm, found no difference in implicit sense of agency in those with a diagnosis of BPD relative to controls. In their experiment, participants’ finger movements controlled the finger movements of an artificial hand that was placed above their own hand (their own hand was blocked from view). These movements caused the artificial hand to press a button, which caused a tone outcome. They found

that the intentional binding effect (i.e., the perceived duration of the interval between the movement of the artificial hand and the outcome) was the same in the BPD and control samples. This suggests that implicit sense of agency is not altered in BPD.

Given this limited and inconsistent evidence-base, it is clear that more data are needed. In the present study the intentional binding paradigm was used. Based on Möller et al., one would expect no correlation between BPD traits and intentional binding. However, this finding is surprising given impairments in self-other discrimination in BPD, which predicts reduced intentional binding. One issue with Möller et al.'s implementation of the intentional binding paradigm was the vicarious nature of agency (participants controlled an artificial hand). This was key to their design as they were interested in both sense of ownership and sense of agency. However, it is necessarily a less direct assessment of agentic experience: instead of the participant making an action that is unequivocally theirs, the experimental set-up introduces agentic uncertainty through its embodiment manipulation. In addition, agentic uncertainty is engendered through the extension of the causal chain in this experimental set-up; rather than the chain consisting only of an action and an outcome, an extra component is added (human action-artificial action-tone outcome). Even if the two actions are simultaneous, it creates a situation where there are two candidate causes of the outcome. Importantly, if the two groups are differentially sensitive these additional sources of uncertainty, this may mask groups differences in implicit sense of agency.

In light of these issues the present study used a standard, non-vicarious, version of the intentional binding task. This provided a more direct assessment of implicit sense of agency than Möller et al. Moreover, the sample was drawn from the general population. Although not without its limitations, this approach avoids certain confounds associated with clinical populations, such as medication effects (Teufel et al., 2010). The analysis used in the present study also goes beyond those of previous studies. With intentional binding, participants estimate the duration of intervals between movements and outcomes. Here, these data were used to examine whether BPD traits are associated with changes in temporal sensitivity (the ability to discriminate between different interval lengths). Impaired temporal sensitivity is already implied by existing research showing reduced influence of temporal asynchronies in the rubber hand illusion (e.g. Neustadter et al., 2019). To calculate slope we regressed interval estimates onto actual interval length. Poorer temporal sensitivity would lead to shallower slopes, revealing a difficulty discriminating the different interval lengths. Overall, we predicted weaker binding and shallower slopes in those with higher BPD traits.

## **Methods**

### *Participants*

30 participants (25 male; average age: 25.6 years; age range: 19 years-43 years) were recruited using the online platform Testable (testable.org).

### *Materials and procedure*

The intentional binding task was programmed in Psychopy and hosted on Pavlovia (pavlovia.org). The questionnaires were created in and hosted on Qualtrics (qualtrics.com). Participants first provided informed consent and demographic information by completing an online questionnaire. They were then taken to the intentional binding task and given full on-screen instructions on how to complete the task.

The intentional binding task was based on the established interval estimation procedure (e.g. Engbert et al., 2007). Participants pressed the space key whenever they felt the urge, which would cause a tone outcome after a sub-second delay. Participants were told the interval would randomly vary between 1 and 999ms, when in fact just three different intervals (100ms, 400ms, and 700ms) were pseudorandomly presented. Participants estimated the duration of the interval in ms using a visual analogue scale. There were 36 trials in total. Participants were also given six practice trials at the start in which different intervals were presented and feedback regarding the actual interval length was given.

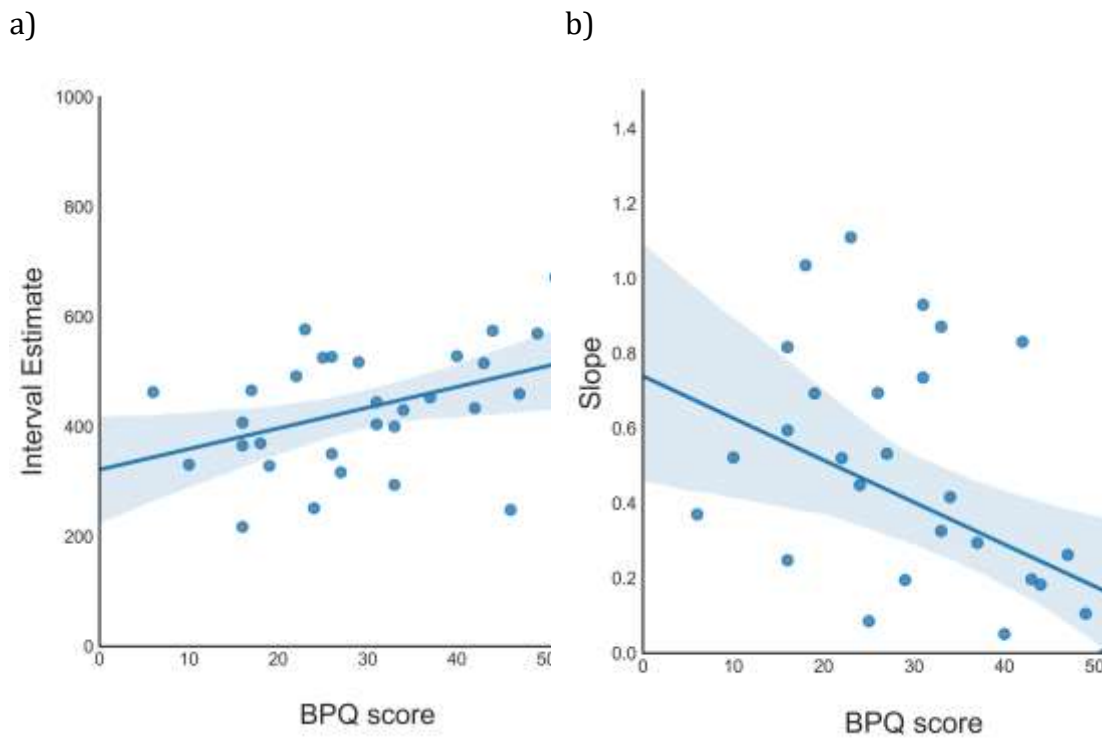
Following the intentional binding task they were taken to The Borderline Personality Questionnaire (BPQ; Poreh et al., 2006), an 80-item questionnaire that captures borderline personality disorder traits in the general population. Participants answer “True/False” to items that fall into one of nine sub-scales: impulsivity; affective instability; abandonment; unstable relationships; self-image; self-mutilation; emptiness; intense anger; quasi-psychotic states. Poreh et al. (2006) report mean sum scores in three different community samples: US: 21.06; English: 20.84; Australian: 21.23. A study by Chanen et al. (2008) has identified a clinical cut-off score of 56 on the BPQ, which predicts diagnosis with sensitivity of .68 and specificity of .90 in an adolescent sample. In terms of its psychometric properties, the BPQ has high internal consistency (Kuder-Richardson coefficient = .94) and convergent validity with MMPI-2 Borderline Personality Scale (Colligan et al., 1994;  $r = .85$ ). Criterion validity is satisfactory using the Diagnostic Interview for Borderline (Gunderson et al., 1981).

### **Results**

Participants' total BPQ scores and average interval estimates were calculated. On the binding task, higher average interval estimates indicate weaker intentional binding. As predicted, there was a significant correlation between BPQ scores and intentional binding, with higher scores associated with a weaker binding effect ( $r = .45$ ;  $p = .006$ , 1-tailed; 95% *CI* [0.17, 1.00]; Fig.1a). This suggests weaker sense of agency in those with higher BPD traits. Also as predicted, there was a significant correlation between BPQ scores and slope, with higher scores associated with a shallower slope ( $r = -.43$ ,  $p = .008$ , 1-tailed; 95% *CI* [-0.15, -1.00]; Fig. 1b). This suggests poorer temporal sensitivity in those with higher BPD traits.

In order to know what effect size our sample was able to reliably detect, we ran a power sensitivity analysis in G\*Power (version 3.1.9.6). This analysis showed

that a correlation coefficient with 30 participants would be sensitive to effects of  $r = .44$  with 80% power ( $\alpha = .05$ , one-tailed). This means the study would not be able to reliably detect correlations smaller than  $r = .44$ . The correlation between BPQ scores and binding exceeds this value, and the correlation between BPQ scores and slope is .01 below that value.



**Fig 1.** Scatterplots of BPQ scores against a) interval estimates, and b) slope.

## Discussion

In this study we explored the relationship between BPD traits and a) sense of agency, and b) temporal sensitivity. It was predicted that higher BPD traits would be correlated with reduced sense of agency and poorer temporal sensitivity. Both predictions were supported.

The observation of weaker sense of agency in those with higher BPD traits is consistent with research, using different measures, showing that implicit aspects of sense of agency are impaired in BPD (Colle et al., 2020). This provides further support to the idea that issues with self-other distinction are a core feature of the disorder (e.g. Bender & Skodol, 2007; De Meulemeester et al., 2021; Neustadter et al., 2021). As noted by De Meulemeester et al. (2021), if there are changes in sense of agency in BPD, this has clinical implications. For example, they argue that the treatment of patients with BPD should aim to address such embodied aspects of the disorder and suggest that non-verbal therapies such as music or dance/movement therapy might be effective. This is something that future research should address.

The finding that higher BPD traits are associated with reduced temporal sensitivity is novel. Moreover, it may shed light on the mechanisms underpinning self-disturbances in the disorder. For example, sense of agency depends on an accurate awareness of sensorimotor relationships (Haggard, 2017). Insensitivity to time delays would suggest that the awareness of these relationships is compromised in BPD. This insensitivity may also explain why those with BPD show the rubber hand illusion with asynchronous as well as synchronous touch (e.g. Neustadter et al., 2019) – if one is insensitive to temporal delays then this incongruence will not break the illusion. It is important to note here that this is speculative – the correlational design used in the present study cannot determine the *casual* role of aberrant temporal sensitivity (indeed this could be a consequence, rather than a cause, of self-disturbances). Future work should address this in order to establish the role of time perception in abnormal self-other discrimination in BPD. However, if it is confirmed then clinically this may be of some relevance, given the susceptibility of time perception to pharmacological manipulations (Meck, 1996).

In terms of limitations, one issue with the present study concerns the sample. Although our power sensitivity analyses suggest that it was large enough to reliably detect the observed effect sizes, a larger sample may still be desirable. This would also have the added benefit of increasing its representativeness of the general population (for example, just five individuals were female).

Furthermore, although the present findings are consistent with certain previous findings showing a reduced sense of agency in BPD (Colle et al., 2020), it should also be noted that they contradict a previous study by Möller et al., (2020). Using the same implicit measure they found no significant difference in binding between controls and individuals with a diagnosis of BPD. As suggested in the Introduction it might be that Möller et al.'s results were linked to the methodology used to measure binding. That is, perhaps the vicarious nature of the agency set-up masked grouped differences in binding. Future work should aim to clarify this issue by assessing intentional binding more directly in those with a diagnosis of BPD.

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