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Brain Oscillations and Diurnal Variations in Hypnotic Responsiveness—A Commentary on “Diurnal Variations in Hypnotic Responsiveness: *Is There an Optimal Time to be Hypnotized?*”

Mark P. Jensen

University of Washington, Seattle, USA

Abstract

A recent study published in the *International Journal of Clinical and Experimental Hypnosis* reported an interesting diurnal pattern of hypnotic responsivity; specifically, the authors found higher hypnotic responsiveness in a large sample of undergraduates in the morning and early evening. However, they did not have an explanation for this pattern of findings. This pattern is consistent, however, with the theta hypothesis of hypnotic responsivity. Further examination of the associations between brain oscillations and response to hypnosis is needed to determine if specific oscillations such as theta (1) actually facilitate response to some hypnotic suggestions, (2) merely reflect hypnotic responding, or (3) reflect another factor that itself plays a causal role in response to hypnosis.

Response to hypnosis and hypnotic suggestions represents an extremely complex phenomenon that is influenced by interacting biological, psychological, and social factors (Jensen, Adachi, Tomé-Pires, et al., 2015). In a recent article published in *the International Journal of Clinical and Experimental Hypnosis*, Green and colleagues examined the diurnal variation in hypnotic responsiveness in two large ($Ns = 697$ and 693) samples of undergraduates (Green, Smith, & Kromer, 2015). In this carefully conducted study, they found higher hypnotic responsiveness in the undergraduates in the morning and early evening. They noted that other researchers have found similar diurnal patterns of hypnotic responsivity when measures were administered to the same individuals over time (e.g., Aldrich & Bernstein, 1987; Wallace, 1993) but improved on the previous research by comparing the responses of *different* individuals who were administered the measure of hypnotic responsiveness at different times of the day. Thus, they addressed the question using a design that removed the potential biasing effects of practice with the hypnotizability measures. The fact that they found the same diurnal effect when examining the question using different methods confirms the reliability of the finding. Based on these findings, Green and colleagues concluded that the mid-morning may be the optimal time to be hypnotized and the afternoon the least favorable.

Critically, Green and colleagues noted that they were "...unable to conjecture why participants were less responsive in the afternoon" (p. 179, Green et al., 2015). They also demonstrated appropriate care in their interpretation of the findings by noting that "... we must be careful not to infer a causal explanation to correlational or observational findings..." and that "...the magnitude of the differences across our morning, afternoon, and evening start times were not huge..." (p. 179; Green et al., 2015). They concluded that "... the consistency of our findings across two data sets is intriguing and invites an explanation" (p. 179; Green et al., 2015). A central idea underlying the current commentary is to propose a potential explanation for their findings that deserves additional study.

Specifically, their findings appear to be consistent with what might be termed the "theta hypothesis" (Jensen, Adachi, & Hakimian, 2015; Jensen, Adachi, Tomé-Pires, et al., 2015)—that theta oscillations play a role (but not the only role) in hypnotic responding. This hypothesis is based on a convergence of three key findings and ideas. First, a large body of research indicates that neuronal ensembles that fire in the theta frequency (4–8 Hz) play a critical role in declarative memory encoding and retrieval (Buzsáki, 2006; Lisman & O. Jensen, 2013). Second, that theta power (reflecting the number of neuronal ensembles firing in the theta frequency) tends to increase with hypnotic procedures (Jensen et al., 2013; Sabourin, Cutcomb, Crawford, & Pribram, 1990; Williams & Gruzelier, 2001) and tends to be more prevalent in individuals who score high on measures of hypnotizability (Freeman, Barabasz, Barabasz, & Warner, 2000; Galbraith, London, Leibovitz, Cooper, & Hart, 1970; Kirenskaya, Novototsky-Vlasov, & Zvonikov, 2011; Montgomery, Dwyer, & Kelly, 2000; Sabourin, et al., 1990; Tebecis, Provins, Farnbach, & Pentony, 1975). Finally, that memory functions are arguably critical in being able to respond to many (or perhaps even most) hypnotic suggestions (Jensen, Adachi, & Hakimian, 2015). Based on this group of findings and observations, we have hypothesized that theta oscillations may facilitate hypnotic responsivity.

If theta plays a role in hypnotic responsivity, and given the findings reported by Green and colleagues we would expect to see peaks in theta power two times a day, on average—once in the morning and once in the late afternoon. Interestingly, and consistent with this hypothesis, while the power of *most* oscillation bandwidths are at their nadir in the early morning and increase during the day, peaking in the afternoon or evening (Aeschbach et al., 1999; Cacot, Tesolin, & Sebban, 1995; Lafrance & Dumont, 2000; Wehr, Aeschbach, & Duncan, 2001), researchers have noted a *biphasic* diurnal power variation in the theta band, with a peak in the mid-morning and late afternoon/early evening (Cacot et al., 1995). Also consistent with the hypothesis that theta oscillations may facilitate response to hypnosis are studies showing that EEG biofeedback reinforcing theta power can result in increased response to hypnotic suggestions (Jensen et al., 2016; Wickramasekera, 1977; see also Brady & Stevens, 2000).

However, identifying the brain oscillation correlates of hypnotic responsiveness is a complicated task for a number of reasons. First, while the power of most bandwidths shows a general increase from morning into the afternoon and evening, different bandwidths show different diurnal patterns, with the slower oscillations increasing sooner than the faster oscillations as the day progresses. In addition, the neurons that fire in the slower frequencies

(theta and alpha) tend to be inhibitory (i.e., result in a decrease in the chances that the receiving or “downstream” neuron will fire), and those that fire in the faster frequencies (beta and gamma) tend to be excitatory (i.e., result in an increase in the chances that the downstream neuron will fire; see review by Jensen, Adachi, & Hakimian, 2015). Thus, the activity measured in any one bandwidth is not entirely independent of the others. While theta has emerged as the most consistent bandwidth associated with hypnotic responding, the associations are not always statistically significant (e.g., Stevens et al., 2003) and one study has reported *reductions* in “theta1” bandwidth power (at the low end of the theta range; 4–5.75 Hz) with hypnosis (De Pascalis & Perrone, 1996). It is possible—even likely—that the absolute power of theta may be less important than how it interacts with other bandwidths; the theta/alpha or theta/beta ratio may be more predictive of hypnotic responsivity than absolute theta power. Researchers have yet to systematically examine this possibility.

Another complicating factor is that all brain oscillations, including theta oscillations, show strong 90–120-minute ultradian fluctuations in power in individuals throughout the day (Gertz & Lavie, 1983; Kaiser, 2008). Thus, while peaks in theta power or relative theta power might be observed in the morning and late afternoon or evening in large groups of individuals on average, there are marked ultradian changes in brain oscillations that shift in 90–120-minute cycles in individuals. Within that cycle throughout the day, there will be times when the power of each bandwidth will peak. Because of these complexities, the associations between the power of different brain oscillation bandwidths and hypnotic responding in correlational studies with groups, even when they show consistent tendencies, will not always emerge as strong or statistically significant. It will therefore be easier to identify these patterns when there is adequate power (i.e., large enough sample sizes) to test for them, as there was in the Green and colleagues' study (Green et al., 2015).

If the absolute power of theta or the amount of theta power relative to other oscillations facilitates hypnotic responding as proposed by the theta hypothesis, then not only would we predict more hypnotic responsivity when theta tends to peak during the day (e.g., in the mid-morning and late afternoon/early evening, on average) but we would anticipate that there would be times within each 90–120-minute cycle when individuals are more prone to respond to suggestions. As Green and colleagues point out, an ultradian pattern of hypnotic responsivity was noted by Ernest Rossi more than 30 years ago (Rossi, 1982). Rossi has also noted that Milton Erickson preferred to meet with clients for 90 minutes or longer and that Erickson was aware that people cycled in and out of receptive states. Erickson would then pay close attention to clients and simply wait until they became naturally more open to new ideas and suggestions during the session. His work did not always involve the use of a formal hypnotic induction. Thus, Rossi notes, Milton Erickson was less a genius of manipulation, “...but rather a genius of observation” (pp. 2–3; Rossi, 1991). Given these considerations, Green and colleagues' conclusion that the mid-morning may be the best time to be hypnotized might be qualified by saying that *all else being equal, and on average*, the mid-morning might be the best time to be hypnotized but that close observation of individual clients for signs of responsivity, even in the early afternoon, may be the best way to identify when a client or patient is ready to respond to hypnosis.

Although the theta hypothesis proposes a link between hypnotic responsivity and brain activity, it does not label a particularly high level of theta or relative theta as representing a “state” of hypnosis; the theta hypothesis is not so much a “state” model of hypnosis as a model that proposes a continuous biological factor that could directly facilitate or interact with other variables to facilitate an individual being more or less able to respond to hypnotic suggestions. However, it is interesting that some psychological variables shown to be associated with more theta power are variables that are also thought to be linked to hypnosis. These include both dissociation (positive association: Giesbrecht, Jongen, Smulders, & Merckelbach, 2006) and anxiety (negative association: Mizuki, Kajimura, Nishikori, Imaizumi, & Yamada, 1984; Suetsugi et al., 2000). In the same way that depression can be assessed and viewed as a continuous variable, while at the same time clinicians find it helpful to diagnose someone as being “depressed” or not, responsivity to hypnosis may be viewed a continuous variable (perhaps related in some way to theta power) and at the same time clinicians might find it helpful to classify someone as “hypnotized” or not based on a specific set of criteria (e.g., endorsing a subset of a number of different subjective experiences such as reduced anxiety, dissociation, and absorption, among others). The extent to which our field can move beyond arguing that hypnosis must or should be viewed primarily as one or the other (state versus nonstate), rather than as something that can usefully be viewed as both, remains to be seen.

Importantly, and as Green and colleagues point out, correlational data cannot be used as evidence for causality (although a lack of a significant correlation when adequate power for detecting a true association is present *can* be used as evidence for a lack of a causal effect). The role that theta oscillations play in hypnotic responding is not yet clear. It is possible, for example, that theta emerges as a by-product of hypnosis, like a daisy wheel held outside the window of an automobile that spins faster as the automobile moves faster; the daisy wheel in this instance is not “causing” the automobile to move faster or even facilitating a faster speed but merely reflecting that speed. On the other hand, it remains possible that the neuronal ensembles that fire in the theta range actually facilitate hypnotic responding, due to the properties unique to slower oscillations that may help to facilitate communication between brain regions, such as is required to encode and access memory (Buzsáki, 2006). As a correlational study, Green and colleagues' study—as important as it is for confirming an important observation—does not help to answer the causal question. Only longitudinal studies and true experiments in which theta oscillations are manipulated experimentally (studies that we are now conducting) can better address the causal role that theta oscillations might play in hypnotic responding.

A final point worth making also relates to the reliable but *weak* effects that time of day plays (and that theta or other oscillations may be found to play) in hypnotic responsivity: no single factor has been found to play a consistently strong role in predicting or explaining hypnotic responses. The factors that have emerged in research studies, such as general hypnotizability, expectancies regarding how one will respond to a hypnotic suggestion, being in a hypnotic context versus a nonhypnotic context, and rapport, among many others, tend to show weak effects and do not emerge as statistically significant every time they are examined (Jensen, Adachi, Tomé-Pires, et al., 2015). Our inability to identify (so far) consistently strong effects for any one factor that explains hypnosis may be the only consistent finding in our field.

This argues against the utility of simple one- or two-factor models for explaining the complex responses associated with hypnosis. Instead, these findings argue for the viability of more complex models that take into account biological, psychological, *and* social factors. Green and colleagues' study provides important support for the importance of time of day as one of these factors. While it appears that their finding may be consistent with the theta hypothesis, additional evidence is needed to determine whether and if theta oscillations themselves are indications of a biological process that actually facilitates response to hypnosis, or are merely a result of hypnotic responding or another factor that itself plays an important role. I have hope that research now underway may help to answer these important questions.

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Mark P. Jensen is the author of two books related to the topic of this paper (*Hypnosis for chronic pain management: Therapist guide* and *Hypnosis for chronic pain management: Workbook*). He receives royalties for the sale of these books.

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