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4. Funding: Bial Foundation.

5. Final Report: July, 2017

A: Abstract and Publications

From a *Gestalt*-theoretical viewpoint, one's subjective experience should be influenced by the sensory environment (Glicksohn, 1993, 1998). Koffka (1935), discussing the visual *Ganzfeld* (homogeneous visual field), wrote: "I expect the subject to feel in a different mood in homogeneous red and violet fields, even if both appear as grey fog" (p. 121). The *Ganzfeld* is a method of perceptual deprivation, involving a reduced patterning of stimulation. Avant (1965, p. 246) notes that observers, exposed to a *Ganzfeld*, "found it difficult to apply to the empty field experience the language usually adequate to express visual experience or structured fields; 'sea of light' seemed most descriptive for most of these observers." Further, after only twenty minutes of exposure, "the observers ... experienced extreme fatigue and a feeling of great lightness of body. Motor coordination was reportedly poor, and observers had difficulty maintaining balance. Time perception was disturbed. Subjects often complained of dizziness and sometimes appeared to be intoxicated. One observer experienced temporary states of depersonalization..." (p. 247). In other words, these observers experienced altered states of consciousness (ASCs; Glicksohn, 1993). In this project, we have been looking at both phenomenology and electrophysiology (EEG) of our participants, who are immersed in Whole-Body Perceptual Deprivation (WBPD; see **Figure 1**).

In the proposal submitted to the 2014/2015 Bial Foundation (228/14), we had set ourselves two objectives: (1) to investigate a WBPD-induced shift in state of consciousness and sense of self, putting our consciousness state space (CSS) model (Berkovich-Ohana & Glicksohn, 2014) to empirical test; (2) to investigate the induction of synesthesia during WBPD, following guidelines first set out be Werner (1978). We had intended to recruit a total of 30 participants, all of whom are experienced contemplative practitioners. The first objective has been successfully implemented. In fact, we were able to extend this goal, and have a total of 32 participants, a number of whom also underwent structural MRI (these data are still being processed at the present time). Our first two papers addressing this goal are under review (these papers are appended to this report). Two other papers are in preparation. The second objective has also been successfully implemented. A paper addressing this goal is in preparation.

To date, these are the publications (published, under review, or in preparation) stemming from this funded project:

1. Berkovich-Ohana, A. & Wittmann, M. (2017). A typology of altered states according to the consciousness state space (CSS) model: A special reference to subjective time. *Journal of Consciousness Studies*, *24*, 37-61.

2. Glicksohn, J., Berkovich-Ohana, A., Mauro, F., & Ben-Soussan, T. D. (under review). Individual EEG alpha profiles are gender-dependent and indicate subjective experiences in whole-body perceptual deprivation. *PLoS ONE*.

3. Glicksohn, J., Berkovich-Ohana, A., Mauro, F., & Ben-Soussan, T. D. (under review). Time perception and the experience of time when immersed in an altered sensory environment. *Frontiers in Human Neuroscience*.

4. Ben-Soussan, T. D., Glicksohn, J., Berkovich-Ohana, A. (in preparation). Differential effects on body, time and space perception: a phenomenological comparison between two learning environments.

These papers were presented at recent conferences:

1. Paoletti, P., Glicksohn, J., Berkovich-Ohana, A., & Ben-Soussan, T. D. (2017). Neurophenomenology of embodied symbols – the case of the Square and the EGG. *The Arbitrariness of the Sign*, Geneva, Switzerland. https://www.clg2016.org/geneve/programme/ateliers-libres/the-arbitrariness-of-the-sign/

2. Ben-Soussan, T. D., Glicksohn, J., & Paoletti, P. (2017). PHASE: from art to neuroplasticity via the mirror neuron system. *Visual Science of Art (VSAC)*, Berlin, Germany. https://www.vsac2017.org/

3. Mauro, F., Lasaponara, S., Glicksohn, J., Berkovich-Ohana, A., & Ben-Soussan, T. D. (2017). Source localization of EEG oscillatory activity in a Whole-Body Perceptual Deprivation paradigm. The Summer School on "*Empathy and Compassion: from Contemplative Traditions to Neuroscience*", Gerace, Italy. https://agliotilab.org/pdf/Empathy-and-Compassion-Summer-School-Gerace-2017.pdf

B: Research Protocol

General

Our participants were welcomed and introduced to the experiment and the research facility. They then filled out various questionnaire: Spielberger State-Trait Anxiety questionnaire (STAI), Scale of Body Connection (SBC), Tellegen Absorption Scale (TAS), and Consciousness State Space (CSS) assessment form. The participants also signed an informed consent form. The study was approved by the ethics committee of Bar-Ilan University.

Whole-Body Perceptual Deprivation (WBPD)

The WBPD chamber is in the shape of an egg (**Figure 1**), created by Patrizio Paoletti and is located in the Cognitive Neurophysiology Laboratory, at the Research Institute for Neuroscience, Fondazione Patrizio Paoletti, Assisi, Italy. Two WBPD chambers were used. The first WBPD chamber with a diameter of 3 m and height of 3.5 m, opens and closes its top electronically. Participants S1 to S16 sat in this chamber. Following the translocation of the lab, the second WBPD was utilized, having a diameter of 1.7 m and height of 2.22 m, and this opens and closes manually (for security reasons, to avoid problems in case of an earthquake). Participants P1 to P16 sat in this chamber. In both chambers the participant could sit comfortably. Instructions were given verbally; sounds are transmitted via concealed speakers. The chamber was first flooded with white light, followed by red light and indigo light (these 2 colored-light conditions were presented in a counterbalanced order across participants), enabling a totally immersive WBPD. The participant's verbal reports were heard through a microphone, and were recorded.

Figure 1. Whole Body Perceptual Deprivation (WBPD)

Participants and Procedure

A total of 32 participants (S1 to S16, P1 to P16) completed this study, and for 22 of these (11 males and 11 females, whose ages ranged between 27 and 66) we have a complete EEG alpha profile. All are experienced practitioners of breathing meditation, chosen to participate due to their enhanced introspective and reporting abilities. They were recruited from the *Ideas - Knowledge of Excellence, International School of Self-Awareness* (http://schoolofselfawareness.org/index.php/pages/page/40), and had been practicing breathing meditation from between 10,920 and 436,800 hours. They all completed a number of questionnaires prior to entering the WBPD chamber (see **Figure 2**). Following this, they completed a time-production (TP) task.

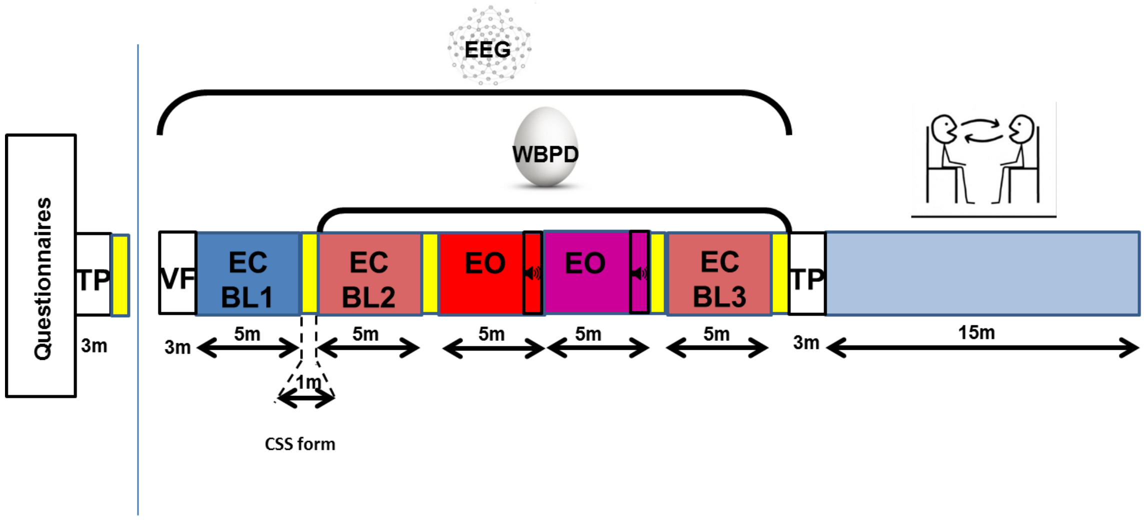


Figure 2: Protocol of the study

Then a 5-minute, eyes-closed EEG baseline recording was obtained in the open WBPD chamber, prior to the closing of its door and its illumination with white light (5 minutes, eyes-closed condition). The white-illuminated WBPD chamber was then closed, and a 5-minute eyes-closed EEG recording (WBPD-1) allowed us to test for the immediate effect of the WBPD. This was followed by red and indigo light, each presented for 5 minutes (eyes-open conditions), after which a short report of subjective experience was assessed using a brief questionnaire. The participants thus underwent 10 minutes of eyes-open WBPD, with two sounds introduced to facilitate the induction of synaesthesia. Then a third 5-minute, eyes-closed EEG was recorded (WBPD-2), followed by a short report of subjective experience, and a second TP task. At the end of the session, the participants underwent an extensive interview (see **Table 1**).

Table 1: The semi-structured interview.

#	Studied dimension	Free descriptions + grade on 1-9 scale
1	Time	Sense of time
2		Sense of space
3		Thoughts about the past (memories)
4		Thoughts about the future (concrete imagination)
5		Momentary experiencing
6	Emotion	Positive emotions (liking)
7		Negative emotions (disliking)
8		Pleasant bodily arousal

9		Unpleasant bodily arousal
10	Awareness	Sensing the external environment
11		Sensing the internal environment
12		Metacognition (thought about mental content or processing)
13		Type of thought (metaphoric/visual/abstract)
14		Evaluation and Decision-Making (cognitive evaluating skills and habits)
15		Internal verbalization
16	Bodily/Sensory processing	Synaesthesia
17		Input Processing (sensory)
18		Motor Output
19		Sense of body boundaries
20		Sense of agency
21		Sense of ownership

EEG recording and analyses

EEG was recorded using a 65-channel geodesic sensor net (Electrical Geodesics Inc., Eugene, USA) at a 500 Hz sampling rate, referenced to the vertex (Cz), with analog 0.1-200 Hz band-pass filtering. The data were subsequently referenced offline to average reference. Impedance was kept under 40 kΩ, which is within the accepted range for this system. Pre-processing of the data was conducted in line with our previous procedures (Ben-Soussan, Berkovich-Ohana, Glicksohn, & Goldstein, 2014; Ben-Soussan, Glicksohn, Goldstein, Berkovich-Ohana, & Donchin, 2013; Berkovich-Ohana, Glicksohn, & Goldstein, 2012, 2013). Primary data analysis entailed spectral analysis of power and coherence, using Matlab EEGLAB and FieldTrip open source toolboxes for advanced analysis of MEG/EEG (Delorme & Makeig, 2004; Oostenveld, Fries, Maris, & Schoffelen, 2011).

C: Neurophenomenological Findings

We are at the present still actively analyzing the data. Following are some of the findings that we have submitted for publication. **Table 2** presents example of protocols from each of the 4 groups identified in this study (for further details see paper submitted to *PLoS ONE*, attached). The first two columns refer primarily (but not only) to a majority of male participants presenting with R > L asymmetry; the last two columns refer to a majority of female participants presenting with L > R asymmetry. As will be readily evident, a number of our participants reported experiences of an unusual character. These reports are quite comparable to those found in the literature. The differential effect of the coloured environments on some of the participants is quite familiar (Tsuji, Hayashibe, Hara, & Kato, 2004). A focus on bodily sensations, coupled with a feeling of immersion, is also well known (Lloyd et al., 2012).

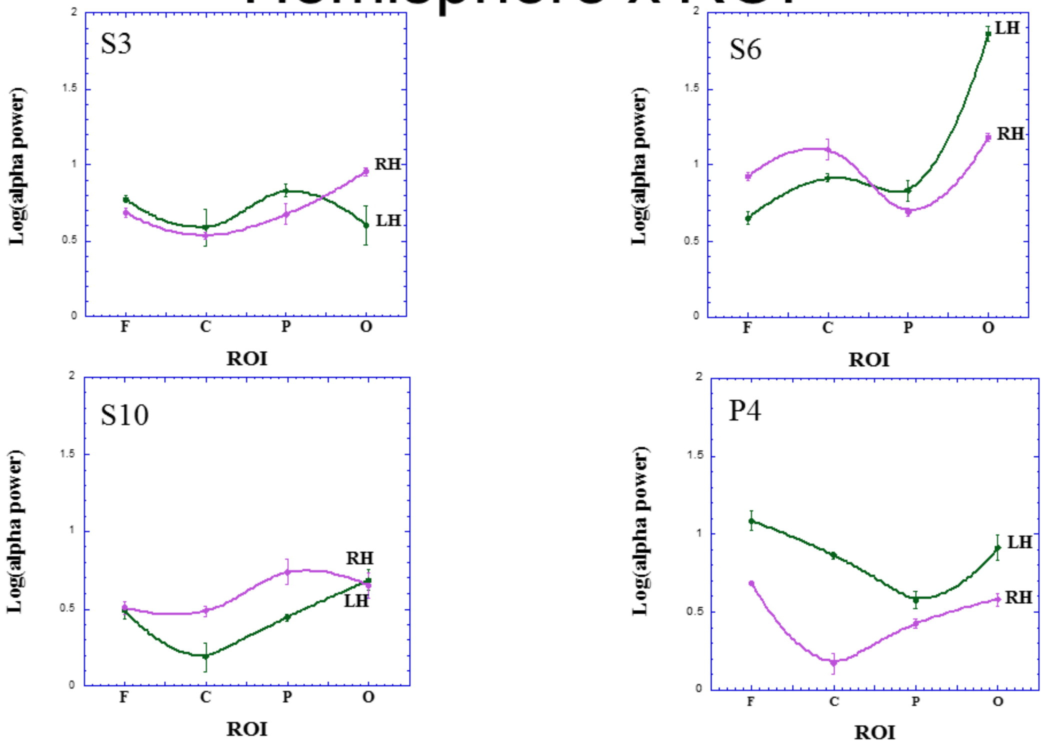
Table 2: Individual protocols from each of the 4 groups. TAS = Tellegen Absorption Scale (0-34; high = TAS $\geq$ 27).

Group of S3	Group of S10	Group of S6	Group of P4
P8 [low TAS M]: "…I was very focussed on my inner experience. I was very relaxed. So much that I was in between wake and sleep…. I saw images coming and going…"	S10 [low TAS M]: "… I felt calm, but less towards the end…"	S16 [low TAS F]: "Relaxed … no sense of time…."	P10 [high TAS F]: "… when the colour set in, I felt very sleepy … with red, I had an association to the body … the blue gave me a sense of freedom, like I was flying…."
S3 [high TAS F]: "… I didn't feel the boundaries, the space opened… the colour was getting inside me …."	P7 [low TAS M]: "When I opened my eyes I had the feeling of light entering my body, and the thing that was more impressive for me was that, even if I had my eyes open, I had the impression that the light was diminishing in intensity, especially with the red light."	S6 [high TAS F]: "...The red blinded me, took my vision…the thoughts were more physical …."	P15 [high TAS F]: "In the blue light I found my depth, my deep being. It was linked to the experience of the sea and the blue … when the white set in … I had the feeling of an expansion. Concerning time, time was not fast or slow … it was just what it was."

P2 [high TAS F]: "… there was this space ship that was carrying me around the universe. When the blue light set in, I saw several corridors that lead me to several doors which could be open, and at the end there was a person dressed in white who welcomed me, and I told myself: 'I'm meeting God'."	P12 [low TAS M]: "The red color was very strong, and it created some discomfort in the chest region. Then, color changes brought in other dimensions. When colors were changing, it was like the space around me was infinite."	P13 [high TAS M]: "I felt like I was at the center of an empty space and I imagined that I was in a spaceship. When colors lightened up, during the blue light I imagined being under water, and I saw the reflections under water, like I was in a bubble in the depth of a swimming pool with crystal water."	P16 [low TAS F]: "When colors were set in, I lost my perception of space, my point of reference into space. Especially with the change to the blue light, which led me to surrender to the experience, like 'it's not me in control of the experience, but I accept the experience'. The feeling was to surrender completely to the experience, so that I was in a more profound state of relaxation, almost falling asleep, and I needed to open my eyes."

Figure 2 presents components of the individual EEG alpha profiles for a number of these participants. There is a predominant R > L asymmetry found for male participants, and a predominant L > R asymmetry found for female participants.

Hemisphere x ROI



Condition x Hemisphere

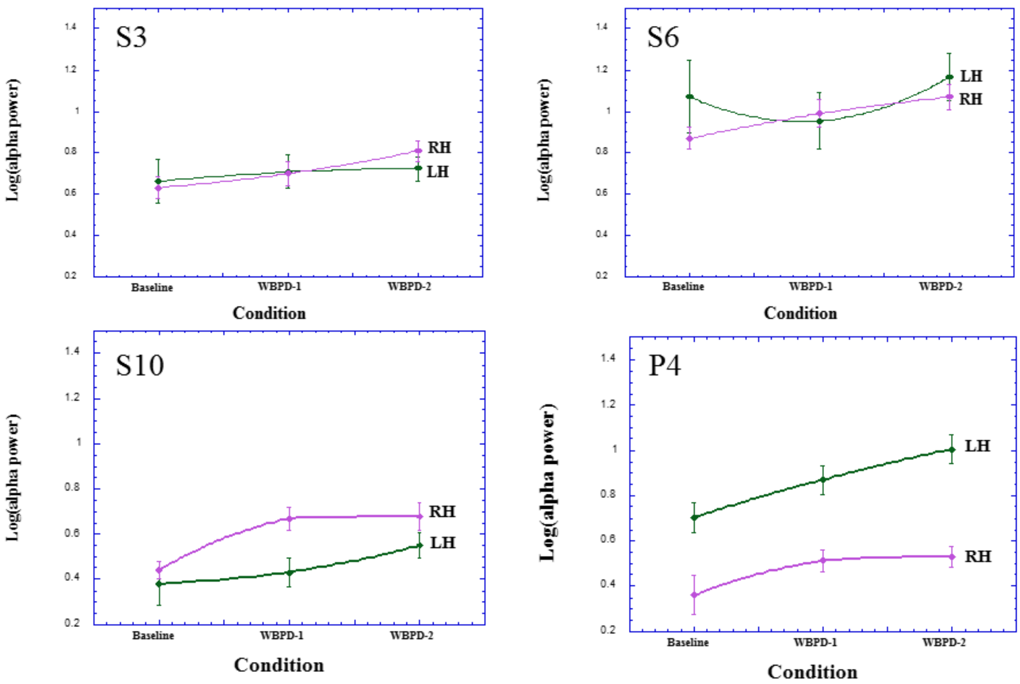


Figure 2: Individual EEG alpha profiles. A: Hemisphere × ROI (region-of-interest) profiles. B: Condition × Hemisphere profiles. LH = Left Hemisphere; RH = Right Hemisphere; F = Frontal; C = Central; P = Parietal; O = Occipital; WBPD-1 = first 5-minute eyes-closed EEG recording in WBPD; WBPD-2 = second 5-minute eyes-closed EEG recording in WBPD.

In trying to investigate to what degree subjective experience matches EEG alpha profile, and in particular the various alpha hemispheric asymmetries observed in the frontal, parietal, and occipital lobes, we consider the following: positive (frontal L < R alpha) or negative (frontal L > R alpha) affect (Davidson, 1992); a more verbal (L > R alpha) or a more imagistic (R > L alpha) mode of thinking (Riding et al., 1997); and a more trance-like (frontal > parietal alpha) or more reflective (frontal < parietal alpha) state of consciousness (Glicksohn & Berkovich-Ohana, 2011).

Turning to our TP task, **Figure 3** presents some of these data.

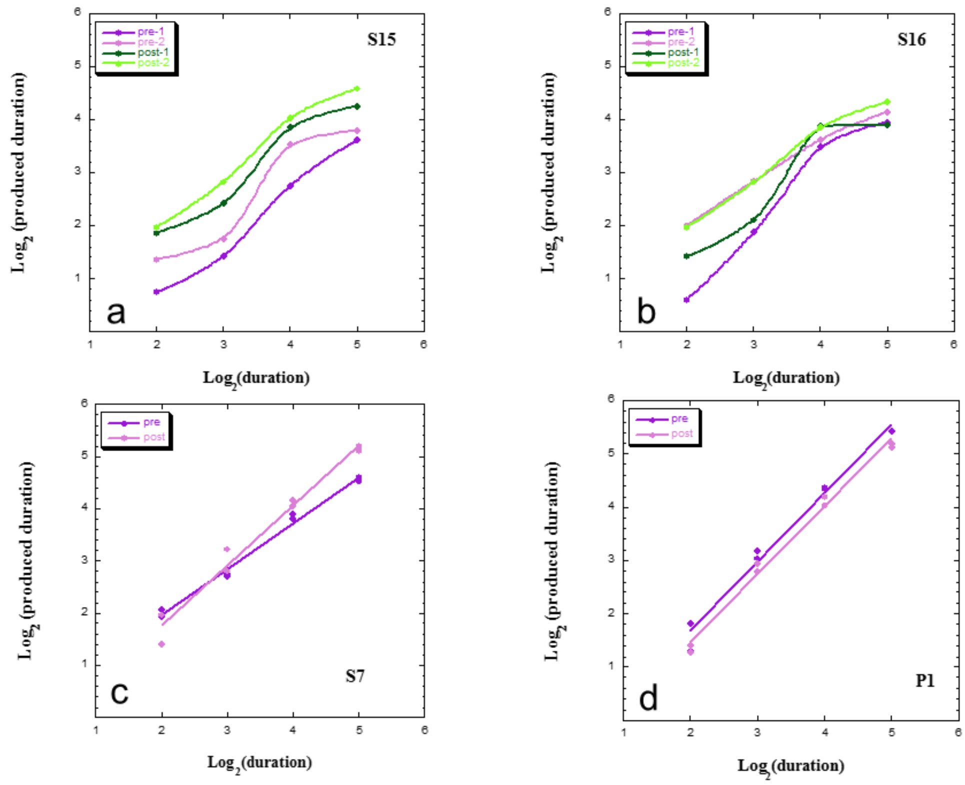


Figure 3: Produced duration as a function of target duration, both after log transformation for: (a) individuals not exhibiting linearity; (b) individuals not exhibiting a clear distinction between pre- and post-WBPD TP data; (c) individuals exhibiting a change in both slope and intercept from pre to post WBPD; (d) individuals exhibiting parallel functions for pre and for post WBPD.

A complete analysis of these data appears in the paper submitted to *Frontiers in Human Neuroscience* (attached). As with the EEG data, there are wide individual differences here. Some corresponding verbal protocols appear in **Table 3**.

Table 3: Individual protocols from each of the 4 groups.

Group of S15	Group of S16	Group of S7	Group of P1
S5 [low TAS M]: "There was no focus on [time]. The time dimension lost its meaning and significance"	S12 [low TAS M]: "[Time] disappeared"	S7 [low TAS F]: "Time was slower"	P15 [high TAS F]: "Concerning time, time was not fast or slow, but I was firm with myself. There was absence of time, but I was setting my own time, for example with my breath, or my sensations, thus it was set on the present, it was just what it was"
S15 [low TAS M]: "It felt as if more time had passed. Time was expanded, I perceived more the passage of time; time passes"	S16 [low TAS F]: "No time"	S9 [high TAS M]: "Expanded, flowing"	P7 [low TAS M]: "It seemed that there was no time. I didn't think about it"

D: Discussion and Preliminary Conclusions

The fact that two diametrically opposed alpha profiles were uncovered in the present study should be contextualized. In their review of research into the effects of meditation, Pagano and Warrenburg (1983, p. 171) argued that the type of shift toward right hemisphere dominance (i.e., an L > R alpha profile), claimed to pertain to the meditative state (and, we note, to other related states) could not be supported, because "individual differences were … a notable aspect." In the present study, we have promoted a focus on such individual differences, looking at individual alpha profiles, prior to grouping. Thus, in agreement with Pagano and Warrenburg (1983), we would argue for first looking at individual differences, and only subsequently pooling data. In addition, it would seem that male participants should not be pooled with female participants, because their alpha asymmetry profiles are diametrically opposed. In this respect, consider findings in the literature indicating baseline differences between male and female participants in global alpha power (Roberts & Bell, 2000) and in parieto-occipital alpha power (Jaušovec, N., & Jaušovec, 2010). Anterior alpha asymmetry patterns have been also reported to differ between male and female participants (Blackhart & Kline, 2005).

We have also reported on time perception in WBPD (see paper submitted to *Frontiers in Human Neuroscience*, attached). Our working hypothesis was that exposure to—in fact, immersion in—WBPD should result in a lengthening of TP (Glicksohn, 1992). Our study was designed such that we could maximize this effect, for our participants were all experienced meditators (in the widest sense of the term). Such a population should exhibit a lengthening of TP during meditation (Glicksohn, 2001b), and also exhibit longer TP while not meditating, at baseline (Berkovich-Ohana et al., 2012). Consider the following: The *Ganzfeld* (and other conditions of restricted environmental stimulation) comprises "… an externally structured analogue of meditation and similar states" (Suedfeld, 1980, p. 44); and conversely, "certain meditative practices … have perceptual and cognitive outcomes similar to sensory deprivation" (Lindahl et al., 2014). Hence, we have compatibility between trait and state in expecting such a lengthening of TP.

What have we learned about the relationship between TP and temporal experience? In spite of the existence of these individual differences—or, better, because of these individual differences—we can make the following tentative claims. First, when "time disappeared", TP becomes haphazard. Second, when "time was slower" or "time was expanded", TP is lengthened. We have also learned that the effects of WBPD are not long-lasting: Participants who remained in the chamber tended to report time as being slower, and tended to exhibit a lengthening of TP, as hypothesized; participants who exited the chamber tended to exhibit shorter productions, in opposition to the hypothesis. Would it have been better, then, to ask our participants to produce durations during WBPD, rather than following WBPD? One could argue either way: If TP reflects time-in-passing (Glicksohn, 2001b), then performing TP during WBPD would be more tightly related to temporal experience during WBPD. On the other hand, by performing TP during WBPD, using a task employing the production of multiple target durations, this might very well disrupt one's temporal experience, and one's subjective experience in general, which is of prime interest for studies of WBPD. In fact, any task might disrupt the effects of WBPD (Glicksohn, 2001a, p. 350; Suedfeld, 1980, pp. 67-68). Thus, TP following WBPD is not necessarily a limitation of the present study. This, however, is an issue worth considering in future studies in this domain.

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