Absorption predicts mysticism and spirituality, but not following intranasal oxytocin administration: A sensory deprivation experiment

Michael Skragge
ABSORPTION PREDICTS MYSTICISM AND SPIRITUALITY, BUT NOT FOLLOWING INTRANASAL OXYTOCIN ADMINISTRATION: A SENSORY DEPRIVATION EXPERIMENT

Michael Skragge

Recent research has indicated a causal link between oxytocin and spirituality. The present experiment sought to examine the effects of intranasal oxytocin (IN-OT) and absorption on mysticism and spirituality in a sensory deprivation setting. The results failed to find any main effects of IN-OT on mysticism, or on spirituality. Interaction effects were discovered however, where IN-OT interacted with absorption both on mysticism and spirituality. More specifically IN-OT undermined the association between absorption and outcomes that were observed in the placebo control condition. The results contradict the findings from the only previous experiment conducted on IN-OT and spirituality. The interaction effects align with previous research on IN-OT, suggesting an increase in suggestibility among low absorption scorers. These results motivate further research on the relation between oxytocin, absorption and spirituality, keeping the idea of suggestibility in mind.

The study of non-ordinary states of consciousness (NOSC) such as mysticism and spiritual experiences has long been undervalued and treated as a fringe phenomenon in the academic sciences (Cardeña, 2011). Mankind has a long history of seeking NOSC through various means and some scholars argue that insights and knowledge gained from these types of experiences may have contributed to shaping modern man into a cultural being (Winkelman, 2011). William James, the influential 19th century philosopher integral to the foundation of modern psychology, proposed that many important insights about the human mind and condition may be found by studying NOSC (James, 1902/1929). Currently, a burgeoning interest in mindfulness, meditation and yoga practices in western countries, as well as a renaissance for studying drug-induced mystical-type experiences in psychotherapy settings hint at an increasing curiosity for exploring spirituality and mysticism. Spiritual and mysticism are related with each other and with the broader term spirituality, in that having had mystical or spiritual experiences can motivate exploring a spiritual life, and at the same time, spiritual beliefs can motivate persons to explore mysticism and spiritual experiences (Hood, Hill, & Spilka, 2009). Spirituality and mysticism have been linked to psychological well-being (Byrd, Lear, & Schwenka, 2000; de Souza, 2009; Griffiths, Richards, McCann, & Jesse, 2006; Koenig, 2010; Park et al., 2017) and it is therefore of interest for psychologists and clinicians to explore these experiences.

Spirituality and religiosity
Spirituality may be seen as a person’s perceived relationship or connection with a higher power or sacredness, often entailing belief in and movement towards a life that has meaning, purpose and connectedness with the world and all living beings (Van Cappellen & Rimé, 2014; Zinnbauer, & Pargament, 2005). Operationalizing spirituality has proven to be difficult, since spiritual beliefs and practices differ widely between individuals, but also due to a fluid overlap between spirituality and traditional religion, where the formal and ritualistic aspects of the latter is often conflated with the former (Hill et al., 2000; Hood, Hill, & Spilka, 2009; Zinnbauer, & Pargament, 2005). Religiosity will for the present study be referring to
practicing religion in the traditional sense, including belief in the doctrines of organized religions, belonging to such a community and regularly partaking in activities associated with such religions (Hood, Hill, & Spilka, 2009).

**Oxytocin, a social-affiliative peptide**
Oxytocin (OT) is a peptide synthesized in the hypothalamus, acting as a neuropeptide in the central nervous system and as a peptide hormone in the peripheral nervous system (Lee, MacBeth, Pagani, & Young, 2009). OT has well-known functions in childbirth and in the release of breastmilk. Animal research has shown that administering oxytocin enhances a range of social behaviours, including maternal nurturing and pair-bonding, while oxytocin antagonists impair bonding (Bartz & Hollander, 2006). As a neuropeptide, OT is involved in modulating brain nerve cell function, and in the regulation of emotion. OT is involved in many pro-social behaviours and affiliative processes, including monogamous pair bonding, in sexual behaviour (Macdonald & Macdonald, 2010), interpersonal trust, attachment, caregiving and positive physical contact with a partner (Meyer-Lindenberg, Domes, Kirsch, & Heinrichs, 2011).

Intranasal OT (IN-OT) administration in humans has been shown to promote reduced self-focus (Liu, Sheng, Woodcock, & Han, 2013), increase positive focus on others (Bartz, Zaki, Bolger, & Ochsner, 2011), increase altruism towards both in- and out-groups, (Israel, Weisel, Ebstein, & Bornstein, 2012), and increase empathy towards the pain of others, including towards members of an out-group (Shamay-Tsoory et al., 2013). IN-OT may have both anxiolytic or anxiogenic properties (Bos, Panksepp, Bluthé, & van Honk, 2012; Eckstein et al., 2014). The social affiliative effects of OT seem to vary a lot depending on whether the individual perceives the social context as threatening, competitive or not (Olff et al., 2013). It also appears that IN-OT may affect females and males differently; research has seen differences in brain activity on all areas of socio-cognitive functioning modulated by exogenous OT, which may be due to sex differences in brain anatomy or differences in hormonal activity (Kanat, Heinrichs & Domes, 2014). The vast majority of studies investigating oxytocin and social behaviour in humans have utilised nasal delivery as the administration method, as it has been argued to be a reliable method for bypassing the blood-brain barrier (Born et al., 2002).

However, there have been contradictory findings between studies on IN-OT and social cognition and many previous studies have failed to replicate well (see for example Nave, Camerer, & McCullough, 2015). Some of these contradictions may at least partly be explained by various methodological issues, the possibility of IN-OT increasing suggestibility, but also due to the fact that individual differences in nasal pathways may result in IN-OT targeting different brain areas for different persons, as well as different contexts eliciting different responses (Bryant, Hung, Guastella, & Mitchell, 2012; Guastella & MacLeod, 2012; Quintana, Alvares, Hickie, & Guastella, 2015).

**Studies on Oxytocin and Spirituality**
A recent experimental study (Van Cappellen, Way, Isgett, & Fredrickson, 2016) found that IN-OT combined with a guided meditation affects spirituality, with effects remaining significant a week after. In their study, the researchers gave 83 male participants either IN-OT or placebo. They found that IN-OT increased spirituality as measured by the Spiritual Transcendence Scale (Piedmont, 1999). It is worth noting, however, that they found the significant effects of IN-OT on spirituality only after controlling for religiosity. Similarly,
Kelsch et al. (2013) found an association between having had spiritually transformative experiences in one’s life and higher levels of OT in the blood. In addition, Holbrook, Hahn-Holbrook & Holt-Lunstad (2015) found an association between higher self-reported spirituality and higher levels of OT in saliva. Thus there are indications that both endogenous and exogenous OT may support spirituality in general and perhaps especially the social-affiliative components of spirituality, as in a sense of connectedness with the world and all living beings, or with a higher power (Piedmont, 1999).

Like all pioneering studies, Van Cappellen et al.’s (2016) experiment had some limitations. First, their study included only male participants, which restricts the generalizability of their findings to men only. Second, Van Cappellen et al. (2016) studied American participants in the U.S, where religiosity and spirituality are highly culturally normative. In other parts of the Western world, including Sweden, religiosity and spirituality are not particularly culturally normative and a large proportion of people in Sweden are atheists or agnostics (Norris & Inglehart, 2011), still, a majority of Scandinavians report that they do hold beliefs that may be considered spiritual or akin to religious beliefs (Zuckerman, 2008). Therefore, it would be of interest to study whether IN-OT facilitates spirituality in more secular cultures. Third, their design was not set up to cause or study spiritual experiences occurring in real-time in the lab. Fourth, Van Capellen et al. (2016) did not examine whether dispositional individual differences contributed to the spirituality outcome, independently, or in interaction with IN-OT. Fifth, although Van Capellen et al. (2016) used meditation as a vehicle for exploring the effects of IN-OT on spirituality, they did not investigate any effects on mystical experiences though these are related to spirituality (Hood, Hill, & Spilka, 2009).

**Mysticism**

Mystical experiences, mysticism or mystical-type experiences may be understood as NOSC that are of a transcendent, religious, or spiritual nature (Hood, Hill, & Spilka, 2009). As with other NOSC, these experiences may occur spontaneously or be elicited through a variety of methods (Tart, 1972). Stace (1960) offered a theory of mysticism on accounts of religious experiences in religious texts. He found that all mystical experiences, although differing in interpretation or in phenomenology, still retained an experience of reduced self-world boundaries, with a sense of oneness or connectedness as their central characteristic. This oneness may manifest as a sense of unity with the external world and all things, including with perceptual objects or a sensed presence (extrovertive), or as a sense of unity in an internal experience of void or pure being, free from perceptual content (introvertive) (Hood, Hill, & Spilka, 2009). Stace (1960) also concluded that these experiences go beyond both our ordinary senses and reasoning.

Building on the work of Stace, Hood (1975) developed the Mysticism Scale in order to measure the qualities of mysticism. The most recent developments of the scale confirms a three-factor structure of Introvertive Mysticism, Extrovertive Mysticism and Interpretation (Chen, Hood, Yang, & Watson, 2011; Chen, Zhang, Hood, & Watson, 2012; Hood et al., 2001) although some studies have found support for a two-factor structure where Extrovertive and Introvertive Mysticism converge into one factor, indicating that the quality and interpretation of mysticism is contingent on the cultural, religious or spiritual context of the person experiencing it (cf. Chen, Qi, Hood, & Watson, 2011; MacLean, Leoutsakos, Johnson & Griffiths, 2012). Although often studied within a religious framework and individuals often interpret mysticism as having a religious or spiritual nature (Granqvist & Larsson, 2006), non-religious people may just as well have these experiences, for example in nature mysticism or...
in psychedelic experiences (Granqvist, Hagekull & Ivarsson, 2012; Lebedev et al., 2015; Snell & Simmonds, 2015). It has been suggested that mystical experiences elicited through various methods may be associated with the same underlying neurobiological mechanisms, with disruptions in the brain’s top-down processing giving way for bottom-up, innate and perhaps evolutionary more ancient systems to emerge (van Elk, & Aleman, 2017; Winkelman, 2017).

Mystical experiences interpreted within a religious framework have been shown to predict self-reported life satisfaction and purpose in life (Byrd, Lear, and Schwenka; 2000). Research on the use of psychedelic drugs in clinical treatment indicate that mysticism may have profound and often long-term effects on a personal sense of meaning and on spirituality (Griffiths, Richards, McCann & Jesse, 2006; Griffiths, Richards, Johnson, McCann & Jesse, 2008), and may even facilitate treatment for several types of mental health (e.g. Griffiths et al., 2016; Ross et al., 2016; Tupper, Wood, Yensen, & Johnson, 2015).

Absorption
Absorption is a disposition that can increase the tendency for experiencing NOSC, including mysticism (Granqvist et al., 2005; Granqvist, Hagekull & Ivarsson, 2012). Absorption may be viewed as a capacity to become deeply immersed in the object of attention (Tellegen & Atkinson, 1974), for example during a meditative practice, during hypnosis or while watching a movie. Absorption is characterized by “an openness to experience emotional and cognitive alterations across a variety of situations” (Roche & McConkey, 1990, p.92) and is an indicator of a personal tendency to be influenced by suggestion. IN-OT has been suggested to increase hypnotizability among people low in hypnotic susceptibility, which is related to absorption (Bryant, Hung, Guastella, & Mitchell, 2012; Tellegen & Atkinson, 1974). It has been shown that females have a higher baseline score for absorption than males (Green & Lynn, 2010).

NOSC in the lab: Sensory deprivation
Experimental research on NOSC has yielded evidence that these states can be induced in a controlled experimental setting (see for example Schjoedt, 2009). Sensory deprivation, i.e. reducing sensory inputs to such a low level as possible (Tart, 1983), has long been used to induce mysticism in religious, shamanic, or spiritual contexts (Winkelman, 2011). In modern times experimental studies have been conducted using sensory deprivation rooms, typically pitch dark and soundproof, or using sensory deprivation tanks, adding a sensation of near weightlessness (Granqvist et al., 2005; Hood & Morris, 1981; Kjellgren, 2003; van Elk, 2014). Research on sensory deprivation has produced reports of unusual experiences, including tactile sensations, seeing light phenomena or sensing a presence in the room (Andersen, Schjoedt, Nielbo, & Sørensen, 2014; Granqvist et al., 2005; Hood, Hill, Spilka, 2009).

Granqvist et al. (2005) attempted to replicate the so-called ‘God Helmet’ experiments. The God Helmet was designed to stimulate people’s brains with weak electromagnetic currents, claimed to reliably cause mystical experiences (Hill & Persinger, 2003; for a critique, see Schjoedt, 2009). Granqvist et al. found that there was no difference between active electromagnetic and control group in reported experience of NOSC, i.e. it didn’t matter if the helmet was turned on or off. Instead, they found that an individual’s level of absorption significantly predicted the occurrence of NOSC, mysticism in particular, in the sensory deprivation setting. The belief in the efficacy of the God Helmet, as measured by individual
suggestibility levels, an aspect of absorption, may have caused high absorption participants to have these experiences.

Andersen et al. (2014) attempted to test the suggestibility hypothesis in a small study by employing a sham ‘God Helmet’ during sensory deprivation in a ‘highly’ suggestive setting in terms of cues and instructions alluding to the likelihood of participants having unusual experiences. Out of the 23 participants, 18 reported some kind of unusual experience. Contrary to Granqvist et. al (2005), Andersen et al. (2014) found no correlation between individual suggestibility and mysticism scores. However, their participants scored above baseline in suggestibility as compared to the general population. Furthermore, the direct measure of suggestibility used in that study may have been influenced by participants not finding this a desirable trait. In contrast, the absorption measure used by Granqvist et al. (2005) is an indirect measure of suggestibility. Moreover, Andersen et al. (2014) gave highly suggestive and leading instructions to participants about what kind of experiences they may have in the room. It is therefore difficult to rule out expectancy effects, that is, that participants interpreted their experiences based on the instructions they had received.

Van Elk (2014) conducted another small study to replicate the ‘God Helmet’, suggestibility and sensory deprivation experiments. In this study 29 participants wore a sham God Helmet. Results showed that those who believed that their helmet was turned on were more likely than non-believers to report having unusual experiences in the room. Van Elk also found that individual differences in absorption were related to mysticism and unusual experiences scores.

The aforementioned studies suggest that NOSC may be likely to occur in a sensory deprivation condition in combination with a suggestive setting. Furthermore, it should be possible to predict their occurrence based on personal characteristics, including absorption.

The present study
The purpose of the present study was to examine the effects of intranasally administered oxytocin (IN-OT) during sensory deprivation on mysticism and spirituality. The second purpose was to examine interactions between absorption and IN-OT in relation to these outcomes. Since Van Cappellen et al. (2016) found that IN-OT appears to have an effect on spirituality, the present study aimed to clarify whether IN-OT has an effect on mystical experiences and spirituality in vivo. The hypothesis was that mysticism and spiritual experiences during sensory deprivation may be affected by IN-OT. Specifically, considering the social and interpersonal functions of naturally occurring oxytocin, IN-OT may increase the frequency of mysticism and spirituality, connectedness being an integral part in both mysticism and spirituality. Moreover, individual absorption levels may interact with IN-OT in relation to mysticism and spirituality. Since IN-OT may affect females and males differently, and that Van Cappellen et al. (2016) only included male participants, the present study controlled for gender. Note that the experiment and hypotheses have been preregistered on the open science platform (https://osf.io/52v8e/).

Method

Participants
Participants were recruited from a larger study (Cortes, Laukka, Lindahl, & Fischer, 2017). Recruitment for the present study consisted of emails sent out to all participants from that
study who had agreed to be contacted for participating in future data collections. Participants who didn’t reply to emails were contacted by phone. Participants were excluded for pregnancy, breastfeeding, previous or current psychiatric or neurological disorders, substance abuse, use of psychoactive drugs, use of drugs affecting the immune or hormonal systems, daily cigarette use, drinking caffienated beverages more than four times a day, claustrophobia, having considerable fear of the dark and for ongoing seasonal nasal allergies. Female participants were instructed that their participation should happen on either the ovulation phase or during the subsequent luteal phase of the menstrual cycle, i.e. 15-27 days from the first day of bleeding.

All participants who were deemed suitable and agreed to enrol in the study received explanation of relevant aspects of the study procedures and were told that they may ask questions about the study. All participants gave written informed consent before their participation. Participants were informed that they could withdraw their consent at any time of the study without any negative consequences. All participants were compensated with gift certificates equivalent to 700 Swedish kronor.

A total of 116 participants took part in the study, men (N=57) and women (N=59). The mean age was 27 years (SD=3,01). Participants who were either currently attending or had completed tertiary education amounted to 78%, while 21% had completed high school. One participant had completed primary school. Two participants were on parental leave while one was unemployed. Participants who declared themselves to be affiliated with an organized religion amounted to 37%. Out of the total sample, 17% were active members of the Lutheran Church of Sweden (Svenska Kyrkan), 7% belonged to other major Christian denominations and 7% were muslim, with the remaining 6% belonging to independent churches, or other religions. The participants who claimed no religious affiliation amounted to 63%, although a number of these added that they were culturally affiliated with various Christian or Islamic denominations.

Procedure
To ensure that participants had made the correct preparations on their day of participation, they received an email 48 hours in advance, instructing them not to smoke, drink alcohol or consume caffeine 24 hours prior to the experiment. They were also instructed to fast, not to engage in sexual activities or moderate/heavy physical activity within 2 hours before their visit. Female participants were further instructed that they were required to take a pregnancy test before proceeding with the experiment.

Participants were tested individually. After reading and signing the consent form, female participants took a pregnancy test, since OT may serve to initiate labour. Participants then received a nasal spray containing either Syntocinon, a synthetic oxytocin, or a placebo substance containing saline solution but no active OT. Before administering the nasal spray, participants were asked to hold a scented pen under their nose and take a good whiff. The pen, emitting a synthetic odour resembling fish or caviar, was used to confuse participants’ sense of taste and smell, so that they would not be able to guess if they had received either OT or placebo in the nasal spray. Participants where then asked to blow their noses, to clear their sinuses. Next, participants self-administered the nasal spray under the experimenter’s supervision. Participants sprayed six puffs in total, alternating between both nostrils, counting silently to ten in between each puff. The procedure was double-blind, meaning that neither the
experimenter, nor the participants, knew whether participants received the spray containing active OT or placebo. The dose for one participant was equivalent to 24 IU.

After administering the nasal spray, participants waited for 30-35 minutes, the time it usually takes for OT effects to come forth (e.g. Israel et al. 2014). While waiting, participants filled out a number of computerized forms, including the scales measuring absorption and religiosity. When the 30-35 minutes were over, participants received instructions that they were going to spend 30 minutes alone in a completely dark, silent room, and that some people may have unusual experiences under such conditions. Next, participants were blindfolded and led by the experimenter to the sensory deprivation room. Participants were then seated on a moderately comfortable chair. The experimenter then instructed participants to try to sit as still as possible and not do anything in particular for the next thirty minutes, save for trying not to fall asleep. Participants were also shown where to find an alarm button, placed under the chair. After the 30 minutes of sensory deprivation, participants were led out of the room and instructed to remove their masks. The experimenter made sure the participants were feeling okay and ready to continue the experiment.

Then, participants were asked to fill out additional questionnaires, on pen and paper, concerning experiences they had in the sensory deprivation room, including the Spiritual Transcendence and Mysticism scales. After they had completed filling out the questionnaires, the experimenter asked participants if they had experienced any discomfort during their time in the room, and if so, if they wanted to talk about it.

Design
Participants were randomly assigned to one of the following conditions: Intranasal oxytocin (IN-OT) (N=59) or placebo (N=57). Gender was evenly distributed between groups with 29 women and 28 men in the placebo condition and 30 women and 29 men in the IN-OT condition.

Scales and measures
Four scales were used for the present study, designed to measure Absorption, Mysticism, Spirituality and Religiosity. For a summary of descriptives for each scale used, please refer to Table 1 below.

<table>
<thead>
<tr>
<th>Instrument</th>
<th>Cronbach’s a</th>
<th>No of items</th>
<th>Range</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tellegen Asorption Scale</td>
<td>0.93</td>
<td>34</td>
<td>1-6</td>
<td>3.33</td>
<td>.81</td>
</tr>
<tr>
<td>Mysticism Scale</td>
<td>0.92</td>
<td>30</td>
<td>1-6</td>
<td>2.02</td>
<td>.76</td>
</tr>
<tr>
<td>Spiritual Transcendence Scale</td>
<td>0.90</td>
<td>15</td>
<td>1-5</td>
<td>2.96</td>
<td>.83</td>
</tr>
<tr>
<td>Religiosity Scale</td>
<td>0.94</td>
<td>6</td>
<td>1-6</td>
<td>1.82</td>
<td>1.25</td>
</tr>
</tbody>
</table>

Religiosity Scale.
This scale consists of six items related to belief and involvement in traditional organized religion (Granqvist, 1998). Sample items include “I have a religious belief” and “I pray to God on a regular basis”. Items were scored on a 1 (Strongly Disagree) to 6 (Strongly Agree) scale. The items in the scale may be thought of as more adapted to followers of Abrahamic religions rather than Indian or Chinese religions. In a Swedish context, a country that has a long history of Christianity, this scale should be appropriate. The internal consistency in the present study was high.
The Tellegen Absorption Scale.
The Tellegen Absorption Scale (TAS) is a measure originally designed to predict susceptibility to hypnosis (Tellegen & Atkinson, 1974). It was translated into Swedish by Granqvist et al. (2005). It consists of 34 items. Items were scored on a 1 (Strongly Disagree) to 6 (Strongly Agree) scale. Sample items include ‘‘While watching a movie, a TV show, or a play, I may become so involved that I may forget about myself and my surroundings and experience the story as if it were real and as if I were taking part in it’’, ‘‘I can often somehow sense the presence of another person before I actually see or hear her/him’’ and ‘‘The sound of a voice can be so fascinating to me that I can just go on listening to it’’. The TAS is well-established, has shown high internal consistency and it is a valid construct in that there are associations with susceptibility to hypnosis, dissociative experiences and having hallucinations (Glicksohn & Barrett, 2003; Kremen & Block, 2002; Roche & McConkey, 1990; Zachariae, Jorgenssen, Bjerring, Svendsen, 2000). The internal consistency was high in the present study.

The Mysticism Scale.
The Mysticism Scale (Hood, 1975) is the most frequently used measure of mysticism (Hood, Hill, & Spilka, 2009). Originally consisting of 32 items, Holm (1982) omitted two items from the Swedish version. Scoring ranged from 1 (Strongly Disagree) to 6 (Strongly Agree). The original scale measures mysticism during a lifetime but for this study, the questionnaire had been adapted to measure mystical experiences as they occurred in the experimental context. This has been done previously in Granqvist et al. (2005). Sample items included ‘‘I had an experience of being absorbed into something larger than myself’’ and ‘‘I had an experience in which everything seemed to disappear from my mind until I was conscious only of a void’’. The reliability and validity of the scale have been thoroughly investigated, showing good internal consistency and good validity in relation to other assessments of mysticism (Hood, Hill, & Spilka, 2009). Internal consistency in the present study was high.

Spiritual Transcendence Scale.
This scale was translated into Swedish by the author and validated through back-translation by a bilingual native speaker of English. Piedmont (1999) defined Spiritual Transcendence as a personal tendency to turn towards a larger, objective perspective of reality than one’s personal life. This encompasses the ability to see a oneness and connection between oneself, other people and nature, transcending life and death. Piedmont argued that Spiritual Transcendence can be regarded a personality trait, akin to the five facets of OCEAN (see for example McRae & Costa, 1999). Sample items include ‘‘There is a higher plane of consciousness or spirituality that binds all people’’, ‘‘I believe there is a larger plan to life’’ and ‘‘Although dead, images of some of my relatives continue to influence my current life’’. The item scoring ranged from 1 (Strongly Disagree) to 5 (Strongly Agree). The original scale contains three subscales – Interconnectedness, Meaning and Purpose and Prayer Fulfillment. Van Cappellen et al. (2016) did not include the subscale Prayer Fulfillment in their study, due to the risk of intercorrelations with religiosity. In order to try to replicate Van Cappellen et al.’s (2016) study, this subscale was excluded from the present study. Van Capellen et al. (2016) found satisfactory reliability for their modified version ($\alpha = 0.86$). Reliability for the modified scale was high also in the present study.

Ethical considerations
The study was approved by the regional ethical review board and the Swedish Medical Products Agency (Läkemedelsverket). The author and his supervisor have both signed a
declaration stating adherence to the principles of the Swedish law regarding ethical vetting of human research activities (Lagen (2003:460) om etikprövning av forskning som avser människor (www.epn.se)).

As noted above, all female participants underwent a pregnancy test before they were administered IN-OT or placebo, because IN-OT may serve to initiate labour. Participants were informed ahead of participation that they were required to perform a pregnancy test.

There was a potential risk that the sensory deprivation procedure could cause mild anxiety among participants. Furthermore, experiencing a non-ordinary state of consciousness could be disconcerting for participants. If any participant found the sensory deprivation condition uncomfortable or distressing, they had the option to end the session prematurely by pushing a button that activated an alarm signal in the experimenter’s control room. The experimenter, a final semester clinical psychology student, was ready to provide debriefing and support for any participants who found the experience unsettling. In the unlikely case of an acute stress reaction, the research team was ready to provide professional support at the university psychotherapy clinic.

The safety profile for doses used in the study (24 IU) have been demonstrated to be safe according to the literature as well as in previous studies conducted at the Department of Psychology. Other than the issues mentioned above, there were no known risks associated with any of the procedures used in this study.

Statistical analyses
Analyses were performed with IBM SPSS Statistics v.24. The alpha level for significance for all tests was set at $p < .05$. Before any statistical analyses were performed, data was examined to determine whether the conditions for the analyses to be performed were fulfilled.

Bivariate correlations were examined as a preparation for regression analyses. In order to test for main effects of IN-OT or placebo on mysticism and spirituality during sensory deprivation, two separate t-tests for independent variables (between-group comparisons) were first conducted, one on mysticism and one on spirituality. Since Van Cappellen et al. (2016) only examined the effects of IN-OT on spirituality on men, gender was included as a variable in an ANCOVA on the Spiritual Transcendence Scale. Consistent with that study, religiosity was controlled for. The same was done for the Mysticism Scale.

Lastly, a series of hierarchical multiple regression analyses were run on each of the dependent variables. In each equation, the dummy-coded experimental condition, the dummy coded gender variable, a centered predictor (absorption), and the interaction term (cross-product) of experimental condition and predictor, as well as the interaction term of experimental condition and gender, were employed. The addition of gender in the regressions was motivated by the previous study (Van Cappellen et al., 2016) only including males.

Results

Descriptive statistics and preliminary analyses
Each data item was checked for missing values. One participant was excluded for the mysticism analyses, missing half of the data. Three other cases of missing data were identified, each missing data for one item. For these three cases, the mean value on the scale
concerned for each case was imputed manually. An analysis of standard residuals was carried out, which showed that the data contained four outliers, according to Tukey’s outlier labelling rule, using the more strict criterion of g’=2.2 (Hoaglin, Iglewicz and Tukey, 1986). Parallel analyses were run in which outliers were excluded, but the pattern of results did not differ. Thus, results are presented with outliers included. There were no significant differences in predictor or demographic variables between treatment groups.

At the end of the experiment, participants were asked to indicate whether they believed they had received IN-OT or placebo, or if they were uncertain as to which one they had received. For those participants who responded that they had received either of the treatments, a chi-square test of independence was performed to examine whether actual treatment predicted participants’ perceived treatment. There was no significant difference in the distribution, χ² (N=79) = 0.961, p=0.327.

The data met the criteria for assumptions of non-collinearity, independence errors, normalcy (normally distributed errors & standard residuals), homogeneity and linearity, and non-zero variances. Thus, the conditions for the subsequent analyses were met.

**Tests of research questions**

Bivariate correlations among all predictors and outcomes were examined (See Table 2 below). There was a weak significant correlation between gender with both mysticism and absorption. Mysticism correlated moderately with Spiritual Transcendence. Absorption did not correlate significantly with either the Mysticism or the Spiritual Transcendence scales.

Table 2. Bivariate correlations among Study Variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Treatment</td>
<td>-</td>
<td>0.00</td>
<td>-0.14</td>
<td>-0.11</td>
<td>0.04</td>
<td>-0.03</td>
<td>0.12</td>
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<tr>
<td>2. Gender</td>
<td>-</td>
<td>0.10</td>
<td>-0.20*</td>
<td>-0.13</td>
<td>0.12</td>
<td>-0.22*</td>
<td></td>
</tr>
<tr>
<td>3. Age</td>
<td>-</td>
<td>0.01</td>
<td>0.03</td>
<td>-0.05</td>
<td>0.06</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Mysticism</td>
<td>-</td>
<td>0.49*</td>
<td>0.17</td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Spiritual Transcendence</td>
<td>-</td>
<td>0.10</td>
<td>0.16</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Religiosity</td>
<td>-</td>
<td></td>
<td>0.13</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Absorption</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *p<0.05. **p<0.01.

**Main effects**

The independent samples t-tests for the effects of treatment on mysticism and on spirituality showed no significant difference between intranasal oxytocin (IN-OT) or placebo. See Table 3.

Table 3. t-tests and effect sizes (d) of differences between intranasal oxytocin (IN-OT) and placebo groups on the dependent variables.

<table>
<thead>
<tr>
<th>Dependent variables</th>
<th>IN-OT</th>
<th>Placebo</th>
<th>t(df)</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mysticism (N=115)</td>
<td>1.94 (0.67)</td>
<td>2.05 (0.73)</td>
<td>0.86 (113)</td>
<td>.16</td>
</tr>
<tr>
<td>Spiritual transcendence (N=116)</td>
<td>2.99 (0.89)</td>
<td>2.93 (0.77)</td>
<td>-0.42 (114)</td>
<td>.07</td>
</tr>
</tbody>
</table>

To study whether controlling for religiosity would generate a significant result on spirituality, as in Van Cappellen et al. (2016), a two-way ANCOVA was performed to compare the
treatment effect whilst controlling for religiosity. The same was done for mysticism. Levene’s test and normality checks were carried out and the assumptions were met. There was no significant difference in spiritual transcendence between treatments $F(1,111)=0.20, p=0.656$. Neither was there a significant difference between treatments for mysticism $F(1,111)=1.364, p=0.245$.

**Interaction effects**
Regression analyses were run on each of the dependent variables: mysticism and spirituality. Experimental conditions as well as gender were dummy-coded.

**Mysticism**
A hierarchical multiple regression was conducted with mysticism as the dependent variable. Treatment, gender and absorption (centered) were entered in block one of the regression. The interaction term (Treatment x Absorption) was entered in block two as recommended in Cohen, Cohen, Aiken and West (2013). A summary of the regression analysis is presented in Table 4.

In the first model, neither of the main effects were significant, nor the overall regression equation (see Table 4). Adding the interaction term between treatment and absorption ($\beta=-0.32$), contributed significantly to the regression model, explaining 6% of additional variation in mysticism, $F(3,112)=3.727, p=0.007$.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th></th>
<th></th>
<th>Model 2</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment</td>
<td>-0.19</td>
<td>0.14</td>
<td>-0.12</td>
<td>-0.18</td>
<td>0.17</td>
<td>-0.12</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.27</td>
<td>0.14</td>
<td>-0.18</td>
<td>-0.28</td>
<td>0.14</td>
<td>-0.18*</td>
</tr>
<tr>
<td>Absorption</td>
<td>0.10</td>
<td>0.09</td>
<td>0.10</td>
<td>0.30</td>
<td>0.11</td>
<td>0.31*</td>
</tr>
<tr>
<td>Treatment x Absorption</td>
<td></td>
<td></td>
<td>-0.46</td>
<td>0.17</td>
<td></td>
<td>-0.32**</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.06</td>
<td></td>
<td>0.12</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^2$ change</td>
<td>0.06</td>
<td></td>
<td>0.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$F$ for change in $R^2$</td>
<td>2.44</td>
<td></td>
<td>3.727**</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Absorption was centered at its mean. *$p < .05$. **$p < .01$.

To investigate the significant interaction between treatment and absorption, simple linear regression analyses (“simple slopes”) were run separately in the IN-OT and placebo conditions. For the IN-OT condition, the regression was not significant, $B=-0.12, p=0.31$. For placebo, the regression showed a significant positive relation between absorption and mysticism, $B=0.33, p=0.001$.

To further scrutinize this interaction effect, simple effects analyses were performed through two independent samples t-tests on mysticism, with absorption median split into low and high scorers. There was no significant difference on mysticism between low and high absorption scorers in either the IN-OT or placebo conditions, placebo, $t(55)=-1.572, p=0.122$, IN-OT, $t(57)=0.733, p=0.467$. 
Spirituality
A hierarchical multiple regression was conducted with spirituality as the dependent variable. Treatment, gender and absorption were entered in block one of the regression. The two-way interaction (Treatment x Absorption) was entered in block two. A summary of the regression analysis is presented in table 5.

The hierarchical regression revealed that in model one, neither treatment, gender nor absorption contributed significantly to the regression model, \(F(3,112)=1.432, p=0.237\). Introducing the two-way interaction terms in block 2 explained an additional 8% of the variation in spirituality, and the overall regression equation was significant, \(F(4,111)=2.739, p=0.032\). The Treatment x Absorption coefficient was significant in model two.

Table 5.Summary of Hierarchical Regression Analysis for variables predicting Spirituality (N=116).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>SE B</td>
</tr>
<tr>
<td>Treatment</td>
<td>0.04</td>
<td>0.16</td>
</tr>
<tr>
<td>Gender</td>
<td>-0.17</td>
<td>0.16</td>
</tr>
<tr>
<td>Absorption</td>
<td>0.14</td>
<td>0.10</td>
</tr>
<tr>
<td>Treatment x Absorption</td>
<td></td>
<td>-0.48</td>
</tr>
<tr>
<td>(R^2)</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>(R^2) Change</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>(F) for change in (R^2)</td>
<td>1.43</td>
<td></td>
</tr>
</tbody>
</table>

Note: Absorption was centered at its mean. * \(p <0.05\). ** \(p <0.01\).

To investigate the interaction between treatment and absorption on spirituality, simple regression analyses were run separately for the IN-OT and placebo conditions. For IN-OT, the regression was not significant \(B=-0.103, p=0.517\). For placebo, there was a positive relation between absorption and spirituality, \(B=0.37, p=0.001\).

To further scrutinize this interaction, simple effects analyses were run, by employing two independent samples t-tests on spirituality with absorption median split into low and high scorers. These analyses showed a significant difference in spirituality between low and high absorption scorers, specifically in the placebo condition, \(t(55)=-2.54, p=0.014\). More specifically, high absorption scorers scored higher on spirituality than those low on absorption. There was no significant difference between absorption groups in the IN-OT condition, \(t(57)=-0.443, p=0.659\).

Discussion

The purpose of the present study was to examine the effects of intranasal oxytocin (IN-OT) on mysticism and spirituality during and following sensory deprivation. Additionally, the study investigated interactions between IN-OT and absorption on these outcomes. The assumption was that IN-OT, associated with social-affiliative processes, would increase mysticism and spirituality during sensory deprivation. Additionally, considering the suggested suggestibility-enhancing effect of IN-OT, and that suggestibility is an aspect of absorption, I investigated interactions between IN-OT and absorption on the outcomes.
**Results in relation to the hypotheses**

1. The results did not support the hypothesis that intranasal oxytocin (IN-OT) causes increased mysticism in a sensory deprivation setting. Neither did the results support the hypothesis that IN-OT causes increased spirituality in a sensory deprivation context.

2. The results supported the hypothesis of interaction effects between IN-OT and absorption on both outcomes (mysticism and spirituality). On mysticism, for those receiving placebo, the positive relation between absorption scores and mysticism scores indicates that absorption scores positively predict mysticism scores. This effect was inhibited for those in the IN-OT condition. For spirituality, there was a positive relation between absorption and spirituality in the placebo condition, but not in the IN-OT condition. Moreover, splitting the sample into low and high absorption scorers showed that high absorption scorers had higher spirituality scores specifically in the placebo condition. This indicates that IN-OT inhibits the relation between absorption and spirituality.

**Results in relation to previous research and theory**

The present study failed to find support for main effects of IN-OT increasing mysticism in a sensory deprivation setting. Previous studies investigating mysticism in experimental conditions have typically employed suggestive cues and conditions, such as ‘God Helmets’ or priming of mystical experiences and sensed presence, both adding to the problems of eliciting certain experiences in a suggestive condition, and affecting the interpretation of the experiences. It is possible that more suggestive cues could have elicited a higher baseline of mysticism among participants and perhaps that any possible increased hypnotizability or suggestibility due to the effects of IN-OT could have exacerbated these effects for low hypnotizable individuals (Bryant, Hung, Guastella, & Mitchell, 2012).

The present study also failed to find any main effects for IN-OT on spirituality, whether controlling for religiosity or not. Therefore the present study does not support the findings of Van Cappellen et al. (2016). There may be several explanations for these different findings. Below I discuss the possibilities of differences between the studies in setting valence and differences in sample demographics.

Van Cappellen et al. (2016) proposed that religiously affiliated people may be less affected by IN-OT due to ceiling effects, these individuals already being at a high level of spirituality (Quintana & Eriksen, 2017). If that had been the case, the sample in the present study, scoring lower in both religiosity and in spirituality compared to Van Cappellen et al.’s (2016) sample, should have been more likely to increase their spirituality scores following IN-OT. Perhaps there might conversely be a lower threshold, where atheists, agnostics or less spiritual people may not be as likely to experience an increase in spirituality following a potentially spiritual or mystical experience, since they would be less likely to interpret such an experience in those terms.

Another possible explanation for the differences in results between the present study and Van Cappellen et al. (2016) may be found in terms of individual differences in the oxytocinergic system that may also manifest as differences between religious and less religious samples on a group level. It has been proposed that the oxytocinergic system may develop differently between individuals depending on their developmental attachment context (Feldman, 2017) but also in interaction with the sociocultural environment (Han, 2017). Attachment theory states that people have an evolutionarily inherited system for the forming of relationships,
which for children governs the tendency to form attachment bonds with close caregivers, and depending on the way in which caregivers have responded to the child’s attachment needs, affects the behaviour of the adult in how they form relationships with romantic partners and with their own offspring (Cassidy & Shaver, 2010). The development of the oxytocinergic and attachment systems are closely intertwined (Feldman, 2017; Han, 2017; Heinrichs, von Dawans, & Domes, 2009). It may thus be possible that Van Cappellen et al.’s (2016) sample, being more religious or spiritual, were more securely attached than the sample in the present study (see for example Granqvist, 2002).

It is likely that the suggestibility and emotional activation aspects of IN-OT makes the experimental setup affect the effects of IN-OT. A recent meta-analysis on IN-OT studies combining socio-behavioural experimental conditions with fMRI imaging suggests that an individual’s emotional appraisal of the experimental context, i.e. the valence of the situation, may explain contradictory outcomes of IN-OT in the literature (Wang, Yan, Li, & Ma, 2017). It is therefore possible that the experimental setup with sensory deprivation may have been interpreted as an uncomfortable or even slightly frightening situation and this may have caused participants to be less receptive to the connectedness-promoting functions of IN-OT. This may have been the case for some participants who reported to the experimenter that they had found the sensory deprivation experience a bit frightening and uncomfortable. In Van Cappellen et al. (2016), their guided meditation setting may have had a more positive emotional valence, perhaps influencing participants to have more connectedness-promoting oxytocinergic effects.

We found interaction effects between absorption and IN-OT on both outcomes studied. That IN-OT inhibits the positive relations between absorption on the one hand and mysticism and on spirituality on the other might indicates that there is a peak level of absorption, hypnotism or suggestibility, so that adding IN-OT on top of already high levels absorption will not raise mysticism or spirituality scores. Rather, IN-OT might “level the field” so that low absorption scorers get an increase in mysticism and spirituality scores. This interaction between absorption and IN-OT suggests that IN-OT affects suggestibility for low absorption scorers. Perhaps the effects of Van Cappellen et al. (2016) may be explained rather by the hypnotizability-increasing effects of OT (Bryant, Hung, Guastella, & Mitchell, 2012), and that the guided meditation contained cues that influenced the subsequent spirituality ratings.

**Disentangling connectedness from spirituality and mysticism**

There may also exist a conceptual issue regarding spirituality, religiosity and connectedness. Perhaps connectedness doesn’t have to entail any spiritual or religious correlates. Rather, connectedness may be seen as a fundamental standalone concept in its own right. Although often overlapping with spirituality and religion, connectedness to larger entities such as nature, nations or even soccer teams may perhaps often be more practically regarded in secular terms. Research on mystical experiences with psychedelics and on nature connectedness seem to suggest this (Carhart-Harris, Erritzoe, Hajen, Kaelen & Watts, 2017; Snell & Simmonds, 2015). Perhaps the proposed increase in spirituality after IN-OT, as well as higher levels of endogenous oxytocin among spiritual persons can be explained purely in terms of connectedness and attachment.

**Critical examination of the results**

The present study followed a rigorous experimental procedure and a large sample, with equally large groups of males and females. The strictly behavioural experimental setup
prevents attribution of effects to any specific brain processes as well as determination of whether the IN-OT contributed to central or peripheral nervous system activation.

It is possible that stratifying the sample into subsets based on other predictors could have generated significant effects of IN-OT on mysticism or spirituality. For example dividing the sample into groups of low, mid and high religiosity scorers, or redoing the statistical analyses on subscales of the mysticism or spirituality scales, might engender significant effects. However, this type of post-hoc analysis is in fact part of the problem that led to the reproducibility crisis in experimental psychology (Wacker, 2017).

The present study challenges the findings of Van Cappellen et al. (2016) that IN-OT increases spirituality. However, with an experimental setup that was quite different to that study and with differing demographics of the sample, the present study can only be considered a conceptual replication and not an exact replication.

Methodological Considerations
Both scales for mysticism and spirituality showed good internal consistency. The predictor variables also showed good internal consistency. Although the Spiritual Transcendence Scale had been translated into Swedish, and this was the first time this version was used, it showed good internal consistency and, with the subscale prayer fulfilment removed, had zero correlations with religiosity and also correlated expectedly with the Mysticism Scale. There were only weak, non-significant bivariate correlations observed between absorption and mysticism and between absorption and spirituality for the whole sample. This can be explained by the effects of IN-OT levelling out the relationship between absorption and these two measures, with negative correlations for the placebo group and positive correlations for the IN-OT group evening out the correlations for the whole sample. The Religiosity scale has been used in previous studies (Granqvist, 1998) and was suitable for controlling for involvement and belief in traditional religion. It is possible that the Mysticism Scale might have been too insensitive to discern subtle effects on the mind, and perhaps it might have been appropriate to use a more sensitive instrument for detecting non-ordinary states of consciousness.

The loss of data was very small with data for only one person missing completely. Neither were there high frequencies of systematically missing data and imputing missing values by case means was deemed suitable. In addition, the sample was pretty representative for young, Swedish adults, in terms of education level and religious (or lack of such) affiliation.

The Swedish sample in this study scored lower on the Spiritual Transcendence scale as compared to Van Cappellen (2016). Therefore, adjusting the Spiritual Transcendence for the sample might have generated significant differences in treatment effects. To estimate whether this may have been a possibility, a subset of the whole sample, with a corresponding mean for Spiritual Transcendence as in Van Cappellen et al. (2016), was created. I then performed the same main effect analyses on this sub-sample. However, these supplementary analyses did not indicate any significant main effects of IN-OT on spirituality either.

There may be a possibility that the sensory deprivation experience may have masked any main effects of IN-OT on the outcomes, since sensory deprivation is a powerful condition in itself to produce mysticism. Since there was no passive (i.e., non-sensory deprivation) control
group, it is possible that the study may have failed to detect any subtle effects of IN-OT on mysticism or spirituality.

Not priming participants too strongly should however have provided a rather neutral sensory deprivation setting, without any effects caused by participant’s expectations due to demand characteristics of the task. This has been a validity threat in some previous studies (see for example Andersen, Schjoedt, Nielbo, & Sørensen, 2014).

The administration of IN-OT and placebo substance was thoroughly conducted both in terms of using a high dose level and a double-blind procedure. Participants not being able to guess whether they had received IN-OT or placebo should indicate that the blinding was not revealed.

Limitations in statistical methodology
For the main effects of IN-OT with the current sample size, a $d$ as small as .26 would have been enough to obtain power .80 (Cohen, 1969). On the other, hand it should be noted that our power was insufficient to detect very small effects.

Null hypothesis significance testing such as equivalency tests or Bayes factors for the non-significant result for any main effects of IN-OT may have given more clarity as to how likely the null hypothesis of no effects is (Quintana, 2017). This would have been an important addition to the IN-OT literature, giving indications as to whether the IN-OT effect on mysticism and spirituality might be an auspicious path for future research (Lane, Luminet, Nave, & Mikolajczak, 2016). Comparing the results from this study with the results from Van Cappellen et al. (2016) may have given more insight into the likelihood of equivalency between the non-significant effects in the present study and the significant effects in that study.¹

Results recap
The present study investigated the effects of IN-OT on mysticism and spirituality in a sensory deprivation setting, including interaction effects between IN-OT and absorption on those outcomes. Results showed that IN-OT did not cause increased scores on mysticism nor on spirituality, but that IN-OT inhibited the relation between the absorption trait on the one hand and mysticism and spirituality on the other.

Contributions
The literature on the effects of IN-OT on social and behavioural processes show mixed findings. The present study adds to the mix by not finding any significant main effects of IN-OT on mysticism nor on spirituality, but at the same time showing that there is an interactive relationship between IN-OT and absorption on the outcomes studied, which may confound results in socio-behavioural IN-OT experiments. Taken together with previous studies on the relationship between endogenous and exogenous oxytocin and spirituality, it may be that oxytocin does have a relationship with spirituality, but perhaps only for those who are already spiritually inclined. As for the interaction effects between absorption and IN-OT, the present study strengthens previous findings indicating a suggestibility effect of IN-OT.

¹ For an elegant application of Bayesian null-hypothesis significance testing on data from the Van Cappellen et al. (2016) study, refer to Quintana & Eriksen (2017).
**Future studies**

To investigate whether IN-OT has an influence on more powerful experiences of non-ordinary states of consciousness, IN-OT could be administered to persons in a Flotation-REST condition, or employing similar reliable non-drug methods for eliciting powerful non-ordinary states of consciousness. It would be of interest to investigate if IN-OT-induced increased absorption, reduced anxiety or perhaps increased feelings of connectedness might shape the mystical or spiritual experiences in a certain way. Conversely, it would also be of interest to study whether IN-OT has an effect on mysticism or spirituality in a less powerful non-ordinary state of consciousness setting, perhaps during a quiet meditation with minimal cues, so as to not confound the effects of IN-OT with expectancy or suggestibility.

The oxytocin literature has suggested links between hypnotic susceptibility, attachment history and oxytocin (Zelinka et al., 2014), as well as with absorption and having a new age personality (Granqvist, Fransson, & Hagekull, 2009) and between mysticism and attachment styles (Granqvist, Hagekull & Ivarsson, 2012). Moreover, it is also likely that individual differences in the oxytocin receptor gene are linked to individual attachment history, and variations at the OXTR are linked to lower hypnotizability (Bryant, Hung, Dobson-Stone, & Schofield, 2013). Clarifying how different personality dispositions interact with IN-OT, the oxytocinergic system and with each other, and putting them in the context of evolutionary and biopsychosocial developmental processes would be an important contribution to psychology.

Future studies could also investigate possible therapeutic applications of IN-OT as it has been proposed that the sense of connectedness – with the self, with others and the world at large – may be essential for psychological well-being, and perhaps that a lack of connectedness may be a key deficiency in many forms of mental health issues (Carhart-Harris, Erritzoe, Haijen, Kaelen & Watts, 2017). Therefore, if IN-OT leads to increases in connectedness, it may improve psychotherapeutic processes in treating several forms of mental health. At the same time, the suggestibility-enhancing effects of oxytocin may also be utilised in facilitating treatment of certain types of mental health (Harris & Carter, 2013), making this another important effect to investigate further.

Future replication studies should employ as similar experimental setups and demographics as possible, while keeping in mind the many individual variables that may influence the effects of IN-OT on mysticism, spirituality, and on other outcomes. It would also be important to take into account and control for social desirability of expected effects, perhaps including post-administration questions about how desirable participants find certain key variables to be explored, to rule out any social desirability effects and demand characteristics of the experimental set-up.

**Conclusion**

The present study may add a little more uncertainty regarding the effects of IN-OT on mysticism and spirituality, in that administering IN-OT may not increase either of these non-ordinary states of consciousness, regardless of controlling for religiosity or not. The finding that absorption interacts with IN-OT on both spirituality and mysticism suggests that IN-OT effects in the present study, and perhaps also in some previous studies on socio-behavioural outcomes, may be explained by IN-OT acting to increase suggestibility among low-absorption individuals.
References


