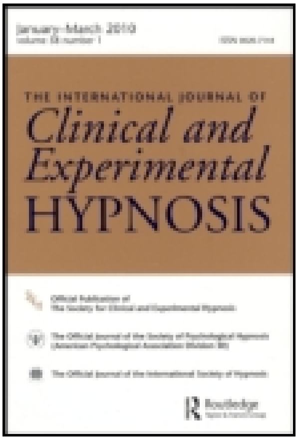

International Journal of Clinical and Experimental Hypnosis
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/nhyp20

A Randomized Controlled Trial of the Effects of Hypnosis With 3-D Virtual Reality Animation on Tiredness, Mood, and Salivary Cortisol

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Version of record first published: 20 Nov 2010

Intl. Journal of Clinical and Experimental Hypnosis, 59(1): 122–142, 2011

ISSN: 0020-7144 print / 1744-5183 online
DOI: 10.1080/00207144.2011.522917

A RANDOMIZED CONTROLLED TRIAL OF THE EFFECTS OF HYPNOSIS WITH 3-D VIRTUAL REALITY ANIMATION ON TIREDNESS, MOOD, AND SALIVARY CORTISOL[1]

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Abstract: Case studies suggest hypnosis with a virtual reality (VR) component may be an effective intervention; although few follow-up randomized, controlled trials have been performed comparing such interventions with standard hypnotic treatments. Thirty-five healthy participants were randomized to self-hypnosis with VR imagery, standard self-hypnosis, or relaxation interventions. Changes in sleep, cortisol levels, and mood were examined. Self-hypnosis involved 10- to 20-min. sessions visualizing a healthy immune scenario. Trait absorption was also recorded as a possible moderator. Moderated regression indicated that both hypnosis interventions produced significantly lower tiredness ratings than relaxation when trait absorption was high. When trait absorption was low, VR resulted in significantly higher engagement ratings, although this did not translate to demonstrable improvement in outcome. Results suggest that VR imagery may increase engagement relative to traditional methods, but further

Manuscript submitted February 10, 2010; final revision accepted March 17, 2010.
[1]This work was funded by a grant from the European PRESENCCIA project (IST-027731).
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investigation into its potential to enhance therapeutic efficacy is required.

The effectiveness of hypnosis in eliciting positive change frequently has been shown to be moderated by the psychological characteristics of the recipient. Low hypnotic susceptibility as a limitation of hypnotherapy has been recognized since the time of Freud, with the consequence that there have been numerous attempts to increase susceptibility through training courses with relaxation, biofeedback, and cognitive training (Batty, Bonnington, Tang, Hawken, & Gruzelier, 2006; Gearan & Kirsch, 1993). Several studies have found that changes in immune parameters following hypnotic visualization were more pronounced in those with high hypnotic susceptibility (Johnson, Walker, Heys, Whiting, & Eremin, 1996; Zachariae et al., 1994). In addition, high levels of trait absorption, ability to engage in vivid mental imagery and openness to experience have also been shown to further enhance the positive effects of hypnosis on mood, sleep, and immune function (Gregerson, Roberts, & Amiri, 1996; Kwekkeboom, Huseby-Moore, & Ward, 1998; Thompson, Steffert, & Gruzelier, 2009; Watanabe et al., 2006). In fact, those low in such imaginative absorption-like traits have often shown little or no benefits in response to hypnosis in such studies. This suggests that hypnotic interventions could be of limited utility for such individuals.

One technique that could be potentially useful for those low in imaginative absorption is the use of virtual reality (VR) technology. If hypnotic imagery presented through a VR medium can provide greater engagement and assist with the generation of mental imagery, such a technique may be particularly beneficial when trait imaginative absorption is low. If low absorbers are presented with compelling visual and auditory stimuli then, in theory, the less they should have to rely on their own imagination (Askay, Patterson, & Sharar, 2009). VR case studies and case series have been reported with burn patients to alleviate pain and anxiety (Askay et al., 2009; Patterson, Tininenko, Schmidt, & Sharar, 2004; Patterson, Wiechman, Jensen, & Sharar, 2006, 2009) and to alleviate stress in autism (Austin, Abbott, & Carbis, 2008). There is also relevance for posttraumatic stress syndrome where both VR and hypnosis applications have been established independently (Gruzelier, 2006).

Although such case studies are highly informative, follow-up research employing larger sample sizes and examining the efficacy of VR relative to standard treatments is clearly required. A recent randomized controlled study by Patterson, Jensen, Askay, and Sharar (2010) examined the effect of various treatments on the pain ratings of 21 hospitalized trauma patients. The study found that standard care plus VR hypnosis with analgesic suggestion resulted in significantly lower pain intensity and pain unpleasantness relative to standard care alone or VR hypnosis without analgesic suggestion. While the results of this study are extremely promising, further research is needed to corroborate such findings and to examine the therapeutic potential of VR in other domains. It would also be especially informative to examine whether immersive VR treatments are best directed towards particular personality types, such as those low in imaginative absorption, and whether benefits can be replicated in nonclinical populations where experimental parameters are more easily controlled. One recent study compared the effects of an immersive 2-D animation-assisted hypnosis against a traditional audiotaped hypnosis treatment and a no-intervention control group in 35 undergraduates who varied in their level of the personality characteristic openness to experience. Outcome measures were immune function and mood (Thompson et al., 2009). The hypnotic visualization scenarios depicted a healthy immune system combating invading viruses, an especially popular intervention in oncology treatment (Simonton, Matthews-Simonton, & Creighton, 1978). Results indicated that when openness to experience was high, those undergoing the traditional audiotape procedure were less tired and showed greater upregulation of cortisol relative to the control group. Importantly, no benefits were observed for the 2-D-animation group for those low or high in openness to experience. However, 2-D screen animations may not be sufficiently immersive and may fail to present compelling enough visual stimuli to capture attention (Askay et al., 2009). As the study did not provide a measure of engagement, the immersive qualities of the animation used cannot be assessed.

The aim of the current study was to tackle the limitations of the 2-D animated imagery study (Thompson et al., 2009) and, within a randomized controlled trial design, examine the efficacy of hypnosis with a VR component on both depth of engagement and outcome measures of sleep, mood, and cortisol in individuals high and low in imaginative trait absorption. Specifically we extended the study by (a) using a more immersive VR technology to induce greater engagement and assist creative visualization and (b) providing a laboratory self-rating scale to measure psychological engagement. We employed a 3-D virtual reality animation viewed through a head-mounted display with immersive sound. As with the 2-D animation study, we measured salivary cortisol, tiredness/sleep, and energy/stress and assessed absorption with the Tellegen and Atkinson (1974) Trait Absorption Scale. Psychology first-year undergraduates were randomized to one of three intervention groups receiving 10 sessions of either self-hypnosis with VR-animated imagery, self-hypnosis with traditional audio imagery, or relaxation training. We hypothesized that (a) VR-animated imagery would produce higher engagement ratings than traditional audio imagery, especially for those low in trait absorption. Given previous findings, we also predicted that (b) both VR-animated imagery and audio-imagery hypnosis would produce more positive changes in outcome measures relative to the relaxation control group, especially for those high in trait absorption.

Method

Participants

The sample consisted of 35 participants (28 females and 7 males) randomly allocated to one of three groups: animated imagery ($n = 12$), verbal imagery ($n = 12$), or relaxation ($n = 11$). Randomization was performed with a computer-generated procedure available at www.randomization.com. All participants were first-year psychology undergraduates from a London university with a mean age of 22.1 ($SD = 3.4$). Exclusion criteria were Sjörgren's syndrome, which inhibits production of saliva, and the use of corticosteroid drugs, which can alter cortisol level (e.g., asthma/allergy medication).

Self-Hypnosis Groups

Animated immune imagery was presented as a 3-D virtual reality display using a head-mounted display (HMD). The HMD was an eMagin Z800 3-D Visor that has one 800x600 screen for each eye. The 3-D Visor provides head rotation that we used to change the view as the user moved one's head. The simulation ran at the frame rate of the display (i.e., 60 Hz). An immersive soundtrack of relaxing music was presented to the user via headphones during the animation. The animation itself consisted of a 4-minute sequence and depicted invading germ cells being progressively destroyed by white blood cells. The sequence began with 8–10 germ cells and one white blood cell and finished with multiple white blood cells and no germ cells (see Figures 1 and 2). Immediately before the imagery sequence, participants listened to 10 minutes of general relaxation audio, based on Gruzelier, Levy, Williams, and Henderson (2001) and aimed to create a deeply relaxed self-hypnotic state with instructions directed at improving energy levels, concentration, and attention. Immediately after the imagery sequence, participants were asked to close their eyes and to spend a couple of minutes visualizing these images again. Five minutes of relaxation audio then followed. The entire session lasted approximately 20 minutes. Ten sessions of such training were administered.

The procedure for the verbal imagery condition was identical to that of the animated imagery, but with a 4-minute verbal imagery sequence replacing the animated imagery. Imagery encouraged participants to generate symbolic mental images of a strong healthy immune system

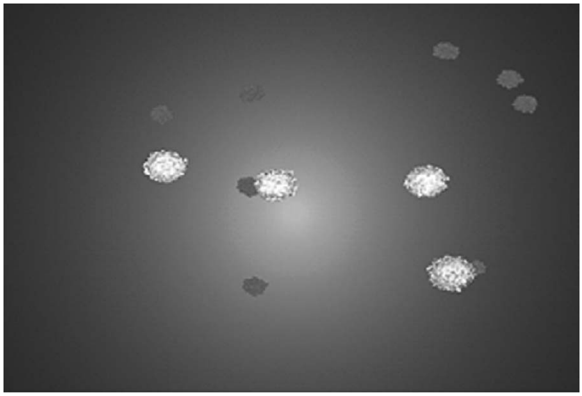

Figure 1. **Early stages of animation depicting white blood cells destroying germ cells.**

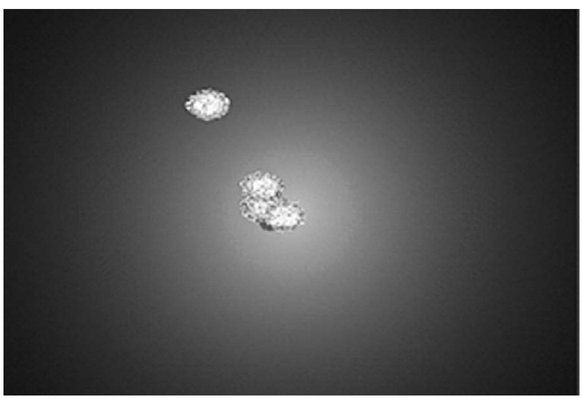

Figure 2. **End of animation where all germ cells have been destroyed.**

fighting off infection (e.g., "Imagine your immune system as strong healthy dolphins swimming around the blood stream destroying germ cells"). This imagery has been used in several previous studies to precipitate changes in immune parameters (Gruzelier, Smith, Nagy, & Henderson, 2001; Thompson et al., 2009).

The procedure for the relaxation control group was identical to the imagery groups except that the immune-specific imagery component was replaced with 4 minutes of relaxation instructions.

Questionnaires

Engagement. A four-item scale was constructed to measure the degree of perceived engagement in the immune imagery (see Appendix A). Each item was scored on a 7-point scale, with all four items aggregated to give a single score. Scale specification was determined in consultation with researchers and expert performers at a leading performing arts college based on components considered to constitute states of engagement. Item content assessed the following four components: psychological engagement, vividness of imagery, freedom from distraction, and sustained concentration. Analysis of the scale from the current data demonstrated good psychometric properties and is reported in the results section.

Pittsburgh Sleep Quality Index. The Pittsburgh Sleep Quality Index (PSQI; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) is a self-report measure used to measure several components of sleep quality and has demonstrated good reliability and validity in clinical and nonclinical populations (Aloba, Adewuya, Ola, & Mapayi, 2007; Shochat, Tzischinsky, Oksenberg, & Peled, 2007). Based on a previous study, only the overall sleep quality and tiredness items were administered to participants in order to minimize the chance of Type I errors (Thompson et al., 2009). In keeping with Thompson et al., the original 4-point ordinal rating scale was adapted to a more sensitive continuous scale of number of days that sleeplessness symptoms had been experienced over the previous week.

Trait Absorption Scale. The Trait Absorption Scale (TAS; Tellegen & Atkinson, 1974) scale consists of 34 items summated to provide an overall measure of an individual's capacity to become absorbed or "imaginatively involved." Concurrent validity of the scale is good with moderate to strong correlations demonstrated with the related constructs of hypnotizability and facets of openness that relate to imaginative involvement (Glisky, Tataryn, Tobias, Kihlstrom, & McConkey, 1991). Tellegen (1982) reported a high level of internal reliability ($r = .88$) and test-retest correlation coefficient ($r = .91$) for the scale.

Depression, Anxiety, and Stress Scale–Short Form. The Depression, Anxiety, and Stress Scale–Short Form (DASS–SF; Lovibond & Lovibond, 1995) consists of 21 items designed to measure the three components of depression, anxiety, and stress experienced over the previous week. The DASS–SF has demonstrated excellent reliability and validity in both clinical and nonclinical groups (Clara, Cox, & Enns, 2001).

Activation-Deactivation Adjective Check List. The Activation-Deactivation Adjective Check List (AD–ACL; Thayer, 1967) is a self-report instrument designed to measure mood and arousal and consists of four subscales: energy, tiredness, tension, and calmness. The AD–ACL has demonstrated good reliability and convergent validity (Thayer, 1967).

Cortisol Assessment

Sarstedt salivettes were used to collect saliva for subsequent cortisol analysis, with each participant providing two samples at both pre- and postassessment. After the participant had chewed on a cotton swab for 1 to 2 minutes, the swab was returned to the salivette and all samples stored at −20°C. Cortisol analysis was performed en masse at the end of the study by the department of clinical biochemistry, Newcastle upon Tyne Hospital. ELISA kits were used for cortisol assessment, with samples analyzed in triplicate. Cortisol readings for Samples 1 and 2 were highly correlated at both assessment periods (rs $>$ .80, $p < .01$) and were thus averaged to give mean pre- and mean postassessment cortisol readings for each participant.

Postassessment collection of saliva time was time matched to within half an hour of that of preassessment, with all sampling taking place from 11 a.m. to 3 p.m. To minimize the possible influence of extraneous factors on cortisol measurement, participants were asked to abstain from caffeine, food, and exercise at least 2 hours prior to assessment and to have been awake for at least 90 minutes. A short self-report checklist asked participants whether they had followed the restrictions and not to worry if they had been unable to. Participants were also asked to indicate how many hours of sleep they had had the night before, their level of perceived stress on a 10-point scale, and details of any medication taken in the previous 48 hours. Although not physiologically validated, all participants reported compliance with restrictions and no use of medication. One-way analysis of variance (ANOVA) indicated no significant differences across the self-hypnosis groups in stress or hours of sleep.

Procedure

All experimental procedures conformed to the ethical standards laid down by the Helsinki Declaration, with ethical approval obtained from the Research Ethics Committee, Goldsmiths, University of London. All participants provided their written informed consent prior to inclusion in the study. Preassessment consisted of completion of the cortisol checklist, PSQI, DASS–SF, and TAS, with participants providing one saliva sample at 20 minutes and a second sample at 40 minutes. Participants then returned for 10 self-hypnosis sessions, with each session taking place in a quiet room at a comfortable temperature and lasting around 20 minutes. The mean interval between sessions was 4.1 days (*SD* = 2.1). Immediately before each session, participants completed the AD–ACL mood scale. Immediately after each session, participants again completed the AD–ACL with those in the animated and verbal imagery groups also completing the engagement measure. Postassessment was administered within 1 week of the final self-hypnosis session and was identical to preassessment except for the omission of the TAS.

Results

Analytical Method

1. To examine the hypothesis that the effect of imagery format on engagement would be dependent upon trait absorption, moderated regression analysis was performed on the subset of participants who received immune imagery (i.e., relaxation controls were excluded). The dependent variable was engagement with predictors of imagery format (animated vs. verbal), trait absorption, and an Imagery × Trait Absorption interaction term. In line with Cohen Cohen, West, and Aiken (2003), the interaction term was created by cross-multiplication of imagery and the centered absorption scores.
2. To determine whether the effect of self-hypnosis on outcome measures was influenced by trait absorption, moderated regression analysis was also performed separately on outcome change score for cortisol, sleep, and stress variables. Change scores were created by subtracting preassessment from postassessment values. As self-hypnosis (animation/verbal/relaxation) is a categorical variable with more than two levels, this was recoded into two separate dummy-coded predictors of "animation vs. control" and "verbal vs. control" (Cohen et al., 2003). Two interaction terms were then created by multiplying each dummy-coded predictor with centered trait absorption scores. Hierarchical regression was performed by entering trait absorption in Stage 1, the two dummy-coded predictors in Stage 2, and the interaction terms in Stage 3 (Cohen et al., 2003). A significant change in R^2 indicates a significant main effect of self-hypnosis (Stage 2) or a significant interaction (Stage 3).

Data Screening

Boxplots revealed one univariate outlier for cortisol change ($z = -3.12$) and one for tiredness change ($z = +3.31$). Each value was winsorized to the next highest change value for that variable to ameliorate any disproportionate influence on the analysis (Tabachnick & Fidell, 2007). Scatterplots of residuals from the main regression analyses revealed assumptions of normality and homoscedasticity were met for each dependent variable with no nonlinear relationships observed.

Controls

To check that self-hypnosis groups did not differ on baseline characteristics, a one-way ANOVA with self-hypnosis (animated/verbal/control) as the independent variable (IV) was performed on preassessment measures of cortisol, PSQI, DASS–SF, absorption, age as well as mean intersession interval (days). No significant effects emerged (all Fs < 4.00, ps $= ns$). In addition, chi-square analysis showed that gender distribution did not differ significantly across imagery groups, $\chi^2(2, N = 35) = .29$, $p = .86$.

Analysis of Engagement Ratings

As the engagement scale was a newly constructed measure, its psychometric properties were investigated. Histograms showed that each of the four engagement items were normally distributed across all 10 sessions, with no floor or ceiling effects, and exhibited similar standard deviations (min $SD = 1.2$, max $SD = 1.9$). Reliability analysis suggested high internal consistency, with Cronbach's alpha for the scale ranging from $\alpha = .80$ to .92 across the 10 sessions. For the moderated regression, a mean engagement score averaged over the 10 sessions was used as the dependent variable given that engagement scores did not differ significantly across sessions (see ANOVA analysis reported in a subsequent section).

Regression analysis of engagement revealed a significant main effect of imagery ($\beta = .34$, $t = 2.36$, $p < .05$) and a significant Imagery × Trait Absorption interaction ($\beta = -.41$, $t = -2.28$, $p < .05$). Figure 3 shows predicted engagement scores for both animated and verbal imagery groups at low (-1 SD) and high ($+1$ SD) trait absorption and suggests that animated imagery may produce a superior engagement effect relative to verbal imagery but only for low absorbers.

To further explore the interaction, simple slopes analysis was conducted (Cohen et al., 2003), with animated vs. verbal imagery groups compared at low (-1 SD) and high ($+1$ SD) levels of trait absorption. In line with Figure 3, the mean engagement score was significantly higher for animated relative to verbal imagery at low trait absorption ($t = 3.27$, $p < .005$), with no group differences at high absorption ($t = -0.10$, $p = ns$). The same analysis conducted on engagement scores from session one (as opposed to an engagement score averaged over 10 sessions) produced a similar pattern of results, suggesting differences in animated and verbal imagery for those low in trait absorption were apparent even during the first session.

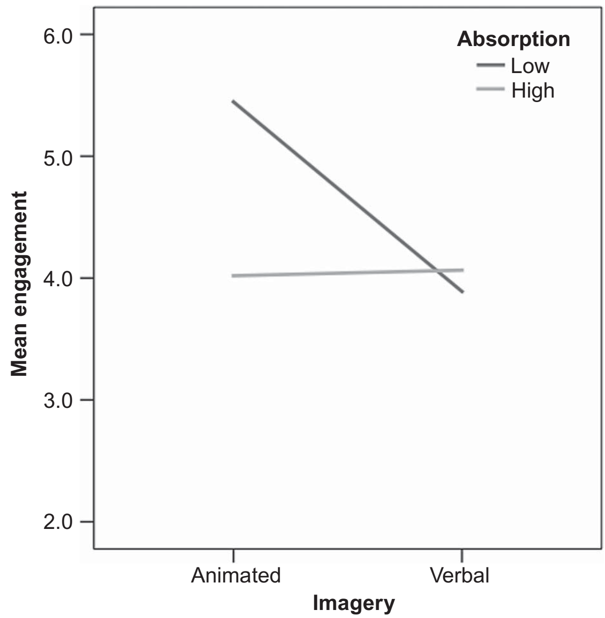

Figure 3. **Mean engagement score (min = 1, max = 7) for animated and verbal imagrey at low (−1 *SD*) and high (+ *SD*) levels of trait absorption.**

Analysis of Outcome Change Scores

Moderated regression analyses were performed on cortisol, PQSI, and DASS–SF change scores with predictors of imagery group, absorption, and their interaction as predictors. Regression of cortisol change scores revealed no significant effects; although the Group × Trait Absorption interaction approached significance, $\Delta R^2 = .13$, $F(2, 29) = 2.93$, $p = .081$. For PSQI tiredness change scores, a significant Group × Trait Absorption interaction emerged, $\Delta R^2 = .15$, $F(2, 29) = 3.44$, $p < .05$. Figure 4 shows predicted tiredness change scores at low (−1 *SD*) and high (+1 *SD*) trait absorption for all three imagery groups. Simple slope analysis was again used to explore the interaction, with pairwise comparisons of all imagery groups performed at low and high levels of trait absorption. In line with Figure 4, when trait absorption was high, significant differences in tiredness change scores between animated and relaxation, $t(29) = -3.01$, $p < .01$, and verbal and relaxation, $t(29) = -2.28$, $p < .05$, groups were observed, with no differences between animated and verbal imagery groups. No significant differences across imagery groups were observed for low trait absorption. Remaining regression analysis revealed no significant effects for PSQI sleep quality or the DASS–SF outcome measures.

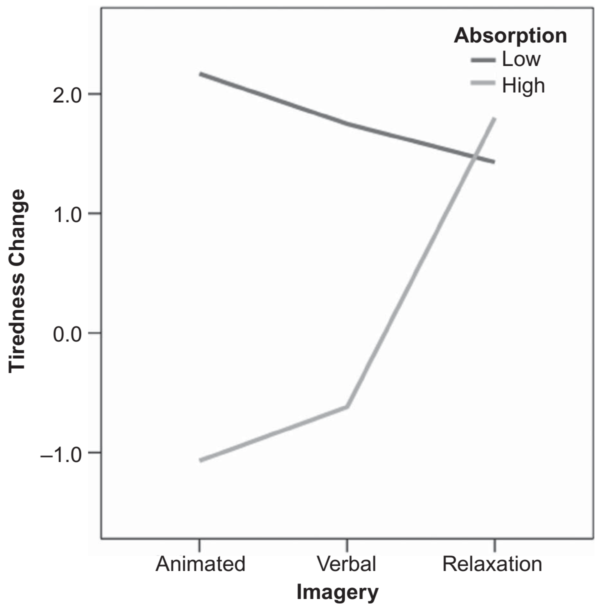

Figure 4. **Mean tiredness change across imagery groups at low and high trait absorption.**

Mood and Engagement Changes Across Sessions

To examine whether mood was affected by self-hypnosis, 10 × 2 × 3 mixed ANOVAs were performed on each of the four AD–ACL mood scales with independent variables of session number (1–10), period (before/after session), and self-hypnosis group (animated/verbal/control). A significant main effect of period on energy, tension, and calmness was revealed, $F(1, 34) > 8.70$, $ps < .01$, with the direction of effects indicating a general reduction in arousal after self-hypnosis sessions. This is illustrated in Figure 5 with the calmness subscale, which shows an increase in calmness averaged across the 10 sessions from $M = 10.7$ presession to $M = 14.3$ postsession. No Period × Group interactions were significant suggesting that the arousal decrease occurred irrespective of group allocation.

To examine whether engagement increased with an increasing number of training sessions, a 10 × 2 mixed ANOVA was performed on engagement scores with IVs of session number (1–10) and group (animated/verbal). The relaxation group was not included in the analysis as they did not receive immune imagery. The main effects of session number and the Session × Group interaction were examined with polynomial contrasts examining any linear trend. Although Figure 6

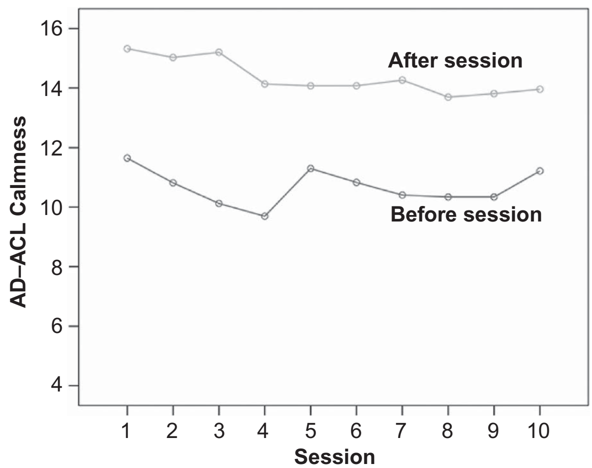

Figure 5. **AD–ACL calmness (min = 5, max = 20) before and after sessions.**

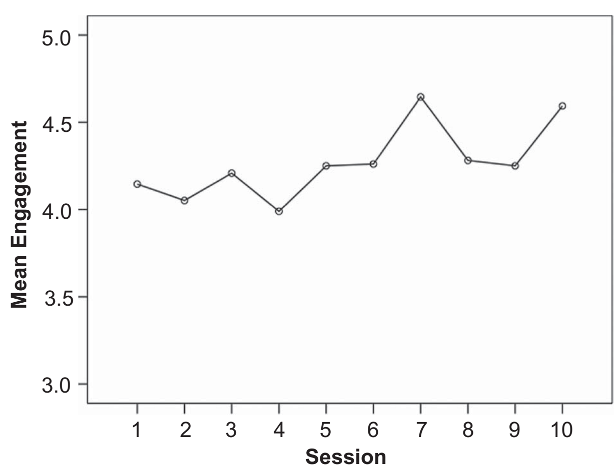

Figure 6. **Mean engagement scores across ten sessions of self-hypnosis training.**

suggests a possible linear increase in engagement with increased training, this effect failed to reach significance, $F(1, 22) = 2.56$, $p = .12$, suggesting that extra training does not result in any noteworthy increase in engagement. No other effects reached significance.

Discussion

The main goal of the study was to examine whether VR-assisted hypnotic visualization offered benefits in engagement, sleep, and cortisol, especially with those who may have difficulty with visualization. VR animation was compared with the traditional verbal visualization method and with a control group that received relaxation training with no hypnosis or immune imagery.

In evaluating whether VR may have utility as an effective medium for hypnosis, our first observation is that the wearing of the VR head-mounted display did not appear to inhibit hypnotic relaxation. Increases in calmness and reductions in arousal following sessions (as measured by the AD–ACL) were similar for the VR group and the groups not required to wear headgear. This also suggests that visualizing with eyes open (VR group) instead of imaging the scenario with eyes closed (verbal imagery group) does not provide a barrier to hypnotic relaxation.

Our aim of facilitating psychological engagement in participants who may find it more difficult to become engaged in mental imagery (i.e., low "absorbers") appeared to be successful. We found that for individuals with low levels of trait absorption, self-rated engagement was significantly higher when a virtual reality format was used compared to the traditional verbal format. Specifically, while traditional imagery resulted in a mean engagement rating of 4 ("moderate" engagement), the mean VR engagement rating was 5.5 (halfway between a moderate rating of 4.0 and the maximum engagement rating of 7.0). In fact, these increased engagement ratings were apparent even in the first of the 10 training sessions, suggesting an immediate advantage of VR imagery. The engagement scale itself reflected psychological immersion, vividness of imagery, freedom from distraction, and ability to concentrate attention with Cronbach's alpha indicating high internal consistency. In contrast to the findings for low absorbers, there were no differences in engagement between VR and traditional imagery when trait absorption was high. One possible explanation for this is that individuals high in trait absorption may tend to prefer internal imagery in mental processing (Nadon, Laurence, & Perry, 1987) and thus might be expected to be affected less by variations in the presentational format of external imagery. These results do not discount the possibility that immersive VR formats have the potential to elevate engagement even in high absorbers but indicate that for those low in absorption even simple and brief VR animations such as the one used in this exploratory study may be relatively effective at promoting engagement.

In addition to examining engagement, the current study also sought to determine whether VR resulted in positive changes in outcome variables. Despite low absorbers reporting higher levels of engagement with VR imagery, this did not appear to translate to any superior benefits in tiredness, mood, and cortisol levels. While a beneficial effect of VR on the tiredness outcome measure was observed in comparison with the control group, a benefit of equivalent magnitude was also observed for the traditional verbal imagery group; in both instances this effect was apparent only at high trait absorption. More specifically, while the relaxation control group reported increased tiredness as examinations and course assessments drew closer and with the accumulated pressures of the freshman academic year (Whitehouse et al., 1996), high absorbers in both VR and verbal imagery groups showed no such increase. These results confirm trait absorption as an important moderator of visualization training and extend findings of moderated trait absorption effects on outcome variables of anxiety and immune measures in previous studies (Gregerson et al., 1996; Kwekkeboom et al., 1998) to include relief from tiredness.

The current pattern of results is generally consistent with our previous study (Thompson et al., 2009) where high levels of openness to experience, a trait conceptually and empirically related to trait absorption (Glisky et al., 1991), similarly facilitated the effects of imagery training on tiredness. Importantly, however, whereas in the current study both the 3-D VR-assisted animation and verbal imagery visualizations resulted in less tiredness at high absorption compared to the control procedure, in the previous study only the verbal imagery and *not* the 2-D screen animation proved beneficial. Taken together, these results could suggest that the use of an immersive technology such as virtual reality may facilitate the effectiveness of self-hypnosis interventions that employ *visual* imagery. Virtual reality technology is, however, expensive at the present time. VR could therefore be argued to be of limited utility when the current results seem to indicate that visualization training may be equally effective when administered in a much cheaper audiotape format. Nevertheless, a comparison of our current and previous (Thompson et al., 2009) studies does appear to suggest that a manipulation of the immersive format may have the potential to enhance the efficacy of visual imagery interventions within visualization training, and that more sophisticated applications of VR beyond the brief and exploratory procedure used here may exploit this potential further.

Furthermore, while VR failed to result in superior changes in outcome in the current study, other research has provided some support for VR as an effective therapeutic medium (e.g., Patterson, Hoffman, Palacios, & Jensen, 2006; Patterson et al., 2009, 2010). Considering this, it is important to recognize that any interpretation of results from the current study is limited to the specific set of parameters that the study was designed to investigate. For example, we used outcome variables that included cortisol, we examined trait absorption as a personality moderator, and we investigated outcome change in a healthy population. Variation in any of these parameters might have implications for the effectiveness of VR. For example, much of the previous work that has been performed has examined VR effects on pain outcome measures. Similarly, while we examined trait absorption as a possible moderator, given that ability to become absorbed in mental imagery was considered central to the intervention, it may be that other characteristics could occupy a more important moderating role. Hypnotizability, for example, may be an important moderator. Although related to absorption (Hoyt et al., 1989), hypnotizability is nevertheless an independent construct that has been shown to moderate the effects of various hypnotic and visualization interventions (Johnson et al., 1996; Patterson, Hoffman, et al., 2006; Zachariae et al., 1994) and may be worthy of further examination.

It should also be borne in mind that here a VR format was applied only to the 5-minute immune imagery sequence, and not the additional 15 minutes of hypnotic induction so that the effects of manipulating the immune imagery format could be studied in isolation. However, it is conceivable that an application of VR to the entire hypnotic procedure could have promoted therapeutic effects. A related issue regards the nature of the imagery itself. What is likely to be the most effective VR imagery is hard to determine at this early stage of research. Might symbolic imagery be best, such as images of dolphins patrolling the blood stream and destroying germ cells? Or would accurate depictions of real germ cells be most effective? And how should animations of such imagery best be presented? Further work is clearly needed to answer these questions. At this point, attempting to design immersive virtual reality scenarios that are maximally effective for subjects/patients is an uncertain enterprise.

In addition to a consideration of how the current results should be interpreted in light of the specific parameters investigated, several potential limitations of the study should also be acknowledged. One such limitation may be the laboratory setting in which the training took place. While laboratory conditions offer a controlled environment for monitoring sessions, such a setting may not be conducive to self-hypnosis training requiring deep relaxation. Home training has the advantage of being done at a time that suits the trainees and may be more conducive to relaxation and absorption in the visualization process. Indeed, home training has been used to successfully elicit a wide range of positive change in outcome variables including cortisol (Fox et al., 1999; Gruzelier, Levy, et al., 2001; Gruzelier, Smith, et al., 2001), which failed to reach significance in the current study. A further limitation is the relatively small sample size. Although no significant treatment effects on cortisol levels emerged, effects did approach significance. It may be that the sample size used limited the sensitivity of the analyses to detecting any genuine effects on cortisol. Salivary cortisol levels can be substantially affected by a range of extraneous factors, which if uncontrolled can lead to large error variance. Although experimental restrictions were applied to control for extraneous variables, adherence was evaluated through a simple self-report checklist with no physiological validation taking place. Considering these limitations, future studies may find it advantageous to make VR facilities available for participants to use at home (although this is likely to incur greater expense) and to employ a larger sample size to maximize statistical power.

It is perhaps an ambitious enterprise given the points highlighted in this discussion and the current embryonic stage of this type of research to expect to be able to demonstrate here superior efficacy of VR-assisted interventions. However, the fact that VR did appear to produce greater engagement in imagery for those who traditionally have difficulties with such imagery may be an important finding. The fact that engagement can be increased and is likely to be an essential component in any type of hypnotic intervention suggests that further research into the use of VR in hypnotic interventions would appear to be worth the investment.

In summary, we found that both VR-animated and traditional visualization training appeared to be most effective for those high in trait absorption, with lower levels of tiredness seen in both types of training compared to relaxation. In addition, we found that visualization training with VR imagery produced superior levels of engagement relative to traditional verbal imagery for those low in trait absorption. This suggests that VR has potential as an effective medium for those who have trouble engaging with interventions involving visualization or where the context for visualization training inhibits engagement (e.g., pain management). Further research is required to determine whether the superior immersive effects of VR are able to translate to enhancements of therapeutic efficacy.

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Appendix A—Imagery Engagement Scale

Please think back to when you were visualizing images of your immune system. Then place a mark in the appropriate box for the following items.

1. How “immersed” in these images did you feel?

1	2	3	4	5	6	7

not at all moderately extremely

2. How vividly would you say you experienced the immune images?

1	2	3	4	5	6	7

not at all moderately extremely

3. How distracted were you by other thoughts while you were visualizing the immune system? **[R]**

1	2	3	4	5	6	7

not at all moderately extremely

4. How long were you able to concentrate your attention on the images?

1	2	3	4	5	6	7

none of the time a moderate amount of the time all of the time

[R] indicates item is reverse-coded.

Eine randomisierte kontrollierte Studie über die Wirkung von Hypnose mit einer *3D Virtual Reality Animation* auf Müdigkeit, Stimmung und den Kortisolgehalt im Speichel

Trevor Thompson, Tony Steffert, Anthony Steed und John Gruzelier

Abstract: Bisherige Fallstudien deuten darauf hin, dass Hypnose mit einer V*irtuellen-Realitäts-Komponente* (VR) eine effektive Intervention sein könnte, wobei bisher nur wenige randomisierte, kontrollierte Follow-up Studien in diesem Bereich durchgeführt wurden, die einen Vergleich solcher Interventionen mit der hypnotischen Standardbehandlung ermöglichen. 35 gesunde Teilnehmer wurden randomisiert und den Gruppen *Selbsthypnose mit VR-Bildpräsentation, Standard-Selbsthypnose, Entspannung* oder *Interventionen* zugeteilt. Es wurden die Veränderungen des Schlafes, des Kortisolspiegels und der Stimmung gemessen. Die Selbsthypnose-Intervention beinhaltete insgesamt zehn 20-minütige Sitzungen, in denen den Probanden ein gesundes Immunsystem-Szenario visualisiert wurde. Die Eigenschaft, sich in eine Aktivität vertiefen zu können, wurde auch als möglicher Moderator aufgezeichnet. Bei einer moderierten Regression zeigte sich, dass beide Hypnoseinterventionen zu deutlich niedrigeren Müdigkeitsratings führten, als dies bei der Entspannungsintervention der Fall war, wenn die Fähigkeit sich in eine Aktivität vertiefen zu können hoch war. Wenn diese Fähigkeit gering war, resultierte die Nutzung der VR in signifikant höheren Engagementratings, wobei dies nicht zwangsweise zu nennenswerten Verbesserungen in den Ergebnissen führte. Die Ergebnisse deuten darauf hin, dass die VR-Bildgebung das Engagement

im Vergleich zu traditionellen Methoden erhöhen könnte, aber es sind weitere Erforschungen des Potenzials zur Verbesserung der therapeutischen Wirksamkeit erforderlich.

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Une essai clinique comparatif à répartition aléatoire sur les effets de l'hypnose, avec animation en réalité virtuelle 3D, sur la fatigue, l'humeur et le cortisol salivaire

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Résumé: Des études de cas indiquent que l'hypnose, accompagnée d'un élément de réalité virtuelle (RV), peut s'avérer une intervention efficace, bien que peu d'études comparatives de suivi à répartition aléatoire aient comparé ces interventions avec des traitements hypnotiques standards. Trente-cinq participants en bonne santé ont été choisis au hasard pour recevoir l'autohypnose avec imagerie en réalité virtuelle, l'autohypnose standard, ou des interventions utilisant la relaxation. Les modifications du sommeil, du niveau de cortisol et de l'humeur ont été examinées. L'autohypnose consistait en 10 séances de 20 minutes chacune de visualisation d'un scénario de saine immunité. La concentration a également été enregistrée en tant qu'agent possible de régulation. Une régression modérée a indiqué que les deux interventions hypnotiques produisaient des coefficients de fatigue significativement inférieurs à ceux de la relaxation, lorsque la concentration était élevée. Lorsque la concentration était faible, la RV produisait des coefficients de mobilisation significativement plus élevés, même si ces résultats n'entraînaient pas d'amélioration démontrable des résultats. Cette étude indique que l'imagerie en RV peut augmenter la mobilisation par rapport aux méthodes traditionnelles, mais une étude plus poussée de son potentiel d'amélioration de l'efficacité thérapeutique est nécessaire.

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Ensayo aleatorio controlado sobre los efectos de la hipnosis con animación de realidad virtual 3D en cansancio, estado de ánimo, y cortisol en saliva

Trevor Thompson, Tony Steffert, Anthony Steed, y John Gruzelier

Resumen: Hay estudios de casos que sugieren que la hipnosis con un componente de realidad virtual (RV) puede ser una intervención efectiva, a pesar de que se han corrido pocos ensayos aleatorios controlados de seguimiento, comparando estas intervenciones con tratamientos hipnóticos estándares. Se asignaron aleatoriamente a 35 participantes sanos a autohipnosis con visualización de imágenes de RV, autohipnosis estándar, o intervenciones de relajación. Se evaluaron cambios en sueño, niveles de cortisol, y estado de ánimo. La autohipnosis comprendía 10 sesiones de 20 min. visualizando un escenario de inmunidad saludable. También se registraró el rasgo de absorción como un posible moderador. Una regresión moderada indicó que

ambas intervenciones hipnóticas produjeron estimaciones de cansancio significativamente menores a la relajación, cuando el rasgo de absorción era alto. Cuando el rasgo de absorción era bajo, la RV resultó en estimaciones de involucramiento significativamente más altas, aunque no se tradujeron en mejoras demostrables en los resultados. Los resultados sugieren que la visualización de imágenes de RV puede incrementar la involucramiento en comparación a los métodos tradicionales, pero se requiere más investigación para evaluar su potencial para maximizar la eficacia terapéutica.

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