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Expanding the Scientific Study of Self-Experience with Psychedelics

Abstract: *The nature of the self has long been a topic of discussion in philosophical and religious contexts, and has recently also garnered significant scientific attention. Although evidence exists to suggest the multifaceted nature of self-experience, the amount of research done on each of its putative components has not been uniform. Whereas self-reflective processing has been studied extensively, non-reflective aspects of self-experience have been the subject of comparatively little empirical research. This discrepancy may be linked to the methodological difficulties in experimentally isolating the latter. Recent work suggests that one potential way to overcome these difficulties is through the experimentally-controlled administration of psychedelic substances that have the ability to reliably alter non-reflective aspects of self-experience. Here, we review what we know so far about the phenomenology of alterations in self-experience that occur as a result*

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of the administration of psychedelics. We also introduce a taxonomy of such alterations in terms that can bridge contemporary cognitive neuroscience and research on psychedelics. We conclude that the scientific understanding of self-experience may be significantly advanced by expanding experimental paradigms and theoretical accounts to incorporate work with psychedelic substances.

1. Self-Experience and its Scientific Study

The sense of oneself as an agent in the world is one of the most familiar components of the human experience. Despite this subjective familiarity, the scientific construct of ‘the self’ has continually eluded precise definition and understanding. Following a long history of discussion in philosophical and religious contexts, recent years have seen the emergence of scientific interest in the self in fields such as cognitive psychology and neuroscience (Christoff *et al.*, 2011; Damasio, 1999; Northoff *et al.*, 2006; Qin and Northoff, 2011; Sui and Gu, 2017). This work conceives of the self as a multifaceted construct that can be divided into reflective (the ‘me’) and non-reflective aspects (the ‘I’), and can encompass multiple components, such as self-location, self-ownership, self-agency, and so on (see Table 1). In addition, a number of types of self have been proposed, such as Antonio Damasio’s tripartite model of a ‘proto self’, ‘core self’, and ‘autobiographical self’ (Damasio, 1999), and more scientifically elusive types such as the ‘minimal self’ (Blanke and Metzinger, 2009; Gallagher, 2000).

The interest in decomposing self-experience and understanding its different aspects has, at least in part, been motivated by an appreciation of its clinical importance. Disturbances of self-experience are a primary feature of a number of psychopathologies. Perhaps the most prominent among these is psychosis (Parnas and Handest, 2003). Individuals suffering an acute episode of psychosis can experience a number of self-disturbances, including dysfunctional self-ownership, self-agency, and sense of first-person perspective (*ibid.*). Disturbances of self-experience are also present in ruminative depression, in which individuals are unable to disengage from an excessive preoccupation with the autobiographical self (particularly its perceived negative aspects) and its associated self-referential mental content (Nolen-Hoeksema, 1991). Another example is the alteration in bodily self-experience that may occur in individuals with anorexia, who can

experience notable disparities between actual body properties (e.g. waist size) and body image (Cash and Deagle, 1997).

Component/type of self-experience	Brief definition	Examples of relevant empirical and/or theoretical work
Self-ownership	The experience of identifying one's physical body or a thought as being 'mine'	(Botvinick and Cohen, 1998; Seth, 2013; Tsakiris, 2010)
Self-agency	The experience of being the initiator of one's physical or mental actions	(Christoff <i>et al.</i> , 2011; Sperduti <i>et al.</i> , 2011)
Self-location	The experience of being located at a particular point in space	(Blanke and Arzy, 2005; Ehrsson, 2007; Ionta <i>et al.</i> , 2011)
First-person perspective/minimal self	The bare awareness of being a subject of experience	(Blanke and Metzinger, 2009; Gallagher, 2000; Ionta <i>et al.</i> , 2011)
Autobiographical/narrative self	The experience of being a distinct individual with a temporally embedded personal history	(Araujo, Kaplan and Damasio, 2013; Araujo <i>et al.</i> , 2015; Damasio, 1999)
Body image/representation	The experience of the size, shape, or configuration of one's body/particular body parts	(Ehrsson <i>et al.</i> , 2005; Longo, Azañón and Haggard, 2010)
Body boundaries	The experience of having distinct boundaries between one's body and the external environment	(Blanke and Metzinger, 2009)

Table 1. A non-exhaustive list of some components/types of self-experience.

Despite the prevalence of a composite notion of self-experience, with multiple aspects and clinical consequences, much of cognitive neuroscience research on the self has focused on tasks involving self-reflective processing (Christoff *et al.*, 2011). Studies of this type typically involve a contrast between stimuli and tasks that are self-related vs. non-self-related, and involve assessments of actions,

personal traits, physical appearances, or images (Northoff *et al.*, 2006; Qin and Northoff, 2011). This work, while contributing to the elucidation of self-reflective processing, leaves out important non-reflective aspects of self-experience (Christoff *et al.*, 2011).

A mature cognitive neuroscience of the self would be one that attempts to address self-experience in all of its heterogeneous components. Towards this end, one proposal put forward an account of agentic self-experience on the basis of sensorimotor and homeostatic self-specifying efferent–reafferent processes (Christoff *et al.*, 2011; Legrand and Ruby, 2009). This proposal introduced the concept of a ‘self-specifying process’ as a potential process of interest to be investigated empirically in the neuroscience of self-experience, and as such provided a useful conceptualization of how self-experience may be scientifically approached. Another proposal specifically argued for a predictive coding approach to certain components of self-experience, such as body ownership and self-agency (Seth, 2013). In this model, interoceptive experience and its associated feelings of body ownership are mediated by actively generated predictive models of afferent viscerosomatic information, which continuously attempt to minimize their prediction error. Yet another approach explores bodily self-consciousness, by means of experimental paradigms that create mismatches between visual, tactile, and proprioceptive sensory input so as to induce distortions of bodily self (Blanke, 2012). This line of research has delineated three aspects of bodily self-experience: self-identification, self-location, and first-person perspective (*ibid.*; Blanke and Metzinger, 2009).

Overall, however, there appears to be a relative lack of experimental approaches to the study of the full spectrum of self-experience. The limited set of experimental approaches in this area is likely a result of the methodological difficulty of investigating self-experience and its different components. Self-experience phenomenologically presents itself as a seamlessly integrated phenomenon during regular waking consciousness. Whereas different components of self-experience may be dissociable based on brain injuries or psychopathology, we only have a limited set of tools that enable us to experimentally manipulate those components in healthy populations. For example, there are currently no established paradigms for the experimental manipulation of components of self-experience such as thought ownership and the stability of one’s autobiographical self. Can work with psychedelic substances expand the repertoire of available experimental tools and expand the scope of scientifically tractable forms of self-experience?

2. Psychedelic Substances and Self-Experience

Recent research with psychedelic substances has suggested that they can induce the reliable, dose-dependent, and transient perturbation of different components of self-experience (Carhart-Harris *et al.*, 2016b; Lebedev *et al.*, 2015; Nour and Carhart-Harris, 2017; Nour *et al.*, 2016; Tagliazucchi *et al.*, 2016). In particular, the serotonergic psychedelics psilocybin (the active compound in ‘magic mushrooms’) and lysergic acid diethylamide (LSD) have received attention for the alterations in self-experience that they induce (Nour and Carhart-Harris, 2017; Carhart-Harris *et al.*, 2016b; Lebedev *et al.*, 2015). This research has emerged in the context of a broader renewal of scientific interest in psychedelics, including research on their potential therapeutic utility for conditions such as depression, obsessive-compulsive disorder, addiction/alcoholism, and end-of-life anxiety (Bogenschutz *et al.*, 2015; Carhart-Harris *et al.*, 2016a; Garcia-Romeu, Kersgaard and Addy, 2016; Gasser, Kirchner and Passie, 2014; Johnson *et al.*, 2014; Moreno *et al.*, 2006). There has also been a resurgence of scientific investigations into the neurobiological basis of psychedelically-induced changes in mental functioning and the alterations in brain network connectivity that accompany them (Carhart-Harris *et al.*, 2012; 2013; 2015; 2016b; Halberstadt, Vollenweider and Nichols, 2018; Kaelen *et al.*, 2015; Lebedev *et al.*, 2015; Lewis *et al.*, 2017; Muthukumaraswamy *et al.*, 2013; Nour and Carhart-Harris, 2017; Nour *et al.*, 2016; Preller *et al.*, 2017; Roseman *et al.*, 2014; Tagliazucchi *et al.*, 2016).

This research has identified the so-called ‘ego-dissolving’ effect of psychedelics as an area of particular interest, due to its therapeutic potential (Garcia-Romeu, Kersgaard and Addy, 2016; Griffiths *et al.*, 2008; 2006), as well as its theoretical utility for understanding self-experience (Letheby and Gerrans, 2017; Millière, 2017; Nour and Carhart-Harris, 2017). Ego-dissolution pertains to a particular set of alterations of self-experience, in which the subject’s sense of being an individual that is distinct from the environment and others becomes blurred or, in some cases, abolished completely (Carhart-Harris *et al.*, 2016b; Lebedev *et al.*, 2015; Nour and Carhart-Harris, 2017; Nour *et al.*, 2016; Pahnke and Richards, 1966; Tagliazucchi *et al.*, 2016).

While recent research regarding psychedelic alterations of self-experience has focused on ego-dissolution, work from the early years of psychedelic research features more comprehensive discussions of psychedelic phenomenology. This work, including a number of

comprehensive monographs (Cohen, 1964; Grof, 1976; Houston and Masters, 1966) and research papers (e.g. Fischer, Georgi and Weber, 1951; Fischman, 1983; Klee, 1963; Leuner, 1962; Linton and Langs, 1962; Savage, 1955), gives an account of psychedelic alterations of self that is broader and more detailed than recent treatments. Here we review and incorporate the descriptions found in this early work, in order to gain a greater understanding of the manner in which different aspects of self-experience can be altered by psychedelics.

The primary goal of this paper is to facilitate greater interaction between research with psychedelics and investigations into the neural basis of self-experience. To do this, we provide a review of the alterations in self-experience discussed in the psychedelic literature, while offering a taxonomization in terms relatable to contemporary cognitive neuroscience. We focus on work involving the serotonergic psychedelic compounds lysergic acid diethylamide (LSD) and psilocybin, because recent years have singled out these substances for their self-altering effects. We also draw explicit comparisons to relevant work in the literature on self-experience and suggest ways in which research with psychedelics may provide novel perspectives and insight.

3. Phenomenological Characteristics of Psychedelic Alterations of Self-Experience

3.1. Alterations in Bodily Self-Experience

The cognitive neuroscience literature on self-experience suggests that bodily self-experience encompasses a number of distinct components, including body ownership, self-location, and first-person perspective (Blanke, 2012; Seth, 2013). In combination, these processes create a sense of owning and inhabiting a physical body which is the locus of one's experience. An additional aspect of body awareness that is relevant for the present discussion is the existence of a body image which includes representations of different body parts and their spatial locations, sizes, and shapes (Longo, Azañón and Haggard, 2010). Although recent research has not explicitly framed psychedelic subjective effects in the above terms, much early work with psychedelics discussed alterations to such processes. In what follows we discuss five different forms of alterations to the bodily self, as reported in the psychedelic literature.



Figure 1. Components of self-experience altered by psychedelics.

3.1.1. Body image/representation

During a psychedelic experience, a range of possible alterations to the representation of one's body may occur. As described in an early comprehensive account of the psychedelic experience, 'the subject may, for example, experience slight or drastic changes in the size, configuration, substance, weight and other attributes contributing to definition of the body' (Houston and Masters, 1966, p. 63). These alterations can involve specific body parts, or the body as a whole (Cohen, 1964; Grof, 1976; Houston and Masters, 1966; Linton and Langs, 1962). Moreover, it is often the case that the alterations occur in line with the allocation of attention (Houston and Masters, 1966; Savage, 1955). For example, body parts that are attended to visually or interoceptively may grow or change in character proportional to the amount of attention allocated to them (Savage, 1955).

With respect to changes in perception of body size, individuals may variably feel contractions and miniaturizations of their body, or expansions and enlargements. These can take the form of, for example, a

particular limb feeling disproportionately large, or the feeling that one has shrunk to the size of an action figure (Fischer, Georgi and Weber, 1951; Houston and Masters, 1966; Savage, 1955). These perceived alterations can also sometimes be grandiose in character; 'he may be reduced to a sub-atomic particle or expanded to the proportions of a galaxy' (Houston and Masters, 1966, p. 63). Interestingly these alterations often seem to have a psychogenic basis, such that, for example, feelings of inferiority lead to the perception of miniaturization (Grof, 1976; Houston and Masters, 1966).

Direct parallels can be found in contemporary research on body image. This work has revealed the remarkable vulnerability of the representations of one's body parts to illusory distortions. Experimental paradigms have found that sending conflicting sensory signals or artificially generating muscle tendon vibrations can elicit alterations such as the perception of arm length contraction (Longo *et al.*, 2009), arm length elongation (Schaefer *et al.*, 2007), and waist shrinking (Ehrsson *et al.*, 2005). Studies in this area also suggest that alterations in body size and shape can be elicited by anaesthesia (Gandevia and Phegan, 1999; Paqueron *et al.*, 2003), pain (Gandevia and Phegan, 1999), and conditions such as strokes and epilepsy (Critchley, 1953; Todd, 1955). Jointly, this research suggests that the representation of one's body parts and their associated size, shape, and configuration is subserved by the multisensory integration of visual, tactile, and proprioceptive information from across the body (Blanke, 2012; Giummarra *et al.*, 2008). Moreover, it appears that this integration seeks to maintain an overarching consistency: contradictory information between body segments result in attempts at reconciliation that manifest as illusions.

This ability of psychedelic substances to elicit alterations in bodily self-experience underscores their potential utility in studying the neural basis of self-experience. Using sensory mismatch paradigms, a number of studies have identified regions of multimodal association cortex as central to maintaining a stable and integrated body representation (Longo, Azañón and Haggard, 2010; Tsakiris, Costantini and Haggard, 2008). The TPJ in particular is thought to be a core region that integrates multisensory information to mediate the experience of a coherent body image (Tsakiris, Costantini and Haggard, 2008). Consistent with this, research with psychedelics such as LSD and psilocybin has demonstrated that these substances exert their most significant effect on the activity and connectivity of regions of multimodal association cortex, including the TPJ (Roseman *et al.*, 2014;

Tagliazucchi *et al.*, 2016). One study notably found a direct relationship between TPJ connectivity and ego-dissolution (Tagliazucchi *et al.*, 2016). We hypothesize that psychedelics elicit alterations in bodily self-experience by altering the multimodal integration of sensory signals that usually mediates the experience of a stable and veridical body image.

There are also alterations in bodily self-experience that seem to be uniquely associated with psychedelic administration, and which have not been observed in other experimental contexts. Psychedelic alterations in body self-experience are often linked to the individual's mental state and/or autobiographical self and sometimes occur in accordance with one's self-referential thought content (Cohen, 1964; Grof, 1976; Houston and Masters, 1966; Savage, 1955). The 'psycho-genic' alterations in body image during the psychedelic experience may occur via mechanisms similar to the distortions that occur in anorexia. Supporting this, research has suggested that the precuneus/PCC (an association region strongly implicated in the mechanism of action of serotonergic psychedelics) and other high-level parietal regions play a role in the aberrant body size estimation of anorexia patients (Ehrsson *et al.*, 2005; Mohr *et al.*, 2010). Additional work has further suggested a direct link between serotonergic activity and anorexia (Kaye *et al.*, 2005). This parallel with body distortions in anorexia also suggests a potential use of psychedelics for clinical applications that may target the normalization of body image distortions.

Another property unique to the psychedelic state is the perceived ability to use one's selective and sustained attention to guide or alter the distortions in bodily self-experience. This perceived ability, if proven to be consistent and reliable, could facilitate targeted experimental investigations into particular alterations of bodily self-experience. Overall, it seems that psychedelics have an important and so far largely overlooked potential to play an important role as experimental tools for the study of body image and its clinically relevant alterations.

3.1.2. *Body boundaries*

Individuals also often experience a marked blurring of the distinction between one's body and the environment, or the incorporation of external objects into their body image (Cohen, 1964; Grof, 1976; Houston and Masters, 1966; Savage, 1955). This exemplifies the oft-repeated claim by individuals undergoing psychedelic experiences that

‘it becomes increasingly difficult to tell where the body leaves off and the rest of the world begins’ (Savage, 1955, p. 9). An individual may claim that they ‘feel as though [their] body is melting away’ (Klee, 1963, p. 3), or, for example, that ‘[their] body outline seems lost and appears confluent with the bed, like a sheet lying on the bed’ (Savage, 1955, p. 8). Experiences can also involve referencing external events as affecting one’s body; for example, ‘the individual [may] look out the window at the cars passing by and feel the cars running over him’ (*ibid.*, p. 9).

The expansion of one’s body image can also feature an experience of ‘uniting’ or ‘merging’ with other individuals, with inanimate objects, with animals, or with ‘all of the universe’ (Cohen, 1964; Grof, 1976; Houston and Masters, 1966; Pahnke and Richards, 1966). Such experiences are often viewed as the peak or pinnacle of alterations in bodily self, and are experienced alongside other alterations in cognition, affect, and sense of self (Grof, 1976; Pahnke and Richards, 1966). They are often received positively by the individual, and viewed as ‘mystical’ in character (see section 3.2.1 for further discussion on mystical/unitive experiences).

Research on bodily self-experiences has induced some of the same alterations of bodily boundaries, including the incorporation of specific external objects into one’s body image (Blanke and Metzinger, 2009). However, the induction of a general loss of bodily boundaries, in contrast to the deliberately elicited incorporation of specific objects, has to our knowledge not been achieved experimentally. Psychedelic alterations of this type, therefore, may offer a unique opportunity to experimentally explore the creation and maintenance of stable body boundaries. It is possible that the ability of psychedelics to induce attenuation or loss of bodily boundaries is related to psychedelics’ capacity to alter the connectivity of critical multimodal integrative regions in the brain — regions such as the TPJ and PCC. Findings suggest a general increase in global functional connectivity after psychedelic administration (Roseman *et al.*, 2014; Tagliazucchi *et al.*, 2016), which could lead to greater integration of information in the brain and a subsequent blurring between external sensory information and interoceptive/proprioceptive information (Roseman *et al.*, 2014; Tagliazucchi *et al.*, 2016). Consistent with this, the connectivity of the TPJ and insula, both of which are highly involved in the processing and integration of sensory signals from within and from outside the body, were found to be associated with LSD-induced ego-dissolution (Tagliazucchi *et al.*, 2016). The blurring

of bodily boundaries and self-environment differentiation also has clinical parallels in the experiences of individuals suffering from psychosis (Chapman, Chapman and Raulin, 1978; Parnas and Handest, 2003), certain localized strokes (Critchley, 1953), epilepsy (Salanova *et al.*, 1995), and certain types of meditation (Dambrun, 2016; Josipovic, 2014).

3.1.3. *Body awareness, ownership, and location*

Following psychedelics administration, individuals may also experience a progressive loss of awareness of body parts (Houston and Masters, 1966; Savage, 1955). Specific limbs may feel as if they are detached from the body, and there may be a progression in which all of one's body parts may sequentially disappear from one's body representation. This can then culminate in a state of 'body-dissolution' in which all perception of having a body is lost (Houston and Masters, 1966; Savage, 1955). This state of body-dissolution is often associated with unitive mystical experience, and is typically positively received (Griffiths *et al.*, 2006; Grof, 1976; Houston and Masters, 1966; Pahnke and Richards, 1966).

The phenomenology of reductions in the awareness of specific body parts under the influences of psychedelics may be similar to conditions caused by brain lesions localized to the parietal lobe, such as autopagnosia (Berlucchi and Aglioti, 1997), and to the experiences of individuals undergoing localized anaesthesia (Paqueron *et al.*, 2003). It may also parallel alterations in self-awareness experienced during early and acute psychosis (Parnas and Handest, 2003). In contrast, the conscious experience of a totally abolished sense of having a body, to our knowledge, has not previously been explicitly examined in an experimental setting. It is of note, however, that such experiences are specifically cultivated in certain meditative traditions (Bryant, 2015; Josipovic, 2014).

Individuals in some cases may also undergo experiences of estrangement from their body (Fischman, 1983; Leuner, 1962; Savage, 1955). They may observe their body parts and deny that they are their own. This involves the perception of being a 'bystander', wherein one observes one's body without identifying with it (Fischman, 1983; Klee, 1963). Suggestive of the phenomenology of this experience, one researcher described it as an experience of the 'separation of body and soul' (Kleinman, Gillin and Wyatt, 1977, p. 573).

This experience is similar to the body-ownership illusions elicited by sensory mismatch paradigms, the most well-known of which is the ‘rubber hand illusion’ (Botvinick and Cohen, 1998). To generate this illusion, one of the subjects’ hands is placed out of sight and replaced by a life-sized rubber hand, and the experimenter uses brushes to stroke both the rubber hand and out of sight hand simultaneously. This temporally synchronized tactile and visual information leads subjects to experience the rubber hand as their own, implying that attributions of body ownership are contingent on the integration of multisensory inputs, and the differential weighting thereof (*ibid.*; Ehrsson, Spence and Passingham, 2004). Notably, however, such paradigms involve the displacement of body ownership to an external object, whereas the psychedelic experience can involve a loss of body ownership altogether. Thus, while related mechanisms may be at work, it is intriguing to consider how psychedelics may elicit this unique effect. The experience of a loss of body ownership is also highly reminiscent of somatopsychic depersonalization as experienced by schizophrenic patients (Zaytseva *et al.*, 2015). Somatopsychic depersonalization is a rare symptom that involves the feeling that there is a large experiential divide between the locus of one’s first-person awareness and the body, such that the body seems to be a foreign, mechanical entity rather than an aspect of the self (*ibid.*). However, an important difference between this experience and the experience when elicited by psychedelics is that the latter is often viewed in a positive light, as an experience of freedom from constraint (Grof, 1976).

Individuals may also experience phenomena similar to so-called ‘out-of-body experiences’ during a psychedelic experience. These are experiences in which one locates one’s sense of bodily self and one’s first-person perspective at a spatial location outside of the physical body (Blanke and Arzy, 2005). During psychedelic experiences such phenomena may occur in a variety of ways. For example, ‘the body may become separated from the individual so that he feels himself sitting off in a corner or standing in back or the side of himself’ (Savage, 1955). Or individuals may feel ‘completely detached from their physical bodies, hovering above them or watching them from another part of the room’ (Grof, 2009). Thus, psychedelics also offer a complementary source of information for this phenomenon, which does not rely on the multisensory mismatch paradigms used in bodily self-experience research.

3.2. Alterations in Mental Self-Experience

During a psychedelic experience, individuals also often report alterations in what are sometimes referred to ‘mental’ aspects of self. Such alterations include attenuation or dissolution of one’s autobiographical self and the sense of internal/external differentiation, as well as reduction in perceived thought ownership. These alterations occur less frequently than bodily alterations, and usually occur subsequent to initial changes in bodily self (Savage, 1955).

3.2.1. Attenuation of autobiographical self/ ego-dissolution

Depending on a variety of factors including dosage and setting, changes in bodily self may be also accompanied by changes in one’s sense of autobiographical self during a psychedelic experience. Recent work has defined the autobiographical self as the sense of self predicated on the retrieval and cognizance of memories and facts about one’s life (Araujo, Kaplan and Damasio, 2013; Araujo *et al.*, 2015). It constitutes one’s temporally embedded identity and facilitates the construction of a personal narrative. An attenuation of the autobiographical self most often occurs at the peak of subjective effects, and is considered to be a core aspect of ego-dissolution (Lebedev *et al.*, 2015; Nour and Carhart-Harris, 2017; Nour *et al.*, 2016). Notably, attenuation of the autobiographical self seems to only occur following initial changes in bodily self (Grof, 1976; Savage, 1955). Thus, alterations in the bodily self and alterations in autobiographical self may have some degree of independence, but co-occur during peak ego-dissolving experiences.

As previously mentioned, ego-dissolution can be seen as the experience of attenuation or abolishment of one’s sense of being a well-defined and temporally embedded individual entity. One recent study described ego-dissolution as pertaining to ‘a reduction in the normally well-circumscribed experience of self... [which] is related to a feeling of increased unity with others and one’s surroundings’ (Nour and Carhart-Harris, 2017, p. 1). In an attempt to refine these definitions and provide a unified measure of ego-dissolution, Nour and colleagues recently introduced a scale they refer to as the ‘Ego-Dissolution Inventory’ (Nour *et al.*, 2016). This scale features eight ego-dissolution-related questions (Table 2), chosen on the basis of the existing literature and devised with the consensus of a number of researchers engaged in psychedelic research. Individuals rate each question on a 0–100 visual analogue scale with incremental units of

one, with 0 defined as ‘No, not more than usually’ and 100 as ‘Yes, entirely or completely’ (*ibid.*).

I experienced a dissolution of my ‘self’ or ego
I felt at one with the universe
I felt a sense of union with others
I experienced a decrease in my sense of self-importance
I experienced a disintegration of my ‘self’ or ego
I felt far less absorbed in my own issues and concerns
I lost all sense of ego
All notion of self and identity dissolved away

Table 2. Ego-dissolution questions featured in the ‘Ego-Dissolution Inventory’ (Nour *et al.*, 2016).

Although the questions from the ‘Ego-Dissolution Inventory’ allow for the assessment of ego-dissolution in some detail, they nevertheless stop short of providing a precise description of the specific components of self-experience that are involved. Although an individual may report experiencing a ‘disintegration or dissolution of self or ego’, it remains unclear how this description is related to specific components of self-experience.

In general, ego-dissolution experiences tend to be considered a core feature of so-called ‘mystical experiences’ (Barrett and Griffiths, 2017; Barrett, Johnson and Griffiths, 2015; Pahnke and Richards, 1966). Psychedelic ego-dissolution experiences may be labelled as ‘mystical’ because of their strong phenomenological correspondence with mystical experiences as described across various religious and mystical traditions (Griffiths *et al.*, 2006; Pahnke, 1963; Pahnke and Richards, 1966; Stace, 1960). Thus, a brief discussion of the phenomenology of such experiences may be informative for an understanding of autobiographical self attenuation or ego-dissolution.

Broadly, two types of mystical experiences have been delineated, both of which have been documented to occur under the influence of psychedelic substances to varying degrees (Barrett *et al.*, 2015; Griffiths *et al.*, 2006; Pahnke, 1963; Pahnke and Richards, 1966). These are referred to as ‘internal’ and ‘external’ mystical experiences (Pahnke, 1963; Pahnke and Richards, 1966; Stace, 1960). Internal mystical experiences involve a progressive detachment from sense perceptions (interoceptive and exteroceptive), such that there is ultimately an experience of body-dissolution and all sensory awareness is lost. This is then accompanied by the dissolution of having a distinct

autobiographical identity, culminating in a phenomenological state of objectless and timeless unity sometimes described as ‘pure awareness’ (Pahnke and Richards, 1966; Stace, 1960). In contrast, external mystical experiences involve a heightened sensitivity to external stimuli which progresses to the point that the phenomenological distinction between the self (encompassing both bodily and autobiographical) and perceptual objects is dissolved, and one feels ‘unified’ or ‘one’ with all phenomena (Pahnke and Richards, 1966; Stace, 1960).

Thus, ego-dissolution experiences can be taken to involve both a blurring or dissolution of bodily boundaries and bodily awareness, and an attenuation or dissolution of the sense of having a temporally extended, individual autobiographical identity. Notably, psychedelics, to our knowledge, represent the only reliable experimental means of inducing such ego-dissolution experiences. Especially noteworthy is their ability to attenuate or abolish one’s temporally embedded autobiographical identity, an important high-level component of the self that has hitherto eluded experimental manipulation. Finally, ego-dissolution experiences can have significant positive effects on well-being (Griffiths *et al.*, 2008; 2006) and are considered central to therapeutic outcomes in psychedelically-assisted therapies (Garcia-Romeu, Griffiths and Johnson, 2013; Garcia-Romeu, Kersgaard and Addy, 2016; Gasser, Kirchner and Passie, 2014).

3.2.2. *Reductions in thought ownership*

As the psychedelic experience progresses, individuals may start to lose identification with their thoughts and emotions, similarly to the progressive loss of identification that can occur with respect to one’s body. Mental phenomena may ‘take on the character of objective reality’ (Savage, 1955, p. 12), and the individual may feel like a bystander watching the mental activity of another person (Fischman, 1983; Klee, 1963; Savage, 1955). This may proceed to the point that the individual experiences their thoughts as projected into the external world, and they may voice concern that their mind is accessible to others (Savage, 1955). This estrangement from one’s thoughts, which is often either subsequent to or coincident with estrangement from the body, has been described as the experience of ‘the observing self [becoming] dissociated from the experiencing self’ (Linton and Langs, 1962, p. 480).

This experience, to our knowledge, has not been induced in an experimental setting, but has parallels with the experiences of

advanced meditation practitioners, as well as individuals with psychosis. Individuals under the influence of a psychedelic may no longer identify with their thoughts, such that the attribution of ‘mine-ness’ to thought is severed. This is very similar to traits that are systematically cultivated in a number of meditation traditions, which explicitly emphasize the importance of reducing identification and attachment to one’s mental phenomena as a means to reduce/abolish suffering (Bryant, 2015; Sayadaw and Maung, 2002). In relation to individuals suffering from psychosis, the loss of thought ownership can also be subsumed under the symptom of somatopsychic depersonalization mentioned above (Zaytseva *et al.*, 2015). In addition, the experience of ‘thought insertion’ in some psychotic patients may be similar to alterations experienced with psychedelics. Thought insertion pertains to an experience of non-identifying with a certain subset of one’s thoughts with the corollary belief that it has been ‘inserted’ via some external source (Mullins and Spence, 2003). One notable difference, however, is that psychotics may feel the need to act on the content of ‘inserted’ thoughts, whereas the psychedelic experience appears to feature greater detachment from the thoughts such that they are seen as independent phenomena (*ibid.*; Savage, 1955). The ability of psychedelics to induce such experiences strongly suggests their potential utility in researching the mechanisms mediating thought ownership and mental agency.

It is interesting to consider the potential clinical application of psychedelically-induced reductions in thought agency, given that disidentification from thought is core to meditative practices such as mindfulness (Kabat-Zinn, 2003) which are themselves aimed at increasing well-being and equanimity. For example, it could be the case that reductions in thought ownership in individuals suffering from ruminative depression may assist these individuals in becoming aware of their maladaptive thought patterns and reshaping these patterns into more desirable directions (Dixon *et al.*, 2017; Fox *et al.*, 2016). Moreover, it is also intriguing to consider how alterations in thought ownership might relate to changes in the content and dynamics of spontaneous thinking, especially since the psychedelic state has often been characterized as a state of ‘unconstrained cognition’ (Carhart-Harris *et al.*, 2014; Christoff *et al.*, 2016; Ellamil *et al.*, 2016; Girn *et al.*, 2017; Mills *et al.*, 2017).

4. Psychedelics as a Tool in the Scientific Study of Self-Experience

Self-experience is a complex phenomenon that has so far presented a major challenge for scientific research. Progress has been slow to achieve, in large part due to the paucity of methods for the reliable experimental manipulation of the many aspects of self-experience. The work reviewed here suggests that psychedelic substances such as psilocybin and LSD can elicit a broad variety of alterations in self-experience and may therefore constitute an important tool to further this area of investigation.

Much of the research on self-experience has focused on bodily self-experience. Psychedelic alterations of body representation, body boundaries, body awareness, body ownership, and body location all have parallels in existing research, and yet feature important differences. Most evidently, psychedelic alterations are pharmacologically induced and are not the result of the targeted sensory mismatch paradigms commonly used. When uncontrolled, they seem to occur in a non-selective manner, but, critically, research also suggests a potential degree of controllability. This controllability is suggested by the apparent ‘psychogenic’ basis of the alterations: there have been ample reports of correspondence between the current mental state of the individual (encompassing thought content and affective valence; Christoff *et al.*, 2016) and the nature of the alterations experienced (Cohen, 1964; Grof, 1976; Houston and Masters, 1966; Savage, 1955). In this vein, it is intriguing to consider whether, under the influence of psychedelics, body image may be more susceptible to targeted alterations based on consciously sustained visual imagery. Individuals may also report greater sensitivity to sensory mismatch paradigms while in the psychedelic state. There have also been reports of conscious manipulation of alterations in body representation (e.g. size and shape of limbs) via sustained selective attention (Savage, 1955). This suggests that attention may have the capacity to amplify or attenuate specific alterations of self during the psychedelic state. The potential utility for the study of self-experience suggested by these hypotheses strongly warrants greater investigation into this area.

Psychedelically-induced alterations of self-experience can differ significantly across different individuals as well as within the same individual over time and different contexts. While some portion of this variability seems to be associated with the individual’s current mental state (Grof, 1976; Savage, 1955), there are likely additional factors

that give rise to differences in the susceptibility of individuals to certain alterations of self. Investigating these factors would provide important information on the causal underpinnings of these experiences, with potential clinical relevance.

The ability for psychedelics to attenuate one's sense of autobiographical identity and the corresponding experience of temporal embeddedness seems unique to psychedelics; to our knowledge, there are no known experimental manipulations that have the capacity to do so with any degree of reliability. This aspect of psychedelic alterations of self has already received strong scientific interest as a component of ego-dissolution experiences (Carhart-Harris *et al.*, 2016b; Lebedev *et al.*, 2015; Nour and Carhart-Harris, 2017; Nour *et al.*, 2016). The reductions in thought ownership possible with psychedelics also represent a unique window into the mechanisms that mediate identification with internal mental states. Additional research into alterations of autobiographical self-experience and thought ownership is important as it represents a potential means of addressing the relative experimental intractability of these components of self-experience.

The induction of changes in self-experience with psychedelic compounds has the potential to be a valuable tool in the scientific study of the self. After decades of dormancy due to drug policy restrictions (Nutt, King and Nichols, 2013), scientific interest in these compounds is resurging. As the research accessibility to these compounds increases, it opens a possibility for assessing their potential to advance particular fields of scientific investigation. Here we have argued that research on self-experience constitutes one of the fields of investigation that would benefit strongly. Psychedelics seem to present a novel and useful means of experimentally manipulating self-experience that may prove indispensable in the future progress of this field.

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