

# 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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## Abstract

Experiences of time and space are core constituents of the sense of bodily self. Depersonalization (DP) is a condition characterized by distressing feelings of estrangement from the self and the external world. While previous studies showed that perception of the space close to the body (i.e., peri-personal space) remains intact in DP, time perception is disrupted. The origin of this asymmetry in spatiotemporal alterations in DP remains an open question. Addressing this gap, we conducted an online study ( $N = 1338$ ) investigating the relation between DP traits measured by the Cambridge Depersonalization Scale (CDS) and altered subjective experiences of body, time, and space perception. The results demonstrated positive relationships between CDS facets and distorted experiences of time, bodily self and space. When considering the shared variance of CDS facets, we found that altered body perception (i.e., *Anomalous Body Experience*) is the most important predictor of altered spatiotemporal experiences, with time “slowing-down”. In contrast, experiences of detachment from reality (i.e., *Alienation from Surroundings*) are associated with perception of time “speeding up”. Altogether, these results suggest that DP facets in relation to body and world perception need to be disentangled to understand the mechanisms underlying atypical space and time perception in DP.

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

## 1. INTRODUCTION

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

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

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

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

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

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

## 1.2 Depersonalization as self-disorder

Depersonalization (DP henceforth) is a clinical condition associated with experiences of disconnection from the self (Sierra & David, 2011; Ciaunica et al., 2021; 2023). Individuals experiencing DP often report i) *Emotional numbness* (i.e., feeling like an automat, Phillips et al., 2001), ii) *Anomalous body experiences* (i.e., altered sense of body ownership and agency, 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).

Transient states of DP are quite common in the general population, often triggered by 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) (Ciaunica et al., 2021; 2022; 2024, Peckmann et al., 2022). However, when lasting more than 3 months, these symptoms are considered persistent, and these experiences of disconnection impair individuals' quality of life (Hunter et al., 2004).

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

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

### *1.3 Current investigation*

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

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

## 2. METHODS

### 2.1 Participants

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

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

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

### 2.2 Questionnaires

#### 2.2.1 Cambridge Depersonalization Scale (CDS-29)

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

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

### 2.2.2 Self, Space and Time Questionnaire (SST)

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

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

<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>
<p><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></p>

## 2.3 Data analyses

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

## 3. RESULTS

### 3.1 Reliability check

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

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

	Cronbach	Mean (SD)	CDS Total	ALIEN	BODY	NUMB
<b>CDS</b>						
<b>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 \*\*\*  $p < .001$

### 3.2 Zero-order correlations

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

**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 from Surroundings</b>	.05	.35***	-.18***	-.06*	-.18***	.43***	.38***	.15***	.48***	.44***	.44***	.40***	.48***	.52***
<b>Anomalous Body Experiences</b>	-.03	.39***	-.16***	-.11***	-.13***	.49***	.46***	.13***	.60***	.56***	.50***	.43***	.62***	.65***
<b>Emotional Numbing</b>	.01	.39***	-.16***	-.07*	-.15***	.43***	.44***	.14***	.55***	.52***	.47***	.40***	.56***	.59***
<b>Anomalous Subjective 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 \*\*\*  $p < .001$

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

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

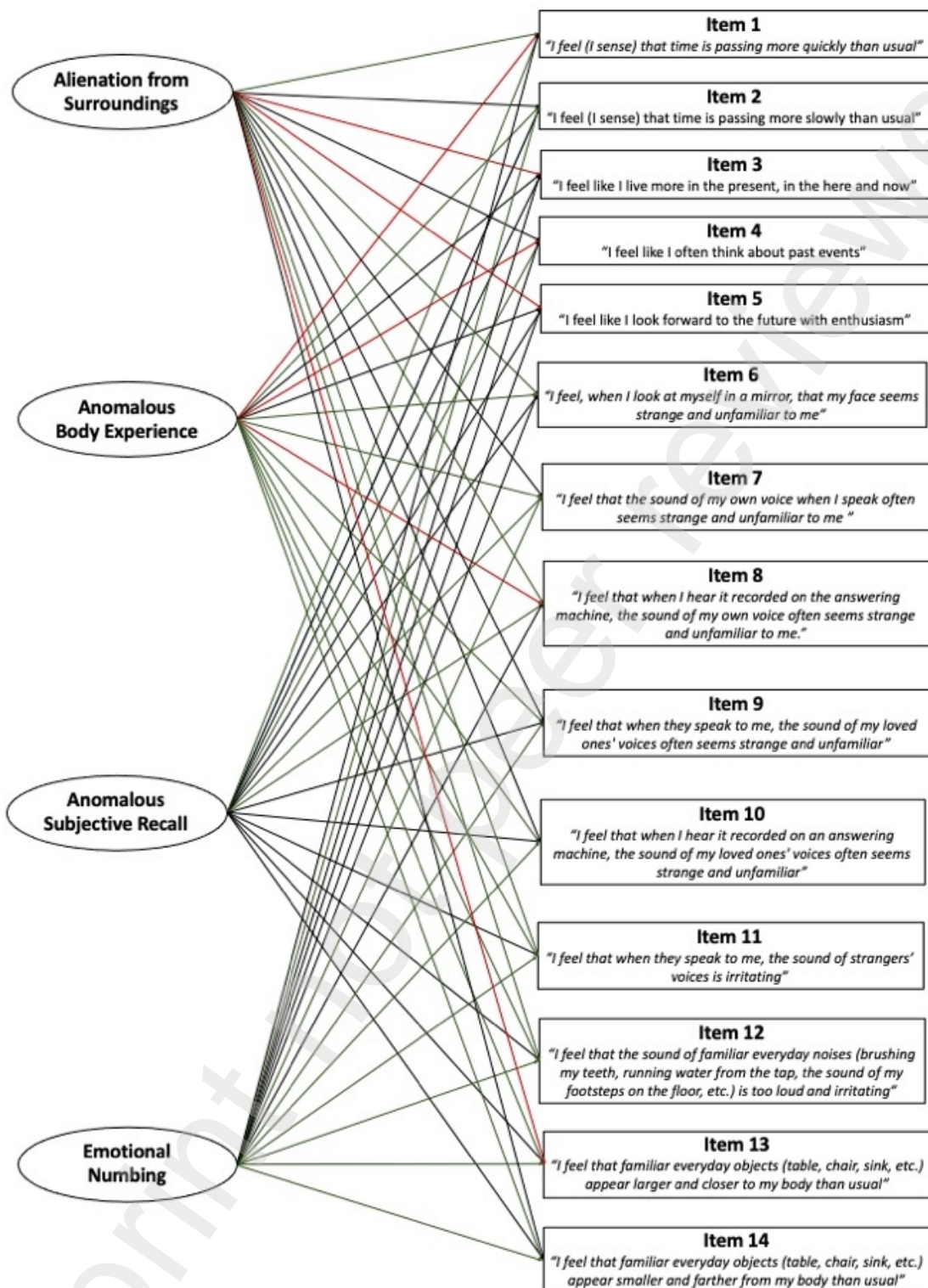
### 3.3 Path analyses

When considering the shared variance between CDS facets, different patterns emerged. First, the facet *Anomalous Body Experience* appears as the most important predictor of altered experiences of space, time and bodily self. Importantly, once shared variance was considered, some CDS facet displayed different associations, suggesting distinct altered temporal and spatial experiences as well as different sensitivities to visual and auditory modalities – see **Table 4** for summary and **Figure 1** for graphical illustration.

**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>														
<b>Anomalous Body Experiences</b>	.17***	.06	-.16**	-.08	-.24***	.10*	-.03	.14**	-.04	.08	.10*	.14**	-.10*	-.05
<b>Emotional Numbing</b>	-.41***	.23***	.04	-.31***	.11	.36***	.27***	-.20**	.55***	.48***	.32***	.19***	.62***	.61***
<b>Anomalous Subjective Recall</b>	.02	.18**	-.07	.04	-.09	.05	.14**	<.01	.13**	.15**	.15**	.11*	.12**	.14**
	.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.

## 4. DISCUSSION

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

### 4.1 Altered bodily self

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

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

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

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

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

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

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

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

#### *4.3 Distinct role of sensory modalities*

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

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

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

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

#### *4.4 Limitations and Outlook*

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

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

## 5. CONCLUSION

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

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

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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</b>						
<b>Total</b>	.93	100.50 (52.01)	-	-	-	-
<b>Alienation</b>						
<b>from Surroundings</b>	.69	14.97 (7.20)	0.85***	-	-	-
<b>Anomalous</b>						
<b>Body Experience</b>	.85	29.36 (18.07)	0.95***	0.78***	-	-
<b>Emotional</b>						
<b>Numbing</b>	.75	20.96 (11.75)	0.91***	0.75***	0.83***	-
<b>Anomalous</b>						
<b>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

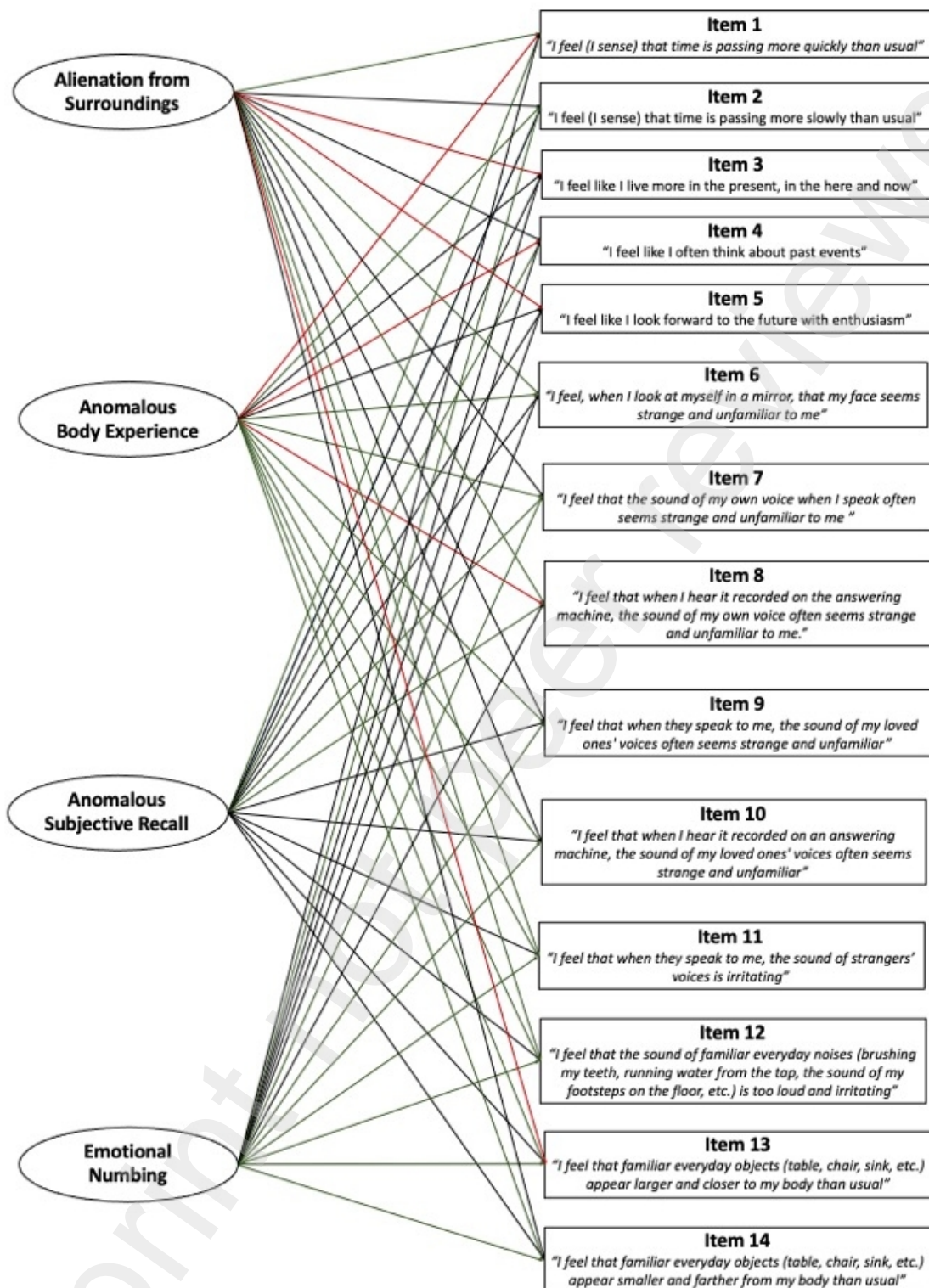
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
<b>Alienation from Surroundings</b>														
<b>Anomalous Body Experiences</b>	.05	.35***	-.18***	-.06*	-.18***	.43***	.38***	.15***	.48***	.44***	.44***	.40***	.48***	.52***
<b>Emotional Numbing</b>	-.03	.39***	-.16***	-.11***	-.13***	.49***	.46***	.13***	.60***	.56***	.50***	.43***	.62***	.65***
<b>Anomalous Subjective Recall</b>	.01	.39***	-.16***	-.07*	-.15***	.43***	.44***	.14***	.55***	.52***	.47***	.40***	.56***	.59***
	.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>														
<b>Anomalous Body Experiences</b>	.17***	.06	-.16**	-.08	-.24***	.10*	-.03	.14**	-.04	.08	.10*	.14**	-.10*	-.05
<b>Emotional Numbing</b>	-.41***	.23***	.04	-.31***	.11	.36***	.27***	-.20**	.55***	.48***	.32***	.19***	.62***	.61***
<b>Anomalous Subjective Recall</b>	.02	.18**	-.07	.04	-.09	.05	.14**	<.01	.13**	.15**	.15**	.11*	.12**	.14**
	.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.