

# Spatiotemporal disruptions of reality perception in depersonalization

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## **Compliance with Ethical Standards**

**Conflict of Interest.** The authors declare that they have no conflict of interest.

**Ethical Approval.** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent was obtained from all participants included in the study.

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1                   **Spatiotemporal disruptions of reality perception in depersonalization**

2

3                   **Abstract**

4     Experiences of time and space are core constituents of the sense of bodily self.

5     Depersonalization (DP) is a condition characterized by distressing feelings of estrangement

6     from the self and the external world. While previous studies showed that perception of the space

7     close to the body (i.e., peri-personal space) remains intact in DP, time perception is disrupted.

8     The origin of this asymmetry in spatiotemporal alterations in DP remains an open question.

9     Addressing this gap, we conducted an online study ( $N = 1338$ ) investigating the relation

10    between DP traits measured by the Cambridge Depersonalization Scale (CDS) and altered

11    subjective experiences of body, time, and space perception. The results demonstrated positive

12    relationships between CDS facets and distorted experiences of time, bodily self and space.

13    When considering the shared variance of CDS facets, we found that altered body perception

14    (i.e., *Anomalous Body Experience*) is the most important predictor of altered spatiotemporal

15    experiences, with time “slowing-down”. In contrast, experiences of detachment from reality

16    (i.e., *Alienation from Surroundings*) are associated with perception of time “speeding up”.

17    Altogether, these results suggest that DP facets in relation to body and world perception need

18    to be disentangled to understand the mechanisms underlying atypical space and time perception

19    in DP.

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21    **Keywords:** *Depersonalization, Derealization, Space, Time, Path Analyses*

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26 **1. INTRODUCTION**

27       The self is a multidimensional construct, allowing conscious beings to interact with their  
28 environment (Damasio, 1999; Gallagher, 2000; Ciaunica & Fotopoulou, 2017). The self is  
29 constituted of several aspects, going from sensory perception (i.e., interoception and  
30 exteroception; Tsakiris, 2017) to “higher-order” cognitive processes (i.e., meta-cognition,  
31 memory, Fleming & Lau, 2014). Previous work argued that the subjective experience of the  
32 self crucially relies on the capacity to infer the self in space (Blanke & Metzinger, 2009).  
33 Defining the spatial boundaries of the self is indeed vital to navigate in the environment while  
34 successful orientation in time allows to build a stable identity of the self (Serino et al., 2013;  
35 Wittmann, 2015).

36

37 *1.1 Space and time perception as core aspects of the self*

38       The link between spatiotemporal perception and the self has been extensively studied  
39 and measured employing experimental paradigms such as body illusions (Botvinick & Cohen,  
40 1998), imitation (Quesque & Brass, 2019), perspective-taking (Arnold et al., 2016), body  
41 representations (Ciaunica & Crucianelli, 2019), peri-personal space (Serino, 2019), and self-  
42 other boundaries (Fairhurst et al., 2023). These paradigms measure how individuals locate  
43 themselves in the world and the plasticity of self-representations (e.g., self-other distinction).

44       The temporal processes underlying the self can be measured by experimental paradigms  
45 measuring memory processes (i.e., the capacity to perform mental time travel in the past or in  
46 future hypothetical events, Tulving, 2002) or intentional binding measuring the sense of agency  
47 (Haggard et al., 2002), linking intentional actions with their outcomes. These paradigms allow  
48 to understand the stability of the self through time and to infer the causality of events.

49       Spatial and temporal processes in relation to the body are thus core pillars of self-  
50 representation (Blanke & Metzinger, 2009), understood as a dynamical construct (Gallagher,

51 2000; Ciaunica & Fotopoulou, 2017). Consequently, the temporal and spatial representation of  
52 the self vary through developmental and life trajectories. Importantly, sudden changes of  
53 spatiotemporal representations are often considered as pathological markers (Wittmann, 2015;  
54 Kent et al., 2023; Giersch, 2024).

55

56 *1.2 Depersonalization as self-disorder*

57 Depersonalization (DP henceforth) is a clinical condition associated with experiences  
58 of disconnection from the self (Sierra & David, 2011; Ciaunica et al., 2021; 2023). Individuals  
59 experiencing DP often report i) *Emotional numbness* (i.e., feeling like an automat, Phillips et  
60 al., 2001), ii) *Anomalous body experiences* (i.e., altered sense of body ownership and agency,  
61 Ciaunica et al., 2022; Millman et al., 2024), iii) *Difficulty in recalling autobiographical  
memories* (i.e., disrupted mental travel, anomalous recall, Medford et al., 2006) and iv) *Sense  
of derealization* (i.e., feeling detached from reality, Hunter et al., 2004; Ciaunica et al., 2023).

62 Transient states of DP are quite common in the general population, often triggered by  
63 drugs consumption (Sierra, 2008) or traumatic experiences (Simeon et al., 2001) but also jet-  
lags, mindfulness meditation or digital activities such as video games and Virtual Reality (VR)  
64 (Ciaunica et al., 2021; 2022; 2024, Peckmann et al., 2022). However, when lasting more than  
65 3 months, these symptoms are considered persistent, and these experiences of disconnection  
66 impair individuals' quality of life (Hunter et al., 2004).

68 DP often shares overlapping symptoms with psychosis and schizophrenia linked to  
69 overlapping disruptions of self-experience (Sass & Parnas, 2003; Sierra & David, 2011).  
70 However, unlike psychosis and schizophrenia, individuals with DP usually experience intact  
71 reality testing and a certain state of lucidity (Sierra & David, 2011; Ciaunica et al., 2022). While  
72 schizophrenia is frequently described as a frightening disintegration of the self, people with DP  
73 are often obsessed by the disappearance or loss of the self, retaining metacognitive awareness  
74

76 of this loss (Sass et al., 2013). In this sense, DP may be conceptualized as a form of “grievance  
77 of the self”, where the loss of personality is mourned, rather than disorganized (Ciaunica et al.,  
78 2022; 2023). Consequently, DP has been recognized as a distinct diagnostic in the DSM-5  
79 (APA, 2013), leading to growing interest in the mechanisms underpinning these abnormal self-  
80 experiences.

81

82 *1.3 Current investigation*

83 Recent studies emphasized important differences between depersonalization and  
84 schizophrenia. For example, while altered spatial body representations are often observed in  
85 schizophrenia (Di Cosmo et al., 2018), DP seems less linked to such illusions, with intact body  
86 representation and peri-personal space (Ferroni et al., 2024). Therefore, despite consistent  
87 reports of anomalous bodily experiences, behavioral measures seem to indicate that spatial  
88 representation of the body remains intact in DP. By contrast, previous work showed that both  
89 in schizophrenia and DP temporal processes are impaired (Martin et al., 2013; Ciaunica et al.,  
90 2023; 2024). Hence, it is important to clarify how space and time perception are differentially  
91 affected in DP.

92 Here we have conducted an online study ( $n = 1403$ ) to investigate the relationship  
93 between body, time and space perception in DP. Participants completed a French version of  
94 the Cambridge Depersonalization Scale questionnaire (CDS-29, Sierra & Berrios, 2000; Lopez  
95 & Elzière, 2022). Building on previous qualitative works investigating altered spatiotemporal  
96 experiences in DP (Ciaunica et al., 2023), participants also completed the Self, Space and Time  
97 questionnaire (SST), measuring altered spatiotemporal experiences in relation to the bodily self.  
98 We hypothesized that CDS scores will be positively correlated with SST items measuring  
99 distorted experiences of self, space, and time. In addition, this study explored the role of CDS  
100 facets in the occurrence of those experiences, by considering their shared variance.

101

102 **2. METHODS**

103 *2.1 Participants*

104 Participants ( $n = 1403$ ; mean age =  $32.51 \pm 8.47$ , 650 men, 741 women, 12 non-binary)  
105 were recruited online via email listings, SONA system and social media using snowball  
106 sampling. Inclusion criteria listed: i) between 18 and 60 of age; ii) fluent in French; iii) no  
107 history of neurological illnesses; and iv) lack of drugs consumption during the last 6 months  
108 due to increased risk of DP occurrence.

109 Participants completed a French version of the Cambridge Depersonalization Scale  
110 (CDS-29, Lopez & Elzière, 2022) on Qualtrics (<https://www.qualtrics.com>). Participants were  
111 excluded due to missing values ( $n = 65$ ), resulting in a final sample of 1338 participants (mean  
112 age =  $32.51 \pm 8.50$  years, 622 men, 704 women, 12 non-binary).

113 A sensitivity power analysis confirmed that this sample size was deemed sufficient to  
114 detect a small effect size ( $f^2 = .03$ ). Informed consent was obtained from all participants and  
115 the procedure was approved by the ethics committee. The experiment was conducted in  
116 accordance with the Declaration of Helsinki.

117

118 *2.2 Questionnaires*

119 *2.2.1 Cambridge Depersonalization Scale (CDS-29)*

120 CDS-29 (Sierra & Berrios, 2000) is a 29 items standard questionnaire used to evaluate  
121 the severity of occurrence of depersonalization experiences by asking participants to estimate  
122 their frequency and duration in the past six months. The total score (between 0 and 290) points  
123 is calculated by summing over all items. CDS-29 has good statistical properties with internal  
124 reliability (Cronbach alpha) for different language versions reported between 0.89-0.94 (Michal  
125 et al., 2004; Sugiura et al., 2009).

126 Previous research has extracted four subscales from CDS-29 (Sierra et al., 2005): i)  
127 *Anomalous Body Experience*, measuring complaints related to changes in body experience; ii)  
128 *Emotional Numbing*, describing attenuated emotional experiences; iii) *Anomalous Subjective  
129 Recall*, capturing complaints about recall of autobiographical events, and lack of mental  
130 imagery; and iv) *Alienation from Surroundings*; describing derealization, and the experience of  
131 being cut-off from the world.

132

133 *2.2.2 Self, Space and Time Questionnaire (SST)*

134 Participants also completed the “Self, Space and Time” Questionnaire (SST) composed  
135 of 14 items, scored on 5-point Likert scales (see **Table 1**). The SST was developed based on  
136 previous qualitative investigations exploring the link between DP and altered spatiotemporal  
137 perception in relation to the bodily self (Ciaunica et al., 2023).

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- 150 **Table 1:** Items from the Self, Space and Time Questionnaire (English translation and original  
 151 French items in italic)

<b>1. I feel (I sense) that time is passing more quickly than usual</b>
<i>J'ai le sentiment (je sens) que le temps passe plus vite que d'habitude</i>
<b>2. I feel (I sense) that time is passing more slowly than usual</b>
<i>J'ai le sentiment (je sens) que le temps passe moins vite que d'habitude</i>
<b>3. I feel like I live more in the present, in the here and now</b>
<i>J'ai le sentiment de vivre plutôt dans le présent, dans l'ici et maintenant</i>
<b>4. I feel like I often think about past events</b>
<i>J'ai le sentiment que je pense souvent à des événements du passé</i>
<b>5. I feel like I look forward to the future with enthusiasm</b>
<i>J'ai le sentiment que je me projette avec enthousiasme dans l'avenir</i>
<b>6. I feel, when I look at myself in a mirror, that my face seems strange and unfamiliar to me</b>
<i>J'ai le sentiment, lorsque je me regarde dans un miroir, que mon visage me semble étranger, non-familier</i>
<b>7. I feel that the sound of my own voice when I speak often seems strange and unfamiliar to me</b>
<i>J'ai le sentiment que le son de ma propre voix quand je parle est souvent étranger, non-familier</i>
<b>8. I feel that when I hear it recorded on the answering machine, the sound of my own voice often seems strange and unfamiliar to me</b>
<i>J'ai le sentiment, quand je l'écoute enregistrée sur le répondeur, que le son de ma propre voix est souvent étranger, non-familier</i>
<b>9. I feel that when they speak to me, the sound of my loved ones' voices often seems strange and unfamiliar</b>
<i>J'ai le sentiment, quand ils me parlent, que le son de la voix de mes proches est souvent étranger, non-familier</i>
<b>10. I feel that when I hear it recorded on an answering machine, the sound of my loved ones' voices often seems strange and unfamiliar</b>
<i>J'ai le sentiment, quand je l'écoute enregistrée sur un répondeur, que le son de la voix de mes proches est souvent étranger, non-familier</i>
<b>11. I feel that when they speak to me, the sound of strangers' voices is irritating</b>
<i>J'ai le sentiment, lorsqu'ils me parlent, que le son de la voix des inconnus est irritante</i>
<b>12. I feel that the sound of familiar everyday noises (brushing my teeth, running water from the tap, the sound of my footsteps on the floor, etc.) is too loud and irritating</b>
<i>J'ai le sentiment que le son des bruits familiers de la vie de tous les jours (brossage des dents, le bruit de l'eau du robinet qui coule, le bruit de mes pas sur le plancher, etc.) est trop fort et irritant</i>
<b>13. I feel that familiar everyday objects (table, chair, sink, etc.) appear larger and closer to my body than usual</b>
<i>J'ai le sentiment que les objets familiers de la vie de tous les jours (table, chaise, lavabo, etc.) sont plus grands et plus proches de mon corps que d'habitude</i>
<b>14. I feel that familiar everyday objects (table, chair, sink, etc.) appear smaller and farther from my body than usual</b>
<i>J'ai le sentiment que les objets familiers de la vie de tous les jours (table, chaise, lavabo, etc.) sont plus petits et plus éloignés de mon corps que d'habitude</i>

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153

154 2.3 Data analyses

155 Reliability of the French version of the CDS-29 questionnaire was tested with Cronbach.  
156 Zero-order correlations computed the association between CDS facets and SST items. Path  
157 analyses considered the shared variance between CDS facets on SST items. All scripts and  
158 datasets are available in OSF:  
159 [https://osf.io/v4cyj/?view\\_only=8b80545be7f949c8b8242a7d13bb07e1](https://osf.io/v4cyj/?view_only=8b80545be7f949c8b8242a7d13bb07e1)

160

### 161 3. RESULTS

#### 162 3.1 Reliability check

163 CDS total score revealed good internal reliability, with Cronbach's alpha = .95. All CDS  
164 facets displayed good reliability (> .70), except for the subscale *Alienation from Surroundings*  
165 (.69). All CDS facets were positively correlated, with overall higher correlations for the facet  
166 *Anomalous Body Experience* – see **Table 2** for summary.

167

168 **Table 2:** Descriptive statistics, reliability and Pearson's correlations between questionnaires

	Cronbach	Mean (SD)	CDS Total	ALIEN	BODY	NUMB
CDS Total	.93	100.50 (52.01)	-	-	-	-
Alienation from Surroundings	.69	14.97 (7.20)	0.85***	-	-	-
Anomalous Body Experience	.85	29.36 (18.07)	0.95***	0.78***	-	-
Emotional Numbing	.75	20.96 (11.75)	0.91***	0.75***	0.83***	-
Anomalous Self Recall	.73	18.61 (8.87)	0.88***	0.73***	0.80***	0.77***

169 Note: P-values are reported with \*for  $p < .05$ ; \*\*for  $p < .01$  and \*\*\* $p < .001$

170

## 171 3.2 Zero-order correlations

172 All CDS facets were positively correlated with distorted experiences of self and space.  
 173 However, differences were observed across items measuring temporal distortions. For example,  
 174 there was a positive correlation with item 2 (i.e., “*I feel (I sense) that time is passing more*  
 175 *slowly than usual*”). By contrast, we found no correlation with item 1 (i.e., “*I feel (I sense) that*  
 176 *time is passing more quickly than usual*”). We also found negative correlations with item 3  
 177 (i.e., “*I feel like I live more in the present, in the here and now*”), 4 (i.e., “*I feel like I often think*  
 178 *about past events*”) and item 5 (i.e., “*I feel like I look forward to the future with enthusiasm*”)  
 179 – see **Table 3** for summary.

180

181 **Table 3:** Spearman’s correlations between CDS facets and STT items

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Alienation</b>														
<b>from</b>														
<b>Surroundings</b>	.05	.35***	-.18***	-.06*	-.18***	.43***	.38***	.15***	.48***	.44***	.44***	.40***	.48***	.52***
<b>Anomalous</b>														
<b>Body</b>														
<b>Experiences</b>	-.03	.39***	-.16***	-.11***	-.13***	.49***	.46***	.13***	.60***	.56***	.50***	.43***	.62***	.65***
<b>Emotional</b>														
<b>Numbing</b>	.01	.39***	-.16***	-.07*	-.15***	.43***	.44***	.14***	.55***	.52***	.47***	.40***	.56***	.59***
<b>Anomalous</b>														
<b>Subjective</b>														
<b>Recall</b>	.05	.35***	-.15***	-.04	-.11***	.42***	.42***	.18***	.49***	.49***	.42***	.38***	.50***	.53***

182 Note: P-values are reported with \* for  $p < .05$ ; \*\* for  $p < .01$  and \*\*\*  $p < .001$ 

183

184 Altogether, these results suggest that CDS scores are positively associated with distorted  
 185 experiences of the self and space. However, the association of CDS scores with temporal

186 distortion appears more complex with tendencies to experience more often slowing down of  
187 time and less often experiences of living in the present and mental time travel.

188

189 *3.3 Path analyses*

190 When considering the shared variance between CDS facets, different patterns emerged.

191 First, the facet *Anomalous Body Experience* appears as the most important predictor of altered  
192 experiences of space, time and bodily self. Importantly, once shared variance was considered,  
193 some CDS facet displayed different associations, suggesting distinct altered temporal and  
194 spatial experiences as well as different sensitivities to visual and auditory modalities – see

195 **Table 4** for summary and **Figure 1** for graphical illustration.

196

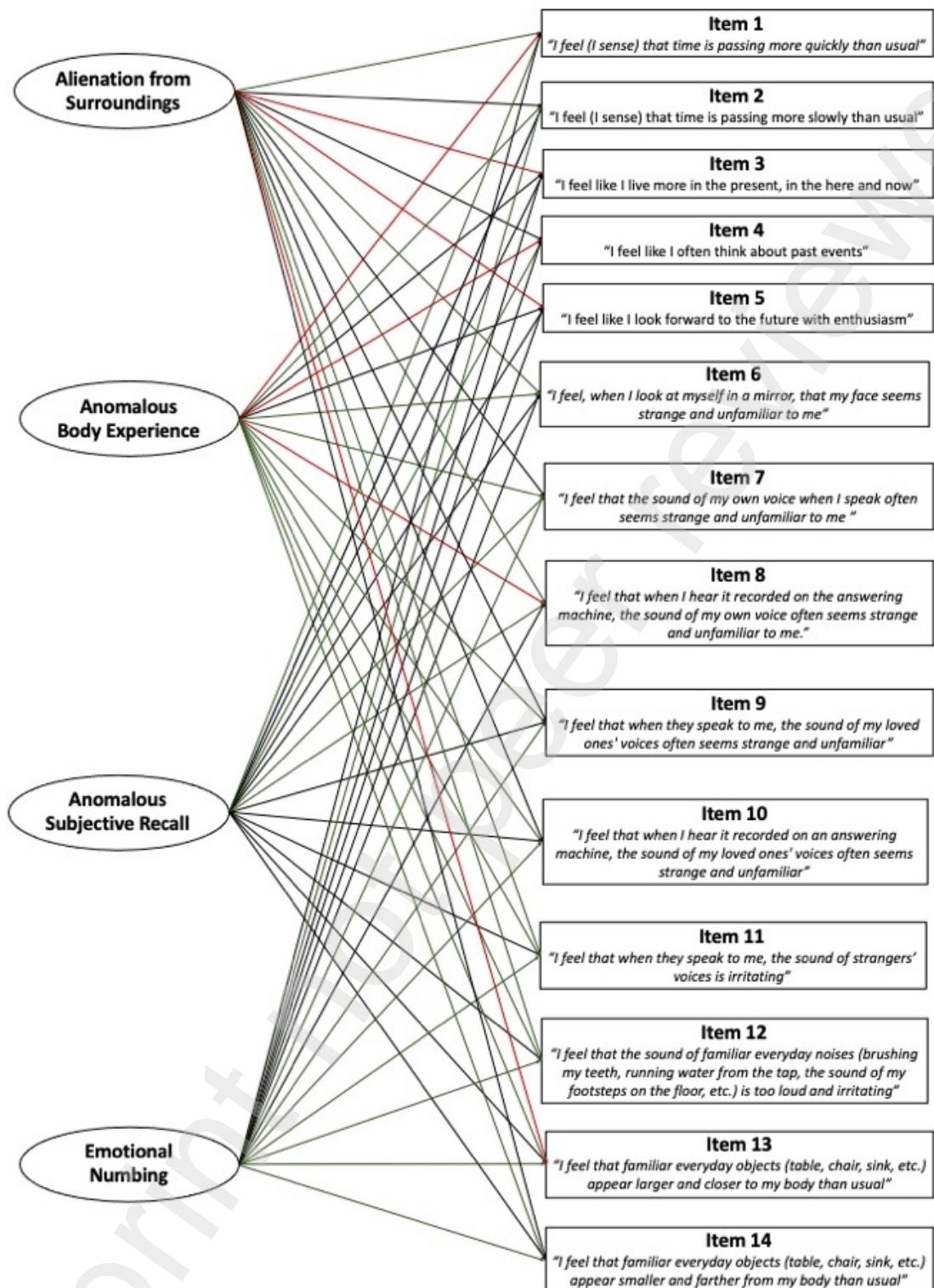
197 **Table 4:** Standardized beta coefficient between CDS facets and STT items when considering  
198 shared variance of CDS facets

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Alienation</b>														
from														
<b>Surroundings</b>	.17***	.06	-.16**	-.08	-.24***	.10*	-.03	.14**	-.04	.08	.10*	.14**	-.10*	-.05
<b>Anomalous</b>														
<b>Body</b>														
<b>Experiences</b>	-.41***	.23***	.04		-.31***	.11		.36***	.27***	-.20**	.55***	.48***	.32***	.19***
<b>Emotional</b>														
<b>Numbing</b>	.02	.18**	-.07	.04		-.09	.05		.14**	<.01	.13**	.15**	.15**	.11*
<b>Anomalous</b>														
<b>Subjective</b>														
<b>Recall</b>	.29***	-.03	-.01		.13**	.04		.02		.12**	.27***	-.05	.02	-.03

199 Note: P-values are reported with \*for  $p < .05$ ; \*\*for  $p < .01$  and \*\*\* $p < .001$

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**Figure 1:** Graphical illustration of the path analyses ( $\chi^2(147) = 5845.47, p < .001$ , CFI = 1.00, TLI = 1.00, RMSEA = .00 [90% CI: .00, .00], SRMR = .00), with black lines representing non-significant coefficients, and with red line representing negative significant correlations and green lines representing positive significant correlations.

207 **4. DISCUSSION**

208 This study examined the relationship between DP experiences and altered sense of time  
209 and self and yielded several significant findings. First, our results suggest that altered spatial  
210 and temporal experiences in DP are strongly associated with anomalous sense of the bodily self.  
211 Second, our results highlight the relationship between DP and time experiences is nuanced,  
212 driven by the different CDS facets. This observation is important for discussion on individual  
213 and personality differences in relation to potential therapy in DP and invites us to reconsider  
214 the “one size fits it all” approach. Finally, this study underlines the distinct role of DP facets in  
215 relation to the self, other and world sensory perception (visual versus auditory), suggesting that  
216 DP subtypes could lead to different spatial and temporal impairments depending on which senses  
217 are involved. In what follows we discuss these results in more detail.

218

219 *4.1 Altered bodily self*

220 First, the analyses of the association between CDS facets reveal that *Anomalous Body*  
221 *Experience*, characterized by altered experience of the bodily self, is one of the central aspects  
222 of DP symptoms, showing the strongest correlations with DP scores. This observation is in line  
223 with a substantial body of theoretical and empirical work linking DP to atypical bodily self-  
224 awareness (Sierra & David 2011; Colombetti & Ratcliffe, 2012; Billon 2022; Alekseeva &  
225 Ciaunica 2025).

226 By contrast, *Alienation from Surroundings*, capturing experiences of estrangement from  
227 the external world (i.e., derealization, DR henceforth), seems to contribute less to DP  
228 symptoms, although remains positively associated with all DP facets. This finding contributes  
229 to the question to what extent DP and DR are two entirely distinct or intertwined phenomena.  
230 DP and DR were initially considered separated constructs, the former referring to feelings of  
231 estrangement from the self, the latter to feelings of estrangement from the world (Sarlin, 1962).

232 However, they are nowadays considered as depersonalization-derealization disorder (DPDR)  
233 considering their significant co-morbidity (Hunter et al., 2004; Michal et al., 2004; Millman et  
234 al., 2024). Nevertheless, some studies suggest that DP and DR may be related to distinctive  
235 behavioral and neural responses. For example, Dewe et al. (2018) observed that DR-trait are  
236 associated with reduced autonomic responses when a threat was administrated to another  
237 individual while DP-trait were associated with responses attenuation when the threat was  
238 addressed to their own body. Similarly, Sierra et al. (2002) reported that visual DR symptoms  
239 seem to be associated with occipital-temporal areas dysfunctions while DP body alienation  
240 symptoms are associated with parietal areas. Therefore, although DP and DR are typically  
241 considered under one single umbrella, they may point to separable phenomena, considering  
242 their distinct neurobehavioral markers.

243

#### 244 *4.2 Altered sense of self, space and time*

245 Correlations between DP facets and altered experiences of space and time revealed  
246 consistent associations with distorted experiences of self in relation to time and space. However,  
247 these are not to be taken as one single block, but rather as a nuanced and multifaceted  
248 phenomenon. For example, our analyses suggested that DP facets affect differentially the  
249 temporal flow in specific ways, i) by increasing experiences of time “slowing down” but ii)  
250 decreasing experiences of “being present” and iii) decreasing the ‘mental time travels’ (i.e., the  
251 capacity to mentally place yourself in past, future, or hypothetical situations and experience  
252 them with a sense of personal ownership and time continuity, Tulving, 2002). These results  
253 aligned with pre-existing work suggesting that DP is often associated with difficulties in mental  
254 time travels (Medford et al., 2006) and emphasize that DP carries a related yet distinct  
255 phenomenology from mindfulness states, nurturing feeling of “being present” (Ciaunica, 2024).

256 Importantly, when the shared variance of CDS facets is considered, distinct patterns  
257 emerged. For example, *Anomalous Body Experience* is associated with i) higher experiences of  
258 time “slowing down”, ii) lower tendencies for retrospective time travel and iii) overall higher  
259 experiences of estrangement from the self and the external world, both in visual and auditory  
260 modalities. Similarly, higher scores of *Emotional Numbing* correlated with i) higher  
261 experiences of time “slowing down” and ii) higher experiences of estrangement from the self  
262 and the world, especially in the auditory modality. Thus, the more people feel detached from  
263 their body and the more emotionally numb they are, the more they experience the passage of  
264 time as being slower than usual. This is consistent with previous work indicating a strong  
265 relationship between emotion and time perception, with emotional numbness being linked to  
266 temporal flatness (Droit-Volet & Meck, 2007; Colombetti & Ratcliffe, 2012; Kent et al., 2023).

267 By contrast, higher scores on the CDS facet *Alienation from Surroundings* are associated  
268 with increasing experiences of time “speeding up”, reduced tendencies for “being present” and  
269 reduced tendency to project oneself into the future. If the world is a place where I feel estranged,  
270 then I may be inclined to speed up and “power through” while at the same time, paradoxically,  
271 avoiding project oneself in the future. This paradox is nicely captured by the French expression  
272 “la fuite en avant”, which can be translated “running away from myself forward”. In addition,  
273 the facet *Alienation from Surroundings* is also associated with experiences of estrangement  
274 from the self, especially in the visual modality (i.e., “*I feel, when I look at myself in a mirror,*  
275 *that my face seems strange and unfamiliar to me*”). By contrast, the experience of relating to  
276 the others appears affected in the auditory domain (i.e., “*I feel that when they speak to me, the*  
277 *sound of strangers’ voices is irritating*”). Finally, higher scores on *Anomalous Subjective*  
278 *Recall* led to experience time “speeding up”, retrospective mental time travel and experiences  
279 of estrangement from the self in the auditory modality. These experiences of time “speeding  
280 up” recall the acceleration of time observed in mania, yet in contrast with the DP facets, mania

281 is usually associated with projections in the future (Kent et al., 2023). Interestingly, difficulties  
282 in projecting oneself in the future are also observed after traumatic events (Ratcliffe et al.,  
283 2014), considered as possible triggers of DP symptoms (Simeon et al., 2001).

284

285 *4.3 Distinct role of sensory modalities*

286 These findings call into consideration the relationship between different sensory  
287 modalities in relation to self and other perception in DP. Indeed, not all senses are building the  
288 sense of self and sense of reality similarly (Alekseeva & Ciaunica, 2025). For example, vision  
289 may put us “out there” in the world, while at the same time visual self-perception (e.g., seeing  
290 one’s face) may put us outside our bodies. Numerous subjective reports from people  
291 experiencing DP indicate that they tend to avoid self-face perception via mirrors (Perkins 2021).  
292 By contrast, touch may put us in the here and now, and help us reconnect with our bodies  
293 (Ciaunica et al. 2021, 2022). For example, a recent study by Maister & Ciaunica (2025) found  
294 atypical self-face perception in DP. Individuals reporting more frequent and intense  
295 depersonalization symptoms had lower self-face representation accuracy, but somewhat  
296 counterintuitively, also higher precision and informational content of this representation.

297 Altogether, these results suggest that perceptual disturbances in DP are thus a nuanced  
298 and multifaceted phenomenon and strongly dependent on the different facets of CDS. Hence,  
299 DP may be best approached as an umbrella phenomenon, encompassing distinct facets which  
300 affects selectively spatiotemporal disruptions across different sensory modalities.

301 For example, those experiencing stronger alteration of bodily self are more prone to  
302 experience time slowing down and difficulties in retrospective time travelling. By contrast,  
303 those experiencing stronger experiences of derealization are expected to experience time  
304 speeding up and difficulties in prospective time travelling. Similarly, those experiencing  
305 emotional numbness and difficulties in recalling events would be more prone to alteration of

306 the self in the auditory domain while those who experience a sense of disconnection from reality  
307 will be more sensitive to visual domain, echoing Sierra et al. (2002)'s findings. Finally, some  
308 DP facets seem more prone to experiences estrangement from the self or the others depending  
309 on the sensory modality, echoing Dewe et al. (2018)'s results. These observations are important  
310 for detecting individual and personality differences which are key for effective and tailored  
311 potential treatment alleviating DP experiences.

312

#### 313 *4.4 Limitations and Outlook*

314 This study has some important limitations that future investigations need to address.  
315 First, this study was conducted online on a French speaking community sample, limiting its  
316 generalization to clinical populations. Second, the reliability of the SST questionnaire remains  
317 to be investigated, questioning the replicability of the present results, especially across different  
318 cultural backgrounds. Finally, these results need to be taken with caution considering the co-  
319 linearity between DP facets that could have influenced the path analysis (Petraitis et al., 1996).  
320 Despite these limitations, this study provides new insights on the relationship between altered  
321 spatial-temporal experiences and DP and the influence of DP facets on those experiences  
322 through different sensory modalities. Further experimental work needs to disentangle what are  
323 the precise connections between altered self-experiences and DP via different sensory  
324 modalities or using sensory substitution paradigms (Auvray et al., 2007). For example, these  
325 results could also be expanded to other modalities such as haptic touch and affective touch  
326 (Ciaunica et al. 2021) as it has been argued that touch is the most primitive and fundamental  
327 one to connect with oneself and other (Ciaunica & Fotopoulou, 2017; de Lagarde et al., 2025).  
328 Finally, these results complement previous work suggesting a strong relationship between  
329 depersonalization and derealization and call for future experiments by considering how DP

330 facets affect differently spatiotemporal perception both in unimodal and multimodal sensory  
331 signal processing.

332

### 333 **5. CONCLUSION**

334 This study investigated the relationship between altered spatial-temporal experiences  
335 and DP, a condition that makes people feel detached from their self, body and world. Our results  
336 suggest a strong relationship between anomalous bodily experiences and atypical space and  
337 time perception in DP. Importantly, distinct patterns emerged when considered the shared  
338 variance of DP facets (*Anomalous Body Experience, Emotional Numbing, Anomalous*  
339 *Subjective Recall, Alienation from Surroundings*) which indicate that DP should be approached  
340 as a multifaceted phenomenon, rather than as one single block. Our results also suggest that  
341 different DP facets affect self and other perception differently, depending on the sensory  
342 modality (vision versus audition), which in turn affect time and space perception in DP.

343 Time and space perception are ubiquitous experiences in relation to the bodily self:  
344 although not all perceptions are *of* space and time, all perceptions happen through a body  
345 situated *in* space and time. Hence, alterations of spatiotemporal perception may give us crucial  
346 insights into the personality and individual differences across different mental health condition,  
347 and particularly self-disorders.

348

349

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**Table 1:** Items from the Self, Space and Time Questionnaire (English translation and original French items in italic)

<b>1. I feel (I sense) that time is passing more quickly than usual</b>
<i>J'ai le sentiment (je sens) que le temps passe plus vite que d'habitude</i>
<b>2. I feel (I sense) that time is passing more slowly than usual</b>
<i>J'ai le sentiment (je sens) que le temps passe moins vite que d'habitude</i>
<b>3. I feel like I live more in the present, in the here and now</b>
<i>J'ai le sentiment de vivre plutôt dans le présent, dans l'ici et maintenant</i>
<b>4. I feel like I often think about past events</b>
<i>J'ai le sentiment que je pense souvent à des événements du passé</i>
<b>5. I feel like I look forward to the future with enthusiasm</b>
<i>J'ai le sentiment que je me projette avec enthousiasme dans l'avenir</i>
<b>6. I feel, when I look at myself in a mirror, that my face seems strange and unfamiliar to me</b>
<i>J'ai le sentiment, lorsque je me regarde dans un miroir, que mon visage me semble étranger, non-familier</i>
<b>7. I feel that the sound of my own voice when I speak often seems strange and unfamiliar to me</b>
<i>J'ai le sentiment que le son de ma propre voix quand je parle est souvent étranger, non-familier</i>
<b>8. I feel that when I hear it recorded on the answering machine, the sound of my own voice often seems strange and unfamiliar to me</b>
<i>J'ai le sentiment, quand je l'écoute enregistrée sur le répondeur, que le son de ma propre voix est souvent étranger, non-familier</i>
<b>9. I feel that when they speak to me, the sound of my loved ones' voices often seems strange and unfamiliar</b>
<i>J'ai le sentiment, quand ils me parlent, que le son de la voix de mes proches est souvent étranger, non-familier</i>
<b>10. I feel that when I hear it recorded on an answering machine, the sound of my loved ones' voices often seems strange and unfamiliar</b>
<i>J'ai le sentiment, quand je l'écoute enregistrée sur un répondeur, que le son de la voix de mes proches est souvent étranger, non-familier</i>
<b>11. I feel that when they speak to me, the sound of strangers' voices is irritating</b>
<i>J'ai le sentiment, lorsqu'ils me parlent, que le son de la voix des inconnus est irritante</i>
<b>12. I feel that the sound of familiar everyday noises (brushing my teeth, running water from the tap, the sound of my footsteps on the floor, etc.) is too loud and irritating</b>
<i>J'ai le sentiment que le son des bruits familiers de la vie de tous les jours (brossage des dents, le bruit de l'eau du robinet qui coule, le bruit de mes pas sur le plancher, etc.) est trop fort et irritant</i>
<b>13. I feel that familiar everyday objects (table, chair, sink, etc.) appear larger and closer to my body than usual</b>
<i>J'ai le sentiment que les objets familiers de la vie de tous les jours (table, chaise, lavabo, etc.) sont plus grands et plus proches de mon corps que d'habitude</i>
<b>14. I feel that familiar everyday objects (table, chair, sink, etc.) appear smaller and farther from my body than usual</b>
<i>J'ai le sentiment que les objets familiers de la vie de tous les jours (table, chaise, lavabo, etc.) sont plus petits et plus éloignés de mon corps que d'habitude</i>

**Table 2:** Descriptive statistics, reliability and Pearson's correlations between questionnaires

	Cronbach	Mean (SD)	CDS Total	ALIEN	BODY	NUMB
<b>CDS Total</b>	.93	100.50 (52.01)	-	-	-	-
<b>Alienation from Surroundings</b>	.69	14.97 (7.20)	0.85***	-	-	-
<b>Anomalous Body Experience</b>	.85	29.36 (18.07)	0.95***	0.78***	-	-
<b>Emotional Numbing</b>	.75	20.96 (11.75)	0.91***	0.75***	0.83***	-
<b>Anomalous Self Recall</b>	.73	18.61 (8.87)	0.88***	0.73***	0.80***	0.77***

Note: P-values are reported with \* for  $p < .05$ ; \*\* for  $p < .01$  and \*\*\*  $p < .001$

**Table 3:** Spearman's correlations between CDS facets and STT items

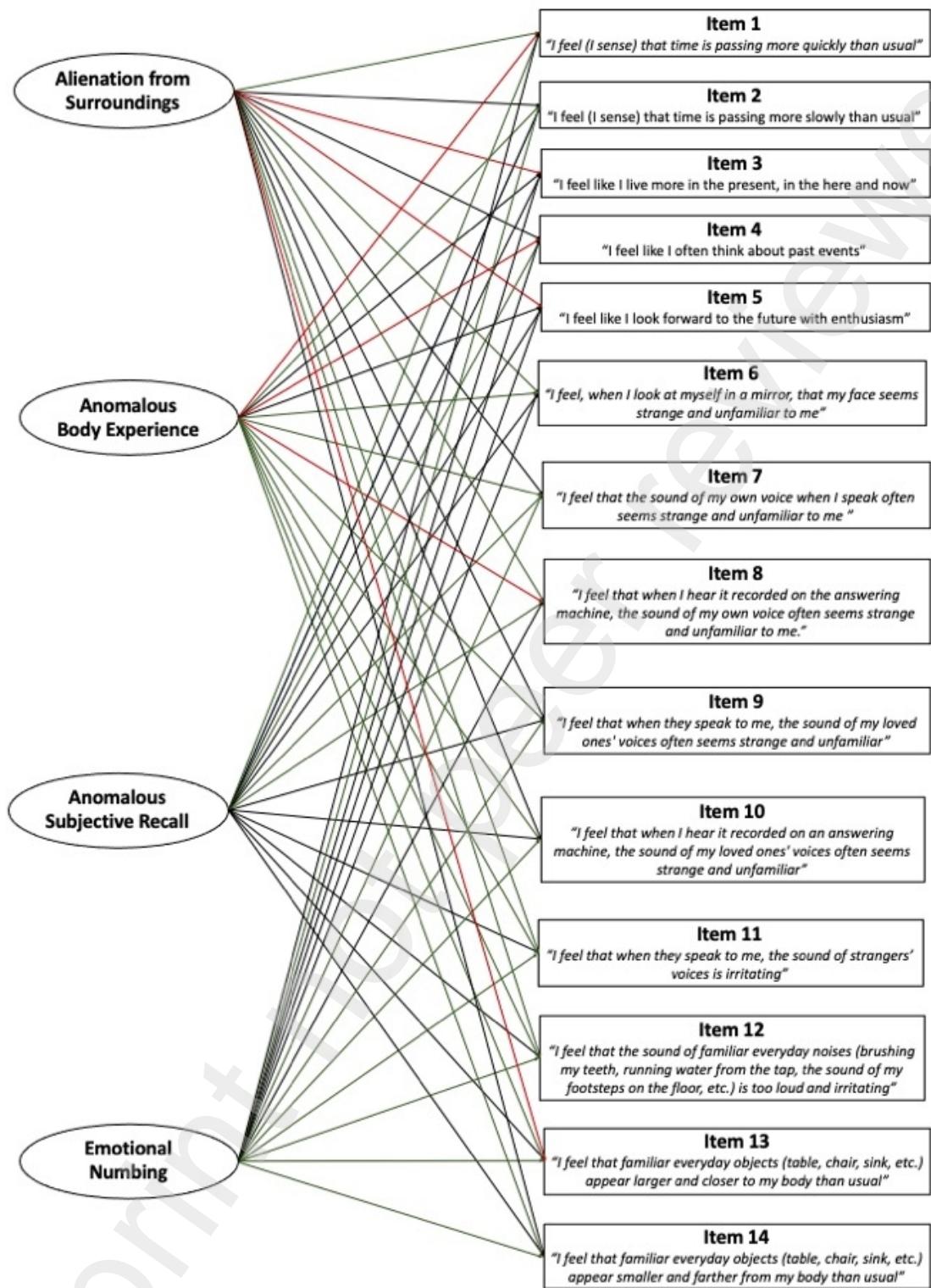
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Alienation</b>														
from														
<b>Surroundings</b>	.05	.35***	-.18***	-.06*	-.18***	.43***	.38***	.15***	.48***	.44***	.44***	.40***	.48***	.52***
<b>Anomalous</b>														
Body														
<b>Experiences</b>	-.03	.39***	-.16***	-.11***	-.13***	.49***	.46***	.13***	.60***	.56***	.50***	.43***	.62***	.65***
<b>Emotional</b>														
<b>Numbing</b>	.01	.39***	-.16***	-.07*	-.15***	.43***	.44***	.14***	.55***	.52***	.47***	.40***	.56***	.59***
<b>Anomalous</b>														
Subjective														
<b>Recall</b>	.05	.35***	-.15***	-.04	-.11***	.42***	.42***	.18***	.49***	.49***	.42***	.38***	.50***	.53***

Note: P-values are reported with \*for  $p < .05$ ; \*\*for  $p < .01$  and \*\*\* $p < .001$

**Table 4:** Standardized beta coefficient between CDS facets and STT items when considering shared variance of CDS facets

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Alienation from Surroundings</b>														
	.17***	.06	-.16**	-.08	-.24***	.10*	-.03	.14**	-.04	.08	.10*	.14**	-.10*	-.05
<b>Anomalous Body Experiences</b>														
	-.41***	.23***	.04		-.31***	.11		.36***	.27***	-.20**	.55***	.48***	.32***	.19***
<b>Emotional Numbing</b>														
	.02		.18**	-.07	.04		-.09	.05		.14**	<.01	.13**	.15**	.11*
<b>Anomalous Subjective Recall</b>														
	.29***	-.03	-.01		.13**	.04		.02		.12**	.27***	-.05	.02	-.03
												.03		-.05
														-.06

Note: P-values are reported with \*for  $p < .05$ ; \*\*for  $p < .01$  and \*\*\* $p < .001$



**Figure 1:** Graphical illustration of the path analyses ( $\chi^2(147) = 5845.47, p < .001$ , CFI = 1.00, TLI = 1.00, RMSEA = .00 [90% CI: .00, .00], SRMR = .00), with black lines representing non-significant coefficients, and with red line representing negative significant correlations and green lines representing positive significant correlations.