



*The Influence of Hypnotizability and Dissociation on Ganzfeld  
Experiences and Mind-Wandering*

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## Abstract

Many studies have shown that people report unusual experiences when their senses are exposed to unstructured, monotonous stimuli. However, individual differences in responsiveness are poorly understood. The present study used a sensory homogenization procedure (i.e., ganzfeld) to address this issue. High ( $n = 15$ ) and low hypnotizable individuals ( $n = 14$ ), also measured on dissociation, completed a mind-wandering task during ganzfeld stimulation and a control condition (in total; 8 males and 21 females,  $M_{\text{age}} = 22.55$ ,  $SD_{\text{age}} = 4.22$ ). They also retrospectively reported their experiences in reference to each condition. Condition, hypnotizability, and dissociation were expected to interact in terms of mind-wandering and alterations in experiences. Significant interactions were found for the behavioral mind-wandering task, but not for the subjective reports. High hypnotizables engaged more in mind-wandering during ganzfeld stimulation relative to control, whereas lows showed the reverse pattern. These two populations are argued to be a valuable source for the study of different types of mind-wandering.

Keywords: Ganzfeld, mind-wandering, hypnotizability, dissociation, altered states

## Table of Contents

Abstract.....	2
Table of Contents.....	3
Introduction .....	4
Altered States of Consciousness .....	4
Ganzfeld.....	7
Mind-Wandering.....	13
Hypnotizability and Dissociation.....	15
The Present Study .....	17
Method.....	17
Participants.....	18
Materials.....	18
Procedure .....	20
Planned Analyses .....	22
Results .....	23
Mind-Wandering.....	23
Alterations of Consciousness .....	26
Discussion.....	29
References .....	33

The human sensory systems are continuously receiving input from various sources of diverse intensities and structures. An important question is what happens when these systems are exposed to “adequate physical stimulation” or “inadequate structure” (Wackermann, Pütz, & Allefeld, 2008, p. 1365)? That is, if the visual, auditory, or any other sensory field consists exclusively of a monotonous, unchanging (homogeneous) stimulus, how will this influence perception and cognition? An experimental technique, known as the ganzfeld, consists of a homogeneous sensory environment and is therefore suitable for exploring these questions. It will be evident from the review that follows that rather unusual experiences are frequently reported during ganzfeld stimulation. Such reports have led many researchers to argue that the ganzfeld induces a so-called altered state of consciousness (ASC, Vaitl et al., 2005). In order to embed ganzfeld in a wider context; this thesis will first review the concept of ASC before turning to the ganzfeld and its characteristics. Individual differences in responsiveness to ganzfeld are hitherto a poorly understood domain, and there is also a scarcity of research on the effect of ganzfeld stimulation on cognition. Accordingly, this thesis will attempt to address these issues as well.

### **Altered States of Consciousness**

ASCs were defined by Ludwig (1969, p.9) as any mental state that is recognized as a “sufficient deviation” from the ordinary waking consciousness in terms of the overall pattern of experiences or psychological functioning. These states can be recognized either by the individual or by a neutral observer. Admittedly, this definition is vague. For instance, it is still a subject of debate what deviations are to be recognized as sufficient (Revonsuo, Kallio, & Sikka, 2009; Vaitl et al., 2005). However, several common denominators of ASCs have emerged.

Ludwig (1969) proposed ten broad features of ASCs based on earlier research. “Alterations in thinking” refer to disturbances in attention, concentration, or rational thinking. “Disturbed time sense” is exemplified by feelings of timelessness, and acceleration or slowing of time. “Loss of control” means relinquishing control of experiences and behaviors. “Change in emotional experience” typically entails emotional extremes such as feelings of ecstasy or joy or feelings of sadness or anger. “Body image change” refers to various distortions in bodily signals (e.g., feeling heavy or weightless) or a changed boundary between one’s body and the environment or other people (e.g., feeling of oneness). “Perceptual distortions” refers to hallucinations, pseudo-hallucinations, or various types of imagery. “Change in meaning or significance” reflects various insights or increased attachment to ideas experienced during an ASC. These insights were described by Ludwig as primarily emotional or affective experiences. “Sense of the ineffable” refers to the difficulty in describing one’s experiences to a person who has not had a similar experience. “Feelings of rejuvenation” reflects sense of hope, rebirth, or renaissance. Finally, “hypersuggestibility” means an increased susceptibility to uncritically accept ideas or automatically act on suggestions or cues.

Although there is some overlap between Ludwig’s categorization and others’, such as the dimensions proposed Tart (1983), there are still large discrepancies across different categorizations. For instance, Cardeña (2009) compared two recent categorizations (Berenbaum, Kerns, & Raghavan, 2000, and Vaitl et al., 2005), and found that they differed on virtually each dimension except for one (level of awareness).

As a means of quantifying patterns of experiences for a given stimulus condition, Pekala (1991) developed a retrospective questionnaire named the *Phenomenology of Consciousness Inventory* (PCI). This questionnaire measures 12 major dimensions (e.g.,

positive affect and imagery), which overlap markedly with the taxonomies proposed by Tart and Ludwig. The questionnaire also includes 14 subdimensions (e.g., joy, love, sexual feelings and amount and vividness of imagery). The PCI has been found to reliably measure phenomenological experiences in reference to various stimulus conditions such as hypnosis (Pekala & Kumar, 1989), monotonous drumming (Rock, Abbot, Childargushi, & Kiehne, 2008), progressive relaxation (Pekala, Forbes, & Contrisciani, 1989), and sitting quietly with eyes closed (Kumar & Pekala, 1989). Thus, the PCI allows two or more potential inducers of ASC to be distinguished in terms of overall patterns of experiences.

Research on ASCs has been mostly empirical in nature (Vaitl et al, 2005), but a few theoretical propositions have been suggested. These have mostly focused on shared neural mechanisms for ASCs. Dietrich (2003) proposed that the unifying process of all ASCs is a deregulation of the prefrontal cortex (PFC), and that the viability of various dorsolateral (DL) circuits contributes to the uniqueness of each state. Although there is support for prefrontal hypofunction for several putative ASCs, such as states induced by meditation, the data is more inconsistent for others, such as hypnosis, (e.g., Kallio, Revonsuo, Hamalainen, and Markela, 2001). For instance, Kallio et al. (2001) implemented five tasks typically ascribed to regions within PFC (e.g., the stroop task and DLPFC) in hypnosis and a control condition, and found no overall support for frontal inhibition in hypnosis. In addition, it remains to be seen to what extent the model can be generalized to other ASCs than the six ones reviewed by Dietrich.

In Tart's (1983) systems-approach it is presumed that psychological experiences can be adequately mapped into a multidimensional taxonomy, at least in theory. For instance, a particular experience might be regarded as highly rational, lowly absorptive, highly arousing, and so on and so forth. If several experiences across various situations are mapped, distinct

clusters of experiences are likely to emerge. These clusters of experiences are what Tart referred to as discrete states of consciousness. Experiences during dreaming, for example, may tend to be regarded as highly irrational and absorptive, whereas experiences during the ordinary waking state may be more rational and less absorptive. An important part of this approach is that it allows for variations within each state of consciousness and for overlaps between different states. Thus, a discrete state of consciousness does not simply refer to the content of consciousness, but rather a qualitatively distinct pattern of psychological functioning. Tart further defined a state of consciousness as a uniquely configured system that consists of several psychological structures. These systems are argued to be quite stable as the psychological structures are typically stabilized in several ways: These ways of stabilization are “positive feedback” (i.e., rewarding when the individual is functioning within the baseline state), “negative feedback” (i.e., correcting when the individual is approaching the limits of the baseline state), “loading” (i.e., keeping consciousness busy so that few resources are left over to disrupt the baseline state), and “limiting” (i.e., restricting different subsystems to function, so that they cannot disrupt the baseline state) stabilization. Thus, a person will not switch between discrete states of consciousness just because the content of consciousness changes. However, when the baseline state is sufficiently destabilized in any of these ways, a shift from one state to another might occur.

Hence, according to the current literature of ASC, an inducer of an ASC should involve a destabilization process of the baseline state and a stabilization pattern for the upcoming state. At an experiential level it should lead to a significantly deviating overall pattern of experiences. A candidate for this title is the sensory homogenization technique known as the ganzfeld.

## **Ganzfeld**

The ganzfeld was originally defined as an unstructured visual field (Metzger, 1930). Typically, this field was created by having observers look at a homogeneously illuminated wide-view screen. It was of particular focus for Gestalt psychologists (e.g., Wertheimer, 1938), as they were interested in how an observer creates perceptual organization out of an unstructured field (e.g., by making figure-ground discriminations, Cohen, 1958).

In contemporary ganzfeld research, the visual stimulation is usually accompanied by a homogeneous auditory stimulation. This setup is sometimes referred to as the multi-modal ganzfeld to distinguish it from the original visual ganzfeld (Wackermann et al., 2008). This setup is generally acquired by having the participants listen to white or pink noise through headphones, while looking at a red light through a pair of anatomically shaped halves of ping-pong balls. The ping-pong balls that are placed over participants' eye orbits prevent the participants from seeing any contour, such as their nose. The ganzfeld setup thus consists of two variables (i.e., the homogeneous light and noise) but the author is not aware of any study varying each variable in a 2 x 2 design. Thus, little is known about the independent contributions of the light and noise, and whether they interact with each other.

Several elementary changes in visual perception have been reported by participants after only a few minutes of ganzfeld stimulation. Despite constant illumination, observers have expressed a perceived "darkening of the field" (Avant, 1965) and heterogeneity because of an appearance of a chromatic "fog" against an achromatic background (Cohen, 1958). These changes in perception are likely caused by retinal adaptations.

After experiencing ganzfeld for about 10-30 minutes, more complex changes in perception have been frequently reported (Wackermann et al., 2008). These changes in perception can be of any sensory modality, but visual appears to be the most common. In three studies (Pütz, Brauenig, & Wackermann, 2006; Wackermann et al., 2002) mentation



reports were provided by participants during ganzfeld stimulation. The researchers coded the reports according to referred sensory modalities. Visual imagery was the most prevalent modality in all three studies (90-98% of all reports included visual imagery across the three studies), with auditory as a distant second (16-29%), and tactile (9-26%), olfactory (3-16%) and kinesthetic (0-5%) falling behind. As is illustrated by these percentages several reports included multiple modalities.

Participants in the ganzfeld environment have not only provided mentation reports of imagery. Tsuji, Hayashibe, Hara, and Kato (2004, p.217) asked participants to report anything regarding the “external world (color, brightness, saturation) and those of the self (somatosensory experiences, body movement, and emotion)”. Ganzfeld stimulation was either of a red, blue, or green light. In addition to the reports regarding the “external world”, the red condition yielded significantly more reports of somatosensory experiences, body movement, and emotion. As an example of body movement, observers in the red condition reported “the body tilting forward”.

Rock et al. (2008) investigated differences in reported experiences in reference to ganzfeld stimulation, monotonous drumming, and a control condition (i.e., sitting quietly with eyes open). The participants completed the PCI in reference to each condition. The three conditions significantly differed in the overall pattern of experiences. Ganzfeld (as well as monotonous drumming) yielded more reports of visual imagery, altered experiences, and altered states compared to the control condition. Specifically, there were significantly more reported alterations in amount of imagery, altered perception, and altered body image. The latter finding supports the reports of changed body movement and somatosensory experiences that Tsuji et al. (2004) found. However, the reports of emotional experiences were non-significant in Rock et al.’s study. Although ganzfeld reports of positive affect were slightly

larger in the ganzfeld than monotonous drumming and control, reports of negative affect were actually less frequent in the ganzfeld.

However, a few limitations regarding the design of the Rock et al.'s (2008) study are worth considering. Most importantly, the instructions differed substantially between the treatment and control conditions. Ganzfeld and monotonous drumming conditions incorporated elaborate instructions on cultivating imagery, including a 2-minute exercise on visualizing a chosen object or location. There was no such instruction or exercise in the control condition. In addition, instructions such as “begin your journey upwards” might provide demand characteristics for reports of altered states or altered experiences. As monotonous drumming and ganzfeld differed from the control condition on the exact same PCI dimensions, it is difficult to conclude whether these differences were caused by the nature of the stimulation or the instructions. Furthermore, the study was a between-groups design and although participants were randomly allocated to conditions, pre-condition group differences are still plausible with moderate sample sizes ( $n \approx 30$  in each group).

Several researchers investigating ganzfeld experiences have noted great inter-subjective differences (e.g., Pütz et al., 2006; Wackermann et al., 2008), but most studies to date have used unselected samples, typically undergraduate volunteers. Pütz and colleagues found a U-shape distribution for participants' responsiveness to ganzfeld (measured in terms of imagery reports). Each participant completed the NEO Five Factor Inventory (Costa & MacCrae, 1992). The seven “high-responders” in this study differed from the remaining 33 in only one factor, namely conscientiousness ( $r = -.31, p \approx .05$ ). Moreover, in Rock et al.'s study (2008), participants completed the Schizotypal Personality Questionnaire (Raine, 1991), but contrary to the authors' expectations there was no influence of the cognitive-perceptual factor of schizotypy on ganzfeld experiences.

Vaitl et al. (2005) argued that the ganzfeld experience can be divided into two distinct phases according to the four-dimensional taxonomy they proposed. The first phase is referred to as a “preparatory” phase that involves decreased activation (i.e., relaxation), widened awareness span, preserved self-awareness, and reduced sensory dynamics. The “productive” phase entails similar levels of activation, but more focused awareness span, reduced self-awareness, and increased sensory dynamics (i.e., emerging pseudo-hallucinations).

Reiterating Tart’s (1983) description of an induction process of an ASC, the concepts of “destabilization” and “patterning forces” seem applicable to the ganzfeld technique. The ganzfeld induction, by definition, destabilizes the physiological pattern of stimulation as the observer is constantly exposed to unstructured stimuli. Psychologically, the influence of the ganzfeld stimulation might be augmented by an accompanying psychological induction, such as a relaxing voice encouraging the individual to withdraw attention from other personal concerns and fully focus on relaxing the body and the mind, the main components of a hypnotic induction. This psychological effect underscores the need to include an induction in the control condition as well, in order to determine the influence of ganzfeld stimulation. Furthermore, if a participant is expecting to have unusual experiences in the ganzfeld, the elementary changes in perceptions that are typically reported in an early phase (e.g., seeing geometric shapes) might facilitate the induction process. This would be similar to standardized measures of hypnotizability, in which the opening suggestions usually are the “easy” ones (e.g., stretching out one’s arm and feeling it getting heavy) and thus they might act as encouragement for experiencing further suggestions.

In the domain of neurophysiology, a few recent studies have investigated the effects of ganzfeld stimulation (Faber et al., 2002; Pütz et al. 2006; Wackermann et al., 2002; Wackermann et al., 2008). A hypothesis that has been tested is whether the ganzfeld-induced

state is of a hypnagogic nature. A hypnagogic state refers to a period between waking and sleeping in which some of the principal characteristics are spontaneously emerging imagery, increased suggestibility, and unusual thought processes (Schacter, 1976). As the ganzfeld and hypnagogic phenomenology share some characteristics (e.g., vividness of imagery), ganzfeld has been hypothesized to induce a hypnagogic state (Braud, Wood, & Braud, 1975; Schacter, 1976). However, Wackermann et al., (2002) compared electroencephalographic (EEG) activity in hypnagogic, ganzfeld, and relaxed waking conditions and the ganzfeld EEG spectra was more similar to relaxed waking than hypnagogic. They found that the ganzfeld was characterized by an accelerated  $\alpha$ -activity with no signs of decreased wakefulness, and with an increased tendency to become absorbed by the experience.

Pütz et al. (2006) asked their participants to press a button whenever they experienced imagery during ganzfeld stimulation. Participants' reports of occurrences of imagery correlated with  $\alpha_2$ -activity. As faster  $\alpha$ -activity has been related to semantic memory (Klimesch, 1997); Pütz and colleagues interpreted these results as indicative of a process of retrieval, activation and embedding of memory content. In sum, ganzfeld appears to induce a relaxed but activated state characterized by internally directed attention and spontaneous imagery.

Even less research has investigated cognitive-behavioral correlates of the ganzfeld-induced state. A practical reason for this scarcity might of course be that ganzfeld requires the individual to have no other visual or auditory input during the stimulation. There are a few studies nonetheless that have addressed this issue. One such study (Vitulli, Laconsay, & Shepard, 1996) implemented a short-term memory task for participants being either in a ganzfeld or a control condition. The ganzfeld did not influence performance on the task, but in the context of ASCs it should be noted that there was no formal induction or prolonged exposure to ganzfeld before performing the task in this study. In addition, if an ASC is

occurring, a short-term memory task might not be the most ideal way of measuring such a change. Given a proposal in the literature (Dietrich, 2003), it should more likely be a task measuring a cognitive ability that is strongly associated with increased recruitment of PFC regions. One such candidate might be the process of Mind-Wandering (MW).

### **Mind-Wandering**

MW was defined by Smallwood and Schooler (2006) as a process in which one's attention is disengaged from a current task and instead directed at unrelated thoughts, such as thinking about dinner plans while reading a textbook. Smallwood and Schooler argued that MW recruits executive resources and therefore it is more likely to occur when engaging in an easy or automatized task as there are more executive resources available for MW. McVay and Kane (2010) disagreed that MW recruits executive resources; instead they argued that it is the result of two factors that relates to failures of cognitive control. First, MW is determined by the presence of personal-relevant concerns that are automatically triggered by internal or environmental cues. Second, it is determined by a failure of executive systems to proactively or retroactively control for these interfering cues.

Although the human ability to think about personal-relevant concerns when engaging in repetitive routine tasks can truly be a blessing at times, it can also have devastating consequences under some circumstances (e.g., in traffic). It is therefore surprising that research on this topic has not emerged until very recently. Part of the answer is likely the issue of measuring MW. It is a process that is not only difficult to observe from outside, but the individual having the experience is often unaware that s/he is engaging in task-unrelated thoughts (Schooler & Schreiber, 2004). In addition, there is already a history of skepticism against introspective reports in cognitive psychology (Jack & Roepstorff, 2003, but see also Pekala & Cardeña, 2000).

A stepping stone in the cognitive literature of MW was thus the development of a signal detection task named *Sustained Attention to Response Task* (SART, Robertson, Manly, Andrade, Baddeley, & Yiend, 1997). The original SART consisted of random, serial presentation of the digits 1-9 on a computer screen. Participants were asked to press a key button as soon as they saw a digit unless it was the digit number three, in which case they were instructed to withhold a response. As an automatic response scheme is easily induced by responding to the frequent non-targets, optimal performance on this task seems to require the participant to sustain attention for the infrequent targets. Committing an error in this task (i.e., responding to digit three) has been correlated to introspective reports of MW (e.g., Cheyne, Carriere, & Smilek, 2006).

In a recent functional magnetic resonance imaging (fMRI) study (Christoff, Gordon, Smallwood, Smith, & Schooler, 2009), participants were asked to perform the SART during fMRI scanning. In addition, participants were asked to answer two questions that were administered on thought probes during the SART. These questions addressed whether their thoughts were “on-task” or “off-task”, and whether they were “aware” or “not aware” where their focus was. Thus a behavioral measure (i.e., commission errors in the SART) and a subjective measure (i.e., off-task reports) of MW were utilized to find physiological markers of MW. Both behavioral and subjective measures indicated that main executive network regions, DLPFC, and dorsal anterior cingular cortex (ACC), were recruited in episodes of MW. Interestingly, typical default network regions (e.g., ventral ACC and precuneus) were also recruited during MW. It is likely that default regions are recruited in the initial phase of MW and that the executive network is recruited when one is catching oneself drifting away.

To date, research on MW have mainly focused on the influence of different task parameters (e.g., stimulus presentation rate, Antrobus, 1968) on MW, but few studies have

focused on individual differences in MW. McVay and Kane (2009) found a negative correlation between working-memory capacity and MW in the SART task. They interpreted this as implying that those with higher working memory capacity are more likely to maintain current goals, that is, to proactively or reactively control for interfering cues. Furthermore, research to date has typically dichotomized thoughts into “on-task” and “off-task”, with little insight into the differential impact various types of MW might have on the task or some other aspect.

In addition to the lack of research on individual differences, there is also a scarcity of research investigating the impact of different conditions or states of consciousness. In a study by Smallwood, Fitzgerald, Miles, and Phillips (2009), participants underwent positive, negative, or neutral mood induction. Those participants in the negative mood condition engaged more in MW relative to those in the positive mood condition. Manly, Lewis, Robertson, Watson, and Datta (2002) found that failures to sustain attention (i.e., MW) were modulated by the circadian cycle. In overall, the results indicated more periods of MW early in the day. The author of this thesis is not aware of a previous study implementing a mind-wandering task in the context of ASCs or ganzfeld.

### **Hypnotizability and Dissociation**

A procedure that assembles ganzfeld in several ways is hypnosis, in which the person that administers the procedure (i.e., the hypnotist) suggests alterations in experiences or actions to a person (i.e., the subject, Barnier & Nash, 2008). A particular type of hypnosis known as “neutral hypnosis” (Kihlstrom & Edmonston, 1971) involves no explicit suggestions after an induction. The unsuggested alterations of experiences that have been reported during neutral hypnosis (Cardeña, 2005) are strikingly similar to those alterations reported in the ganzfeld. Participants in Cardeña’s study were selected for their strong

susceptibility for hypnosis and they reported alterations in body image, time sense, perception and meaning, state of awareness, and amount and vividness of imagery during neutral hypnosis.

As noted earlier, virtually nothing is known about individual responsiveness to the ganzfeld. Given the similarities between the procedures of hypnosis and ganzfeld and their phenomenology it is likely that there is an overlap in responsiveness to the two procedures. This thesis therefore focuses on two traits and their potential influence on the ganzfeld experience, namely hypnotizability and dissociation. Hypnotizability refers to the ability to respond to suggestions following a hypnotic induction. Dissociation is typically divided into two subcategories (Cardeña, 1994; Holmes et al., 2006). “Compartmentalization” is a type of dissociation where there is a failure to deliberately access or control processes or actions that are ordinarily expected to be amenable to such control (e.g., dissociative amnesia). “Detachment” is a type of dissociation where there is a tendency to have alterations of consciousness that are characterized by a detachment either from the self (e.g., out-of body experiences) or the outer world (e.g., derealization).

The relationship between hypnotizability and dissociation has been the subject of much debate within the field of hypnosis. A few of the major theories of hypnosis focus on dissociation as an central explanatory factor of hypnotic phenomena (e.g., neodissociation theory, Hilgard, 1986, 1992; dissociated control theory, Bowers, 1992; Jamieson & Woody, 2007) whereas others are skeptical to the idea of dissociation as a cause of hypnotic phenomena (e.g., response set theory, Lynn, Kirsch, & Hallquist, 2008; Kirsch & Lynn, 1998). Nevertheless, high hypnotizables have been shown to be a relatively heterogeneous population compared to the mediums and lows (McConkey & Barnier, 2004), and differences in dissociation have been posited to account for some of this variance (Terhune, Cardeña, &



Lindgren, 2009; Barber, 1999; King & Council, 1998). When assessing the overlap between responsiveness to hypnosis and ganzfeld it might therefore be of importance to account for level of dissociation as well.

Furthermore, high hypnotizables have demonstrated greater behavioral automaticity compared to lows (Laurence, Beaulieu-Prévost, & du Chéné, 2008). Because the present study addresses a MW task in which performance is associated with behavioral automaticity (Robertson et al., 1997), hypnotizability is also of interest from this point of view. It might be that high hypnotizables are more likely automatize responses in the task and thus engage more in MW.

### **The Present Study**

The first aim of this study was to investigate the effect of ganzfeld stimulation on subjective experience, with hypnotizability and dissociation as between-groups factors. High and low hypnotizable individuals, also designated as either high or low in dissociation, were asked to complete the PCI in reference to a ganzfeld context and a control condition. The second aim of this study was to investigate the effect of ganzfeld stimulation on MW. Participants were asked to perform the SART during ganzfeld stimulation and control.

I expected that high hypnotizables, especially if they are also high in dissociation, would be more responsive to the ganzfeld condition than lows would be. Thus, the highs were predicted to report greater alterations in multiple dimensions of consciousness. Also, since the highs were expected to be more responsive to ganzfeld stimulation, I also predicted that they would be more prone to engage in MW and thus make more commission errors in the ganzfeld relative to the control.

### **Method**

## Participants

Participants in this study were recruited from a larger pool of individuals ( $N = 332$ ) whose level of hypnotizability had been evaluated previously. The experimenter remained masked to the levels of hypnotizability until all data were collected. The participants consisted mainly of undergraduate students. A sample of 15 high and 14 low hypnotizable individuals participated in this study. The highs consisted of four males and eleven females ( $M_{\text{age}} = 22.00$ ,  $SD = 5.04$ ) and the lows consisted of four males and ten females ( $M_{\text{age}} = 23.14$ ,  $SD = 3.21$ ). Thus, age and sex were virtually equal across groups. Each participant was compensated with a cinema ticket and provided informed written consent.

All participants completed the S-DES (see the materials section) and were consequently designated as either high or low in dissociation, which yielded the following four groups: low dissociative/ low hypnotizables (LD lows,  $n = 9$ ), high dissociative/ low hypnotizables (HD lows,  $n = 5$ ), low dissociative/ high hypnotizables (LD highs,  $n = 6$ ), and high dissociative/ high hypnotizables (HD highs,  $n = 9$ ). Mean age was virtually equal across the four groups, and there was a majority of females in all groups (with no male among the LD highs). Each individual except one were right-handed, as measured by a handedness questionnaire (Chapman & Chapman, 1987).

## Materials

**Dissociative Experiences Scale (DES).** The DES is a 28-item scale that was developed to measure dissociation in non-clinical and clinical populations (Bernstein & Putnam, 1986; Carlson & Putnam, 1993). The Swedish version (Körlin, Edman, & Nybäck, 2007), the S-DES, is a scale with good psychometric properties. Participants rate the extent they have had different dissociative experiences on an 11-point scale from 0 to 100 percent, with the individual outcome measure being the mean of all ratings. Participants were

designated as high in dissociation if their DES scores were above a cut-off value of 20, following previous research (Giesbrecht, & Merckelbach, 2009).

**Harvard Group Scale of Hypnotic Susceptibility, Form A (HGSHS: A).** The HGSHS: A (Shor & Orne, 1962) is a standardized measure of hypnotizability developed for use with groups. It was used as an initial screening measure for this study. The measure consists of twelve suggestions of varying difficulty level. Outcomes scores range from 0 to 12 with scores of 0 to 3 taken to reflect low hypnotizability and scores of 9 to 12 taken to reflect high hypnotizability.

**Phenomenology of Consciousness Inventory.** The PCI (Pekala, 1991) is a valid and reliable self-report questionnaire completed in reference to a preceding stimulus condition. Each of the 53 items provides two opposite statements separated by a seven-point likert scale. The PCI assesses 12 major dimensions of consciousness and 14 sub-dimensions. The dimensions (and sub-dimensions) are: Positive affect (joy, sexual excitement, and love), negative affect (anger, sadness, and fear), altered experience (body image, time sense, perception, and meaning), visual imagery (amount, vividness), attention (direction, absorption), self-awareness, altered state, internal dialogue, rationality, volitional control, memory, and arousal.

**Sustained Attention to Response Task (SART).** This auditory modification of the visual SART task (Robertson et al., 1997) was administered on a PC computer. The task was created with E-Prime v. 2 (Psychological Software Tools, Pittsburgh, PA). This modification of the task included auditory stimuli, consisting of digits 0-9 in Swedish, recorded in Audacity 1.2.6 by a female voice. Digits were played serially for 450 ms through headphones with inter-stimulus intervals of 900ms. The task was to respond by a key press to each digit as soon as the respondent heard the digit unless it was number three for which the participant was asked to withhold response. Consequently, digit three was designated as the target with

the remaining digits serving as non-targets. The task consisted of 15 blocks, each of which included 20 randomly ordered digits. Five blocks included two targets each and ten blocks included one target each. The participants were asked to give equal weight to accuracy and speed of response. Each participant also completed a practice block with two targets out of 20 digits.

**Room layout and ganzfeld equipment.** A sound-attenuated laboratory room was used in this study. It contained a reclining chair that allowed the participants to adjust the position of the chair as they preferred. The ganzfeld setup included a set of headphones (Steelseries 5H V2) with a pullout microphone and a pair of anatomically shaped halves of ping pong balls that the participants were asked to tape over their eye orbits. The auditory ganzfeld stimulus consisted of pink noise whereas the visual stimulus consisted of two 40-watt light bulbs providing a red light directed at the participants from a comfortable distance.

## **Procedure**

At the first stage, my supervisors administered the HGSHS: A. Subsequently, volunteers were recruited by phone or email, being asked to participate in a psychological study addressing relaxation and awareness. Each volunteer participated in an individual session.

Each session started with instructions of the SART followed by a practice block. The SART was presented as an awareness task with no mention of mind-wandering. Once the practice block was finished participants completed a handedness questionnaire (Chapman & Chapman, 1987).

Subsequently, the ganzfeld and the control (i.e., sitting relaxed with closed eyes) condition followed in a counterbalanced fashion across high and low hypnotizables. Each condition was presented as a “relaxation exercise” and included three phases:

The first phase consisted of 10 minute and 30 seconds of relaxation instructions with looping water waves as background sound. The conditions only differed in one way during this phase; the homogeneous red light in the ganzfeld versus closed eyes in the control condition.

The second phase consisted of 20 minutes of mentation reports, where each participant was asked to report ongoing experiences (i.e., “thinking-out-loud,” Pekala & Cardeña, 2000). Each participant was instructed to report any impression from “outside” (e.g., sensory impressions) and from “inside” (e.g., thoughts, emotions, and bodily signals). They were encouraged to filter as little as possible. During this phase, the conditions differed in two ways: The homogenous red light and pink noise in the ganzfeld versus closed eyes and no sound in the control.

The third phase consisted of 6 minutes and 45 seconds of the SART task. As background noise has been shown to influence cognitive performance in tasks similar to the SART (e.g., Soderlund, Siktstrom, & Smart, 2007), it was decided that the noise should be included in both conditions during this phase. Otherwise, any difference between the conditions could be caused by a difference in background noise rather than the induction per se. Consequently, the conditions differed in only one way during this phase: The homogeneous red light in the ganzfeld versus closed eyes in the control.

Subsequently, participants completed the PCI in reference to the preceding condition. Two versions of the PCI (i.e., forms 1 and 2; Pekala, 1991) were counterbalanced across participants and conditions. The second condition proceeded analogously, and condition order was counterbalanced across participants. Finally, after completing both conditions,

participants were given the S-DES and asked to bring it to another session (for an unrelated study).

### **Planned Analyses**

**Mind-Wandering.** A 2 x 2 x 2 mixed ANOVA was conducted with Hypnotizability and Dissociation as between-subjects variables (high vs. low hypnotizability and high vs. low dissociation), Condition as within-subjects measure (ganzfeld vs. control) and number of commission errors in the SART task as the dependent variable (DV).

Analyses were also conducted for responses to non-targets in the SART task. In accord with previous research (Cheyne et al., 2009), responses to non-targets that were below 100ms were defined as anticipations, whereas responses between 100 and 200ms were considered ambiguous and were therefore excluded from analysis. Omissions were defined as absent responses to non-targets. Mean response time (RT) and coefficient of variability (CV, equal to  $SD/M$ ) were calculated for non-target responses that exceeded 200ms. Correlations were computed between mean CVs, anticipations, omissions, and commission errors.

**Alterations of consciousness.** The planned analyses were divided into two separate MANOVAS. The first attempted to replicate the three major dimensions that Rock et al. (2008) found to be significantly different between ganzfeld and control, namely altered experiences, altered states, and imagery. The second attempted to explore dimensions that have been inconsistently or suggestively related to the ganzfeld context, namely positive and negative affect (Rock et al., 2008; Tsuji et al., 2004), self-awareness & arousal (Rock et al., 2008; Vaitl et al., 2005). Thus, two multivariate repeated measures ANOVAs (2 x 2 x 2), with Hypnotizability (high vs. low) and Dissociation (high vs. low) as between-group factors, and Condition (ganzfeld vs. control) as within-group factor, were conducted with altered experiences, altered states and imagery as the DVs in the former and positive affect, negative

affect, self-awareness, & arousal as the DVs in the latter. An alpha level of .05 was used in all planned analyses

## Results

### Mind-Wandering

All in all, 29 participants completed the SART once during each condition, although missing data required one case to be dropped from the analysis. Participants made on average 10.82 commission errors out of 40 targets (27.05 %,  $SD = 7.52$ ). Descriptive statistics regarding RTs, CVs, anticipations, omissions, and commission errors are given in Table 1.

*Table 1*

*Means and Standard Deviations of RT, CVs, anticipations, omissions and commission errors for each Condition (n = 28)*

SART variable	Condition			
	<u>Ganzfeld</u>		<u>Control</u>	
	M	SD	M	SD
RT	413.60	75.10	409.11	72.13
CV	0.22	0.07	0.23	0.08
Anticipations	1.61	7.35	2.82	10.31
Omissions	5.00	6.63	3.79	4.12
Commission errors	5.04	3.50	5.79	4.49

To test the assumption that commission errors in this study reflected episodes of mind-wandering, commission errors was correlated with CV, anticipations, and omissions,

respectively. In line with previous findings (Cheyne et al., 2009), these four variables significantly correlated with each other, as can be seen in table 2.

*Table 2*

*Pearson Correlation Coefficients for CV, Anticipations, Omissions, and Commission Errors*  
( $p < .01$  for all correlations)

	RT CV	Anticipations	Omissions	Commissions
RT CV		.82	.68	.75
Anticipations			.70	.62
Omissions				.61
Commissions				

As was illustrated in Table 1, participants made slightly fewer commission errors in the ganzfeld than the control condition. The MANOVA yielded a suggestive main effect for condition ( $F [1, 24] = 3.98, p = .058, \eta_p^2 = .14$ ). The MANOVA yielded no main effect for Hypnotizability ( $F [1, 24] = 0.26, p = .873, \eta_p^2 = .00$ ), but a significant interaction between Hypnotizability and Condition ( $F [1, 26] = 8.63, p = .007, \eta_p^2 = .26$ ). Highs made more commission errors ( $M = 6.07, SD = 3.56$ ) than the lows ( $M = 4.00, SD = 3.23$ ) during ganzfeld stimulation. However, in the control condition lows committed more errors ( $M = 6.14, SD = 4.19$  for the lows;  $M = 5.43, SD = 4.91$  for the highs).

High dissociative individuals (HDs) made non-significantly more commission errors than low dissociative (LDs) for both conditions ( $F [1, 24] = 1.13, p = .299, \eta_p^2 = .05$ ). This



difference was slightly larger in the ganzfeld ( $M = 6.31$ ,  $SD = 3.28$  vs.  $M = 3.93$ ,  $SD = 3.41$ ) than in the control ( $M = 6.23$ ,  $SD = 5.25$  vs.  $M = 5.40$ ,  $SD = 3.87$ ) condition, but the Condition X Dissociation interaction did not achieve statistical significance ( $F [1, 24] = 2.85$ ,  $p = .328$ ,  $\eta_p^2 = .04$ ). However, a three-way interaction was found between hypnotizability, dissociation and condition ( $F [1, 24] = 4.41$ ,  $p = .046$ ,  $\eta_p^2 = .16$ ). This interaction is illustrated in figure 1, and was followed up with multiple comparisons between difference scores (i.e., ganzfeld-control) for each group. HD highs had a significantly higher different score than LD lows ( $p = .026$ ), and HD lows ( $p = .013$ , bonferroni corrected  $\alpha$ ). Although LD highs had a negative difference score, they did not significantly differ from HD highs ( $p = .214$ ).

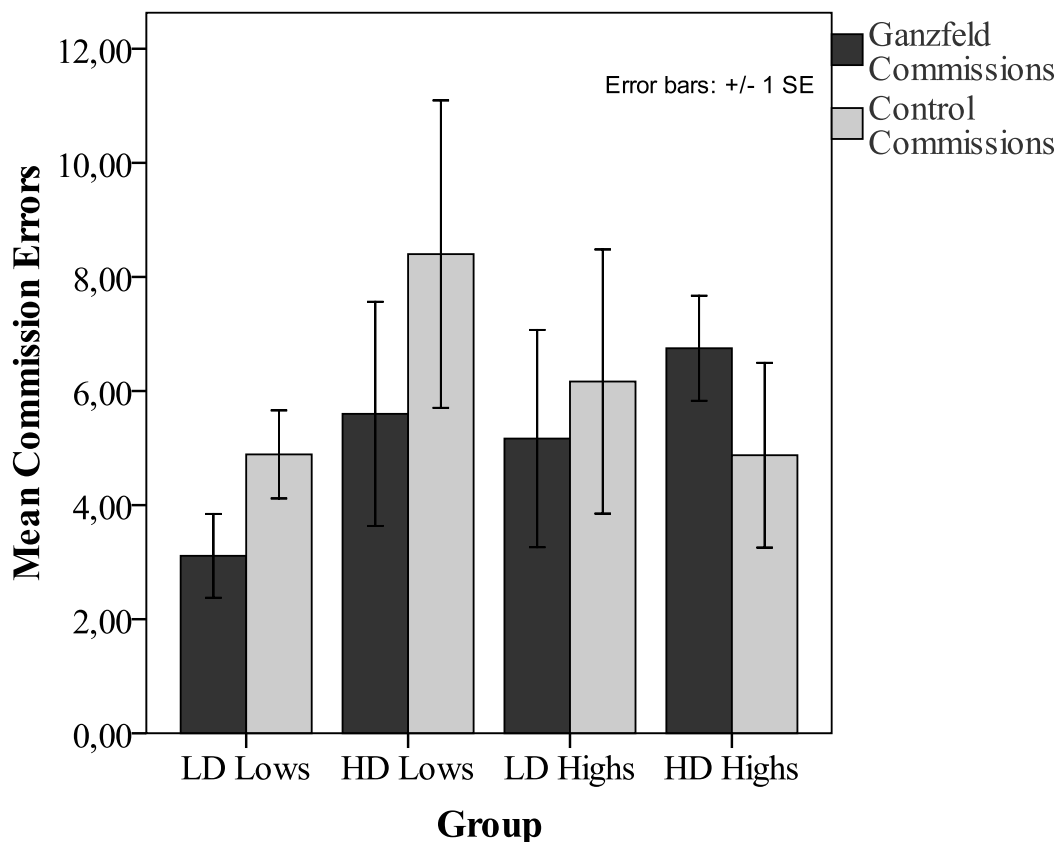


Figure 1. Average Commission Errors across Levels of Hypnotizability (highs vs. lows), Dissociation (LD vs. HD) and Condition (ganzfeld vs. control).

### Alterations of Consciousness

All 29 participants completed the PCI in reference to each condition. One respondent had a reliability index score of 2.40 which is above the suggested cut-off (Pekala, 1991). Since the sample size is relatively low and the case did not substantially alter the results it was kept in the analysis.

As shown in Table 3, highs reported more altered experiences and altered states than lows did, in both ganzfeld and the control condition. Although highs in overall reported more imagery than lows, it was unexpected that highs would report less imagery in the ganzfeld relative to the control.

*Table 3*

*Means and Standard Deviations for Reported Altered Experiences, Imagery Intensity, and Altered States across Conditions and Levels of Hypnotizability*

PCI Dimension	<u>Ganzfeld</u>				<u>Control</u>			
	<u>Highs</u>		<u>Lows</u>		<u>Highs</u>		<u>Lows</u>	
	M	SD	M	SD	M	SD	M	SD
Altered experiences	2.75	1.24	1.81	0.94	2.54	1.31	1.45	0.93
Imagery intensity	3.04	1.44	2.75	0.98	3.52	1.40	2.21	1.22
Altered States	3.55	1.76	2.24	1.46	2.88	1.41	1.90	1.53

A Condition x Hypnotizability x Dissociation MANOVA with Altered experiences, Imagery intensity, and Altered states of awareness as DVs yielded no effect for Condition ( $F [3, 23] = 0.73, p = .580, \eta_p^2 = .08$ ), a suggestive main effect for Hypnotizability ( $F [3, 23] = 2.49, p = .086, \eta_p^2 = .25$ ), and no main effect for Dissociation ( $F [3, 23] = 1.57, p = .223, \eta_p^2 = .17$ ). A two-way interaction between Condition and Hypnotizability was not significant ( $F [3, 23] = 1.50, p = .242, \eta_p^2 = .16$ ), but a suggestive interaction effect was found for Condition and Dissociation ( $F [3, 23] = 2.83, p = .061, \eta_p^2 = .27$ ). The three-way interaction between Condition, Hypnotizability, and Dissociation was non-significant ( $F [3, 23] = 2.27, p = .107, \eta_p^2 = .23$ ).

The suggestive between-subjects effect for Hypnotizability on Altered experiences, Imagery intensity, and Altered states was followed up with a 2 x 2 ANOVA for each dimension. Highs reported significantly more altered experiences and altered states than lows ( $F [1, 25] = 6.47, p = .018, \eta_p^2 = .21$  for each dimension) but only suggestively more imagery ( $F [1, 26] = 3.51, p = .073, \eta_p^2 = .12$ ).

The suggestive Condition x Dissociation interaction was followed up by separate 2 x 2 ANOVAs for each dimension. A significant two-way interaction was found in terms of Altered experiences ( $F [1, 27] = 5.73, p = .024, \eta_p^2 = .18$ ). Specifically, HDs reported more altered experiences in the ganzfeld relative to control ( $F [1, 13] = 6.15, p = .028, \eta_p^2 = .32$ ), whereas LDs did not differ between conditions ( $F [1, 14] = 0.41, p = .514, \eta_p^2 = .03$ ). Furthermore, HD highs and LD highs significantly differed in their pattern of experiences ( $F [3, 11] = 5.78, p = .013, \eta_p^2 = .61$ ). This can be seen in figure 2 that also shows levels of hypnotizability. Interestingly, all four groups reported more altered experiences in the ganzfeld compared to the control, except LD highs which showed the reversed pattern.

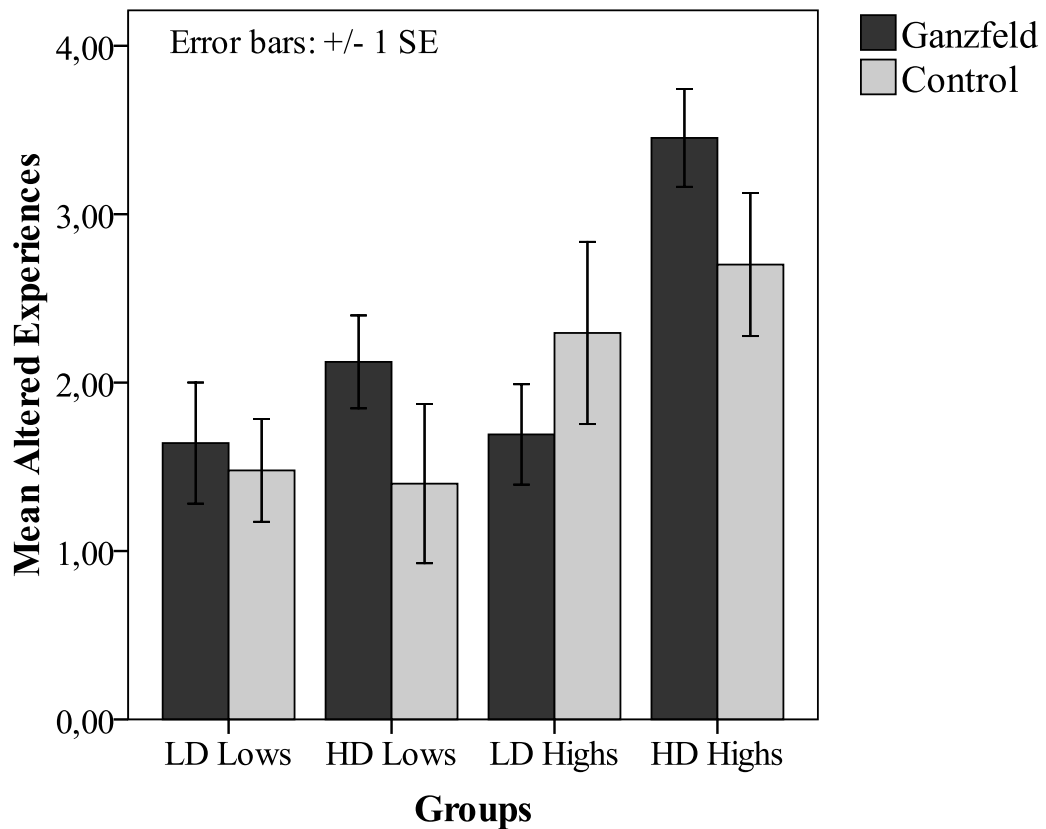


Figure 2. Average Altered Experiences across Levels of Hypnotizability (highs vs. lows), Dissociation (LD vs. HD) and Condition (ganzfeld vs. control).

The 2 x 2 x 2 MANOVA with Positive affect, Negative affect, Self-awareness, and Arousal as DVs yielded no significant main effects of Condition ( $F [4, 22] = 2.10, p = .116, \eta_p^2 = .28$ ), Hypnotizability ( $F [4, 22] = 0.84, p = .518, \eta_p^2 = .13$ ), nor Dissociation ( $F [4, 22] = 0.84, p = .167, \eta_p^2 = .25$ ). Similarly, there were no significant two-way or three-way interactions (all  $ps > .24$ ).

In order to explore the potential causes for the interaction between hypnotizability, dissociation and commission errors, behavioral data from the SART task was correlated with experiential data from the PCI. As can be seen in Figures 1 and 2, HD highs and LD highs

showed opposite patterns on both dependent variables. HD highs reported more altered experiences and made more commission errors in the ganzfeld than control, whereas LD highs made fewer errors and reported less altered experiences. As it is hypothesized that alterations in consciousness influence mind-wandering, SART commission errors was correlated with the reported altered experiences. Accordingly, difference scores (i.e., ganzfeld – control) were computed for commission errors and reported altered experiences, respectively. These two variables were significantly correlated, but only for the highs ( $r = .67, p = .008$  for the highs;  $r = -.17, p = .56$  for the lows). Using r-to-Z transformations, these two correlations were significantly different,  $Z = 2.35, p = .018$ . Thus, those highs who reported more altered experiences in the ganzfeld relative to the control also tended to make more commission errors in the ganzfeld. However, difference scores in altered experiences also correlated with difference scores in negative affect ( $r = .68, p = .007$ ) for the highs, and differences scores in negative affect also correlated with commission error difference scores ( $r = .66, p = .010$ ). Neither negative affect nor altered experiences correlated with commission errors when partialing out the variance from the other variable.

## Discussion

The ganzfeld and control condition did not significantly differ in terms of performance on the SART. However, as hypothesized, high and low hypnotizable individuals showed significantly different patterns of MW across conditions. Highs committed more errors in the SART during ganzfeld stimulation relative to the control, whereas lows committed fewer errors in the ganzfeld. This study also found an interaction between hypnotizability, dissociation and condition in terms of MW. Specifically, HD highs committed more errors in the ganzfeld relative to the control, whereas LD lows, HD lows and LD highs committed fewer errors in the ganzfeld.

In terms of altered experiences, there was no significant difference between the ganzfeld and control. Contrary to expectations, conditions did not significantly influence experiences across levels of hypnotizability and dissociation. However, the two-way interaction between condition and hypnotizability was suggestive with a moderate effect-size. The interaction between condition and dissociation was also suggestive with a moderate effect-size. A larger sample might therefore have yielded a significant outcome.

It is interesting, given the literature on heterogeneity in high hypnotizable individuals, that HD highs and LD highs demonstrated significant differences outside the hypnotic context. MANOVA analyses yielded a significant difference in terms of PCI reports. In overall, HD highs reported more alterations of consciousness in the ganzfeld relative to the control, whereas LD highs reported less in the ganzfeld.

It was surprising that lows performed the SART so differently across conditions, as it was expected that they would experience the ganzfeld and control similarly. Interestingly, this difference between conditions did not correlate with differences in altered experiences, whereas it did for the highs. Thus, it is likely that the lows' episodes of MW had other causes than the highs'. A speculative hypothesis is that lows' commission errors resulted more from typical laboratory-unrelated thoughts (e.g., thinking about what to eat for dinner) whereas highs' errors resulted more from engaging in vivid imagery, altered perceptual experiences, and so on. The fact that lows made fewer errors in the ganzfeld could be because it was a novel environment and that the noise in the induction phase prevented them more from drifting away and attending to personal concerns as much as in the control condition. The impact that different types of MW have on task performance is a research question that deserves more attention and these two populations might be especially suitable for research on that question.

The lack of significant interactions between condition, hypnotizability and dissociation in terms of the PCI reports gives rise to several potential concerns about the different aspects of the induction design.

**Minimized expectancy effects.** On the one hand, demand characteristics are reduced when minimizing participant's expectancies of entering an ASC. On the other hand, expectancy itself is a relevant component in the induction of an ASC (Ludwig, 1969, but see also Lynn, Kirsch, & Hallquist, 2008). As this study aimed for a relatively low level of expectation (e.g., by presenting the inductions as two "relaxing exercises"), it is possible that the PCI effects were attenuated. It is also plausible that some individuals were anticipating the forthcoming SART when undergoing induction. In terms of Tart's (1983) stabilization processes, "negative feedback" could be occurring if a participant wanted to stay alert for the SART task knowing that he or she might not perform well otherwise.

**Mentation reports during the induction.** Little is known about the potential influence of mentation reports on ganzfeld experiences. Insofar as ASCs may be associated with reduced metacognition, there may be some metacognizing while thinking-out-loud, which in turn reduces the potential to enter an ASC. However, mentation reports did not eliminate an effect between high and low hypnotizables in the hypnosis study by Cardeña et al. (2007). A difference from this study is that participants in Cardeña et al.'s study were asked to report every five minutes, whereas participants in this study were asked to report continuously. Another plausible issue is that participants' own voice disrupted the perception of homogeneity, which, unlike that of hypnosis, is an essential component of the ganzfeld. Thus, mentation reports might have more influence on experiences during ganzfeld than hypnosis. However, the MW part of this study also compromised with auditory homogeneity

since the SART stimuli were auditory, but did not eliminate an effect. Having no online verbal reports during induction would therefore be an interesting follow up to this study.

**Control condition being more than a “control”.** For the ganzfeld condition, the highs reported similar levels of altered experiences as the respondents did in Rock et al.’s study (2008). A larger difference between the studies was found within the control condition where highs in this study reported larger degrees of altered experiences ( $M = 2.54$ ,  $SD = 1.26$ ), than the overall sample in Rock et al.’s study ( $M = 1.90$ ). As the relaxation instruction, which was included in both conditions in this study, is similar to standardized hypnotic inductions (e.g., focusing on specific parts of the body and giving mild suggestions to feel warm), this could be sufficient for highs to have altered experiences (see also Hilgard & Tart, 1966). However, it is also plausible that this study eliminated an artificial effect in previous studies that had no induction in the control condition. A 2 x 2 design with condition (ganzfeld vs. control) and induction (present vs. absent) has the potential to resolve this issue.

In sum, although some interactions between condition, hypnotizability, and dissociation were found regarding the PCI reports, the proposed improvements might clarify these findings. Nevertheless, a number of interesting effects were found in this study, particularly the effect that the ganzfeld induction had on MW. High and low hypnotizables showed reversed pattern of performance on a MW task being performed during two different state conditions. This finding emphasizes the need to acknowledge that individuals’ cognition may differ substantially across states or conditions. It also provided an interesting platform for further research on the impact different types of experiences may have on MW. It is intriguing that performance in the MW task correlated with reported altered experiences among highs, but further investigation is needed to find causal links behind this relationship.



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