Hypnosis and brain injury: four cases and three predictions

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Abstract

Recent studies have found large effects of hypnotic suggestion on cognitive impairment following acquired brain injury. However, little is known about the underlying mechanisms. A general framework is presented in which (1) a substantial part of cognitive brain-injury sequelae can be attributed to negative self-expectancies, and (2) hypnosis is a powerful way to manipulate negative self-expectancies. Four cases exemplify and add to this framework. First, mental imagery of brain recovery can be effective even if it does not correspond to the "real" physical brain injury. Second, some patients do not subjectively experience large objective. Third, ongoing litigation can selectively inhibit positive treatment effects in contexts where this is incentivized. Fourth, pre-injury autobiographical memories may be an important precondition for positive treatment effects. I conclude with three testable predictions, which can further optimize hypnosis for acquired brain injury.

Keywords: hypnosis, brain injury, concussion, rehabilitation, cognition

Hypnosis and brain injury: four cases and three predictions

Hypnosis has been successfully applied in rehabilitation of a wide range of sequelae following acquired brain injury, including motor disorders (Irawan, Mardiyono, Suharto, & Santjaka, 2018; Spankus & Freeman, 1962), aphasia (Thompson, Hall, & Sison, 1986), pain, vertigo, and many more (Appel, 2003; Cedercreutz, Lähtenmäki, & Tulikoura, 1976).

In the following, I will discuss the effects of hypnotic suggestion on cognition following acquired brain injury. Following a presentation of the general framework, I will discuss four illustrative cases to discuss nuances to the general framework.

The most prevalently impaired cognitive functions following acquired brain injury are working memory, concentration, attention, and fatigue. This is generally true across types of injury - from Mild Traumatic Brain Injury (sometimes called concussion) to severe strokes. Estimates point to prevalence rates around 50% for these sequelae (Carroll et al., 2004; Cumming, Marshall, & Lazar, 2013; Dunning, Westgate, & Adlam, 2016; Serino et al., 2006). Patients suffering from deficits in these domains will often complain that thinking itself has become a strenuous and unreliable activity. In everyday life, they experience difficulties understanding written and verbal language, they forget important appointments, and feel overloaded with information in public and social situations. Usually, this leads to elevated anxiety and the eventual retraction from many activities (Thomsen, 1984).

The most prevalent sequelae have a remarkable similarity to what is found in functional neurologic disorders and may, in part, be a functional overlay on an underlying neurological condition (Teodoro, Edwards, & Isaacs, 2018). Teodoro et al. (2018) have argued that these effects could be due to excessive interoceptive monitoring which interferes with routine

cognitive functions. The cause of such excessive interoceptive monitoring may be variants of negative self-expectancies (Lindeløv et al., in review).

For example, pre-injury expectations of hypothetical brain-injury sequelae are known to predict long-term outcomes of traumatic brain injury (Hou et al., 2012; Lange, Iverson, & Rose, 2010; Mittenberg, DiGiulio, Perrin, & Bass, 1992) on subjective outcomes in particular (Kaptchuk & Miller, 2015). It has a high degree of resemblance to the “nocebo effect”, which is the self-fulfilling prophecy of negative expectations (Polich, Iaccarino, Kaptchuk, Morales-Quezada, & Zafonte, 2018; Silver, 2015).

Another source of negative expectancies following acquired brain injury is the “being patient effect”. Many people with diagnoses take otherwise normal experiences of small failures or negative feelings in everyday life as evidence of a permanent impairment (Hou et al., 2012; Lange et al., 2010; Polich et al., 2018; Teodoro et al., 2018). In this way, the negative expectations become self-sustaining once they are in place.

Lastly, temporary disabilities may be over-generalized to an expectancy of permanent disability. Brain injuries often involve a post-acute period of imbalances in the brain. For example, strokes are followed by the ischemic cascade and traumatic brain-injuries are typically followed by inflammation. These temporary effects will wane after a few months, but if a patient’s expectations about his/her post-injury abilities are formed in this period, they would underestimate their long-term functioning. This would constitute a cognitive version of learned non-use, a well-known phenomenon in motor- and aphasia rehabilitation (Meinzer, Elbert, Djundja, Taub, & Rockstroh, 2007; Wolf, Lecraw, Barton, & Jann, 1989). It could be manifest as “cogniphobia” and fear avoidance following traumatic brain injury – the expectancy that engaging in challenging activities will lead to negative outcomes (Silverberg, Iverson, & Panenka, 2017; Silverberg, Panenka, &

Iverson, 2018). These have been shown to be strong predictors of long-term outcomes and thus constitute important targets in neurorehabilitation.

In summary, brain-injuries are very potent inducers of negative self-expectancies. These expectancies are likely to contribute negatively to the objective and subjective sequelae over and above the effects, which can be attributed directly to the permanent loss of neural tissue. Intervening on the negative expectancies could not only break the viscous cycle of self-sustaining negative expectancies, but also directly challenge them with the goal of improving cognitive functioning.

Hypnosis seems particularly well positioned to change expectancies, whether formed pre-injury or post-injury, as the modulation of expectancies is a core mechanism of hypnotic effects (Jamieson, 2016; Kirsch, 1985; Lifshitz, Howells, & Raz, 2012; Raz, 2007).

Recent studies have found large effects of hypnosis on cognitive and affective domains for patients with acquired brain injury (Cui-Ping, 2011; Lindeløv, in review; Lindeløv, Overgaard, & Overgaard, in review, 2017) as well as a smaller effect from a very brief intervention in one older study (Sullivan, Johnson, & Bratkovitch, 1974). However, this literature also has some methodological shortcomings (Lindeløv et al., in review). A randomized controlled study found very large and persistent improvements on working memory (all $d > 1.4$) following four and eight hours of hypnosis (Lindeløv et al., 2017). A further analysis of interview data from this study found a one-hour reduction in the median need for daily sleep as well as progress on 75% of patient-reported outcome measures (Lindeløv et al., in review). A study on patients suffering from long-term deficits following mild traumatic brain injury found very large improvements on self-reported fatigue ($d = 1.8$) and large improvements on self-reported depression and anxiety for non-malingering MTBI patients ($d > 0.8$) while the effects were considerably smaller for malingering

94 MTBI patients (Lindeløv, in review). The available evidence indicates that hypnosis is more cost-
95 effective than other methods for this patient group (Lindeløv, 2015).

96 **Our Approach**

97 The hypnotic procedures used in our studies have centered on suggestions that
98 thinking will become automatic, effortless, and reliable after the hypnotherapy (Lindeløv et al.,
99 2017). The protocol encourages the expectation that thinking “just works” and thereby tone down
100 the interoceptive monitoring and its detrimental effects on cognition (Teodoro et al., 2018).

101 Techniques towards this end include regression to the premorbid state (i.e., the
102 experience of being oneself prior to the injury), imagery of neuroplasticity, and posthypnotic
103 suggestions about improved memory capacity and attentional focus. We also specifically included
104 suggestions about trusting that the patient can improve, no matter his/her preconceptions or what
105 he/she has been told by others.

106 I present some illustrative excerpts from our manuscripts below. The square brackets
107 mark sections which are excluded here for brevity. Each script was read slowly and with frequent
108 brief pauses.

109

110 Regression to the premorbid autobiographical self:

111 *And while you continue relaxing, please imagine your life as a timeline.*

112 *Notice that you can float above yourself, so now you can look down on*

113 *yourself and your timeline. It stretches far into the future and far into the*

114 *past. Now, begin sliding back towards your past [More sliding] to a time*

115 *when your brain was functioning perfectly, and where you could take for*

116 *granted that you could do the things which you now find difficult to do.*
117 *[Find specific situations and experience them vividly] And take this re-*
118 *found knowledge and move forward, along your timeline, to the present*
119 *moment. Let this knowledge be a seed inside you, which begins to grow and*
120 *sprout. Brains are like roads: if something is blocked or closed, you can*
121 *find another way, and the new route can be just as good – or even better -*
122 *than the old one.*

123
124 Countering the ideas that a brain injury is static:

125 *Throughout life, your body has repeatedly repaired itself. If you had a*
126 *scratch on your skin, the bleeding automatically stopped. If you had a virus*
127 *infection, your immune system defeated it. Actually, everyone has tiny brain*
128 *hemorrhages throughout their life, so small repairs and restructuring is*
129 *happening all the time. In a moment, I will ask you to use this capability,*
130 *which is in your unconscious mind, to repair the things you need to repair.*
131 *[The brain is a computer that can be reprogrammed] So begin... continue...*
132 *and finish the changes or restructuring, necessary to regain what you lost.*
133 *You are regaining the ability to concentrate, be with others as before the*
134 *injury, you can rely on your memory, and in all other respects you regain*
135 *the functions that were affected.*

136
137 Hypnosis is not the only intervention targeting expectancies. Therapies directly
138 targeting expectancies, metaphors, and roles/identities have previously been successfully applied in
139 neurorehabilitation (Lorenz, 2010; Ylvisaker, Mcpherson, Kayes, & Pellett, 2008), though with

smaller effects than the hypnosis literature reviewed above. Compared to these quite deliberate methods, I believe that the above hypnotic procedures take a few shortcuts that enhances the treatment effect.

First, our hypnosis use the patient's premorbid self as a possible future self rather than some fictional or animal character, as Ylvisaker and colleagues did. As the autobiographical memory of the premorbid self is often idealized (Lange et al., 2010), the "memory" of a premorbid self may be thought of as an a goal rather than a blueprint. Second, compared to e.g. trying to identify with Superwoman, explicit and implicit memories of one's own premorbid self include well-rehearsed action schemas, so little deliberation is needed to transform this role into action. Consistent with this, implementation suggestions enhance responsiveness in and out of hypnosis – especially for low-hypnotizables (Barnier & McConkey, 2001; Bayer, Achtziger, Gollwitzer, & Moskowitz, 2009; Gallo, Pfau, & Gollwitzer, 2012), perhaps exploiting the fact that learning is most effective when it closely resembles the target situation (Lindeløv et al., 2016; Perkins & Salomon, 1989; Thorndike & Woodworth, 1901). Third, the patient's relatives "knows" his/her premorbid self so they can readily adjust to accommodate and sustain this change.

However, a "pure-expectancy" theory or a "pure pre-morbid role" theory would fail to account for important observations. The following cases serve to add nuances as well as to give real-world examples of how mechanisms could reveal themselves.

Case #1: Mental Imagery Need Not Correspond to the Physical Brain Injury to be Effective**Patient**

A middle-aged woman was diagnosed with idiopathic normal pressure hydrocephalus (iNPH) 13 years prior to undergoing hypnosis. NPH is a condition where neural tissue is displaced due to expanding cavities in the brain. iNPH is usually associated with a significant reduction in cognitive functioning (Miyoshi et al., 2005; Thomas et al., 2005).

In the present case, the iNPH had stabilized, and no medical procedures were undertaken to correct it. Her primary symptoms were strong fatigue, which she coped with by sleeping for four hours every afternoon in addition to seven hours of nightly sleep. She felt unable to work in her present condition and sought a hypnotist. Her aim was to (at least) regain the ability to take on a part-time job, e.g., in a thrift shop.

Results

During hypnosis, she found one imaginative experience particularly effective. She visualized walking along her cerebral cortex, noticing whether there were any abnormalities. As she was walking from the prefrontal cortex towards the parietal cortex, she “discovered” a large section of scarred, inflamed, and “disgusting” tissue. She described it in great detail, pointing to her superior parietal lobe. She immediately felt an insight that this was the cause of her problem. The hypnotist invited her to apply a healing ointment to the area, and she did. She reported seeing it heal up completely, becoming “smooth and tidy.” This was a very strong emotional experience for her, and she was in tears during the session and several hours afterward. Following this session, she needed only sleep one hour each afternoon. In other words, she had a three-hour reduction in daily sleep. In her waking hours, she reported that she was ready to seek work again but mused that until she got a job, her main challenge was now finding activities to fill in her extra wake-hours.

Discussion

Needless to say, hydrocephalus does not cause focal scarring of the cerebral cortex.

Case #1 indicates that, at least for some patients, the characteristics of the actual brain injury is of lesser importance for functioning (or perceived functioning) than the “perceived brain injury.”

Several other metaphors used in Lindeløv (2017) are physically implausible, including returning the brain to the premorbid state and undergoing extensive neuroplasticity in the order of minutes. Yet, only a few patients noted that these suggestions were nonsense. This is congruent with the finding that the general population has little introspective access to our cognitive functioning (Nisbett & Wilson, 1977; Zell & Krizan, 2014) as is also the case following acquired brain injury (Knight, Harnett, & Titov, 2005; Schiehser et al., 2011). Much less do we have introspective access to our brain structure. Even when objective assessments of brain integrity is available, such as lesion size and post-acute Glasgow Coma Scale Scores, they explain only around 10% of the variance in long-term outcomes (Carroll et al., 2004; Grafman, Salazar, Weingartner, Vance, & Amin, 1986; Zafonte et al., 1996).

As such, the “perceived brain injury” has a large space to roam free because it is only vaguely corrected by objective functioning. This also means that the patient and the hypnotist have a large degree of freedom to find the imagery, metaphors, or suggestions that most effectively target the core of the problem.

When case #1 metaphorically repaired her brain, she may have adopted a state of reassurance that her brain would automatically (or “subconsciously”) function much better. In this imagery lies an implicit expectations that she can rely on her thinking, which frees up mental resources by decreasing interoceptive monitoring (Teodoro et al., 2018).

The practical implications are the following: for cognitive sequelae following acquired brain injury, the hypnotherapist should provide suggestions that tap into the patient’s imagery and challenge the (negative) expectancies about the brain injury, regardless of whether this

207 imagery correspond to the objective reality or not. Attention to details of the autobiographical
208 memories or the actual premorbid condition may aid in ensuring transfer to the present state.

209 **Case #2: No Subjective Experience of Objective Improvement**

210 **Background**

211 Continuing on the same theme as case #1, we have been puzzled that a substantial
212 proportion of the participants lacked subjective experience of improvement despite large objective
213 treatment effects. We analyzed this extensively elsewhere (Lindeløv et al., in review) where an
214 exploratory factor analysis showed that only changes on objective outcomes (neuropsychological
215 tests and relatives' evaluation) co-varied while subjective reports were independent. Here, we
216 present one illustrative case of this phenomenon and its potential implications for theory.

217 **Patient**

218 A 58-year-old woman had suffered an intercerebral haemorrhage in the left parietal
219 lobe five years prior to enrollment in the study. She was on a disability pension. Her baseline
220 SHSS:C score was 2, i.e., low hypnotizability. She received procedure B in Lindeløv et al., (2017),
221 which consisted of four sessions of hypnosis based on mindfulness suggestions, followed by four
222 sessions of targeted suggestion (see the excerpts above). As with many low-hypnotizables, she
223 reported no experience of trance, worrying that she was unfit for the treatment. The therapist
224 assured her that hypnosis need not feel in a particular way to be effective (when blinding was lifted,
225 we later learned that low SHSS:C scores did not reduce treatment effects).

226 **Results**

227 She had major improvements in the cognitive tests. These were the Working Memory
228 Index which is calculated from mental arithmetic, digit span and letter-number sequencing from the

Wechsler Adult Intelligence Scale (Wechsler, Coalson, & Raiford, 1997) and the Trail Making Tests form A and B (Sánchez-Cubillo et al., 2009). Her Working Memory Index improved from a the 0.17 % percentile to the 10% percentile, i.e., 1.67 standard deviations. Similarly, she halved the completion time on the Trail Making Test from 39 to 19 seconds on form A and from 109 seconds to 39 on form B. However, she did not experience these improvements when asked how her present performance compared to the baseline performance.

By chance, I met her at a party two years later. She reported that although her friends and relatives had noted a large improvement in her energy, communication, and planning abilities, she did not experience any change herself. It was only after a few months when her husband pointed out to her that she did not have bruises anymore that she realized that something had changed. She had stopped walking into doorframes, tables, etc. without noticing it! At this point, she learned not to trust her subjective self-evaluations, and this led her to notice other tangible evidence of improvements, e.g., that since hypnosis, she had not left a party early like she often used to do. She stayed for the full party where I met her, being very engaged and talkative.

Discussion

We have received similar reports from around a third of the participants in Lindeløv et al. (2017). Most participants report immediate improvement, but were later surprised to learn that the improvement was much larger than initially felt.

This is the awareness-problem in reverse. Some patients with acquired brain injury do not feel impaired in the days and weeks following the injury, but come to understand their own abilities through hard evidence from experiences of failing (J. Schmidt, Lannin, Fleming, & Ownsworth, 2011). Mirroring this, our participants did not feel an *improvement* in the days and weeks following therapy, but came to understand their own abilities through experiences of

succeeding, including experiences of not failing where they used to. In both cases, external observers are sometimes needed to bring about this awareness.

This is congruent with the poor introspective access to cognitive functioning, mentioned in the discussion of case #1 (Knight et al., 2005; Nisbett & Wilson, 1977; Schiehser et al., 2011; I. W. Schmidt, Berg, & Deelman, 2001; Zell & Krizan, 2014). However, it does put a constraint on negative expectancy as one (out of several) mechanisms sustaining the impairment. Case #2 continued to have an unchanged explicit expectancy following hypnosis which is at odds with expectancy change as an underlying mechanism. However, expectancy need not be all explicit. Indeed, placebo and nocebo effects can, at least in part, be realized through effects of classical conditioning, as can the effects of hypnotic suggestion (Dienes et al., 2015; Kirsch, 1985; Lifshitz et al., 2012; Polich et al., 2018). This would be congruent with the experience of surprise that case #1 experienced upon experiencing a vivid image of her “brain injury” as well as the lack of experienced effect in case #2.

I think that two factors provide a substantial contribution towards this experience of automaticity.

First, most of our suggestions were furnished with instructions to let the “conscious” or “controlled” parts of the mind relax while the “subconscious” or “automatic” parts make the desired changes during therapy and post-hypnotically. In other words, the patient is directly asked to experience nothing, and this, of course, increases the likelihood that he/she reports no experience (Spanos & Gorassini, 1984). As a positive side effect, this “amnesia” may have reduced or avoided any dissonance between expectancy and ongoing experiences, thus allowing the effect of strategic self-deception to continue (Dienes et al., 2015).

Second, I speculate that if they adopt the role of a better-functioning individual, e.g., like their premorbid self or an idealized non-injured version of themselves, the accompanying better

276 functional level is less salient or “surprising”, thus attracting less attention so that it goes unnoticed.
277 Such mechanisms underlie adaption effects in the affective domain (Lyubomirsky, 2010; Wilson &
278 Gilbert, 2008) and may apply to self-evaluations of behavior as well. In other words, when (tacit)
279 expectancy to one’s own abilities and objective improvement go hand in hand, the relative
280 evaluation of one’s own performance remains stable and there is no experience of improvement.

281 This is not to say that all effects go through implicit expectancies, but merely that
282 some effect can be realized through this pathway.

283 This phenomenon could have implications for therapists, who often use the client’s
284 own report of progress (or lacking progress) to guide the therapy. Therapists should be aware of the
285 potential low validity of such reports as an index of objective functioning if they are not
286 accompanied by measurable facts (Knight et al., 2005; Schiehser et al., 2011). The next case speaks
287 to this point, though in the context of litigation.

288

Case #3: On Litigation and Role-Playing**Background**

Ongoing litigation sometimes incentivizes the patient to remain ill. Therefore, litigation for compensation or pension is detrimental to treatment outcomes in neurorehabilitation in general, with the largest detrimental effects for milder injuries (Belanger, Curtiss, Demery, Lebowitz, & Vanderploeg, 2005; Binder & Rohling, 1996). Indeed, we found strong effects of litigation (up to a $d = 0.9$ difference) on the treatment effect of hypnotic suggestion in a sample of patients with mild traumatic brain injury (Lindeløv, in review). Here, we report on one case from this study.

Patient

A 23-year-old male fell from a ladder at work, due to an electric shock. He suffered a head trauma upon hitting the ground. At the time of hypnotherapy onset, this work-related accident was five years old, and he had been out of work since the accident. He sought to get monetary compensation from his previous workplace, and the trial was ongoing. In addition, he sought permanent monetary support from the municipality so that he could be financially independent through part-time work.

He was referred to a support group. Symptom-wise, he walked and talked slowly, was easily fatigued in the support group, and often left early. Overall, the symptoms were consistent with that of the post-concussion syndrome (Hou et al., 2012; Sayegh, Sandford, & Carson, 2010).

He was offered individualized hypnotherapy to which he agreed. The procedure was similar to the excerpts in the beginning of this article, though tailored to his specific needs. Later hypnosis sessions also addressed pain, anxiety, and depressive thoughts.

Results

After a few sessions of therapy, multiple observers noted that he had gained an upright posture, brisk walking style, and talked fluently upon arriving and leaving the support group. He also now stayed for the full duration of the sessions and had taken up new projects in his free time. However, while in the support group, he assumed the same behavior as prior to hypnotherapy onset, both physiologically and verbally. He was the only participant with ongoing litigation in the group, and the only one who did not report large improvement from the hypnotherapy. To the contrary, he reported feeling more fatigued. His score on the Mental Fatigue Scale and the Hospital Anxiety and Depression Scale was unchanged, and he did not improve his performance on the Digit Span test and the Trail Making Test. He continued expressing that his goal was to succeed in the litigations.

Discussion

Case #1 and #2 served to establish that the metaphor of being the premorbid self could work subliminally/automatically to bring about cognitive improvement through changed (implicit) expectancies. Case #3, however, indicate that while this improvement may be manifest, there is no compulsion to express it in all situations. Rather, case #3 was able adopt the role of a sufferer when the social system afforded or incentivized it, and the role of a higher-functioning individual in other contexts.

Healthy participants who are hypnotized to "be" brain-injured patients succeed in manifesting the most overt signs of a true brain injury, e.g., body posture, speech, and performance on neuropsychological testing (Fromm, Sawyer, & Rosenthal, 1964). However, they fail malingering tests, indicating that they are not true "brain injury models" but rather playing the role to the best of their knowledge (Gruenewald & Fromm, 1967; Wagstaff, Parkes, & Hanley, 2001). After hypnotherapy, case #3 was similar in this respect. His behavior lends itself to the idea

proposed by Theodore Sarbin that individuals can strategically adopt different roles in different “miniature social systems”, e.g., in and out of hypnosis (Sarbin, 1950).

In this case, and in recent literature, the hypnotist used age-regression to empower the participants with a new “role”: the high-functioning role of being their premorbid selves. In the introduction, I discussed how the positive effects of such a role may go through a reversal of the overly active interoceptive monitoring and negative self-expectancies. Case #3 indicates that, rather than compulsory adoption of the premorbid role, it may be more accurate to say that hypnosis makes it *available* again, and that motivational factors determine whether it is adopted.

Thereby, regression to the pre-morbid self may be an important strategy, as the next case illustrates.

Case #4: The Importance of Premorbid Autobiographical Memories

Introduction

Autobiographical memories elicited through age-regression in Lindeløv et al. (2017) served as a template to which the patient could refer when given suggestions for improvement. It is important to note here that it is ambiguous whether the vividness of hypnotic age-regression reflects a truly accurate recollection, or whether it reflects a larger degree of constructive filling-in (Dywan & Bowers, 1983; Geiselman, Fisher, MacKinnon, & Holland, 1985; Klatzky & Erdelyi, 1985). Accurate or not, the participants generally find their “re-experiencing” of past events believable.

Patient

Only one patient from Lindeløv et al. (2017) had a complete retrograde amnesia, i.e., no autobiographical memory prior to her brain injury. At the age of nearly seven years old, she was riding her bike when a car hit her. She fell and suffered a moderate head trauma but no other physical injuries. She was immediately hospitalized and unconscious for around an hour. In the

357 following week, her language was impaired and several weeks passed before she attended school
358 again. As she grew up, she completed a short education. When enrolled in the study at the age of 48
359 years, she reported barely being able to work all her life and that she had no energy left for family
360 or leisure when she worked.

361 Her SHSS:C score at baseline was 10, i.e., highly hypnotizable (Weitzenhoffer &
362 Hilgard, 1962). The hypnotic script was read to her according to protocol, including the regression
363 to the pre-morbid state, even though she complained that she had no such recollections due to her
364 retrograde amnesia. However, she felt able to follow the other suggestions, including imagery of
365 brain plasticity, suggestions that thinking would become effortless, etc.

366 **Results**

367 Of all 49 patients in the treatment arms, she was a negative outlier on most of the
368 outcomes: She had the smallest improvement on the WAIS Working Memory Index of only two
369 points from start to finish compared with a sample mean improvement of 24.8 points (Lindeløv et
370 al., 2017). Following hypnosis, her need for nightly sleep increased from 8.0 to 8.5 hours, returning
371 to 8.0 hours after a 7-week break. The median improvement in the rest of the sample was a 1-hour
372 reduction (Lindeløv et al., in review). Like the rest of the sample, she reported a small improvement
373 of 0.19 points in symptoms using the European Brain Injury Questionnaire (Teasdale et al., 1997).
374 However, whereas relatives generally reported improvements of 0.2 points (on a scale from 1 to 3),
375 her relative (a close friend) observed a slight *deterioration* of 0.15 points. On the Trail Making Test,
376 she experienced little improvement during the first four hypnosis sessions, which relied heavily on
377 regression, but a larger improvement during the last four hypnoses, which relied less on regression.

Discussion

This case indicate that hypnotic regression to the premorbid state could be an important driver of the effect compared to the other techniques. Indeed, in case #1-#3, I have entertained the possibility that the (perhaps idealized) memory of the premorbid self may serve to replace the negative expectancies associated with the “role” of being brain-injured with the more nuanced expectancies associated with the pre-morbid “role”. Case #4 had no such premorbid reference experience, and this seems to have reduced the effect of hypnotic suggestion.

I receive similar reports from practicing hypnotists who report a low success rate for congenital brain injury and pediatric cases though these reports should be given lower evidential weight. One may object that duration since injury confounds this phenomenon. However, this objection is discredited by the fact that the treatment effect was statistically independent of duration since treatment (Lindeløv et al., 2017).

I currently entertain two mechanisms explaining how age-regression to the premorbid state may facilitate a positive effect on cognition. This autobiographical memory may act as

- *a backward-looking retrieval cue*: Hypnotic regression could act as a strong retrieval cue, which activates important parts of the functional connectivity that characterized the premorbid brain, potentiating it in the process. The minimal version of this type of explanation is that hypnosis unlearns a learned non-use of relatively intact cognitive abilities (Lindeløv et al., 2017; Meinzer et al., 2007). However, this view is also challenged by the findings that the accuracy of autobiographical memories are inversely proportional to the time passed (Barclay & Wellman, 1986). From this, one would predict that the time since injury would be negatively correlated with treatment effects, but no such moderation of treatment effects was found (Lindeløv et al., 2017).

- *a forward-looking suggestion*: Re-experiencing a premorbid state, whether truthful or not, could act as a strong suggestion that such a state can be obtained in the future, and induce a strong motivation to obtain it.

Most likely, both of these mechanisms work in concert. They are both supported by the empirical finding that mental imagery activates the very neural networks that would process the imagined, if it was actual (Miller et al., 2010). Hypnosis is known to enhance imagery (Derbyshire, Whalley, Stenger, & Oakley, 2004), thus potentially strengthening the neural underpinnings that would potentiate a better-functioning state and depress states associated with negative expectancies or learned non-use. This may explain why hypnotic suggestion often achieve larger treatment effects than conventional methods in and out of rehabilitation (Cedercreutz et al., 1976; Kirsch, Montgomery, & Sapirstein, 1995; Lindeløv, in review; Lindeløv et al., in review, 2017).

General Discussion

The use of hypnosis was motivated by a general theoretical framework in which (1) a substantial part of cognitive brain-injury sequelae can be attributed to negative self-expectancies, (2) hypnosis is a powerful way to manipulate (self-)expectancies. I have presented and discussed four cases to exemplify the effects of hypnosis, and to discuss nuances to this framework.

To summarize, case #1 indicates that the perception of the injury may be quite independent of the physical reality, and can be manipulated in this “subjective reality” using hypnosis. If the “perceived brain injury” can be rendered benign, it may facilitate more positive self-expectancies, thus reducing the excessive interoceptive monitoring and its negative effects on cognition. Case #2 demonstrates that the associated expectations can, at least in some cases, change outside of explicit awareness so that the concomitant improvement goes unnoticed to the patient.

424 Case #3 indicates that hypnosis merely makes this altered (or re-gained) perception of the brain
425 injury available, perhaps as a “premorbid role” and the associated positive self-expectancies, but
426 that it is not compulsory adopted in all contexts. Case #4 shows that autobiographical memory of a
427 premorbid role may be necessary, or at least the most powerful mechanism, through which one can
428 achieve the effects.

429 The first three cases are somewhat “pure” representatives of phenomena which we
430 have observed in many patients. Case #4 was the only patient without a premorbid autobiographical
431 memory, though practicing hypnotists have reported a similar finding.

432 This framework also accounts for many other observations, which were not elaborated
433 in the interest of brevity. Briefly, they include (a) the effect seems smaller for patients who are
434 averse to- or unable to engage in- metaphorical or abstract thinking. (b) The effect is independent of
435 hypnotizability – a finding which has been seen before when the hypnotic intervention is clinically
436 relevant (Montgomery, David, Winkel, Silverstein, & Bovbjerg, 2002). This indicates that, in these
437 cases, hypnosis facilitates or enhances normal processes, such as expectancy, in a way that is not
438 bottlenecked by individual differences in hypnotizability. (c) The type and extent of the brain injury
439 did not moderate the effect, suggesting that a psychological level of explanation may give a higher
440 yield than a biological one (see also Case #1). And (d), as in case #1, many patients reported a
441 stronger sense of change in their thinking after the age-regression than to other techniques
442 employed during hypnosis.

443 The present framework point towards a whole family of treatment modalities targeting
444 expectancy effects, of which hypnosis is one. Other treatment modalities include working with
445 visual metaphors of the brain injury, working with metaphors of one’s identity, and placebo, which
446 have all shown positive effects on functioning and cognition (Buckalew, 1972; Oken et al., 2008;
447 Parker, Garry, Einstein, & McDaniel, 2011; Weger & Loughnan, 2013). However, these effects are

generally in the small-to-medium range and shorter-lived (Polich et al., 2018). It remains a question for future research to see whether hypnosis holds a privileged role, and if so, why.

This framework is a work-in-progress as evidence is still scarce. It does allow for making a few non-trivial and testable predictions:

- Hypnotherapy aimed at making the “perceived brain injury” benign will yield larger treatment effects than hypnotherapy based on characteristics of the physical brain injury and matching biological science.
- Hypnotherapy based on regression to premorbid experiences will yield larger effects than hypnotherapy based on any other single technique. Patients with congenital brain injury or complete retrograde amnesia (no premorbid autobiographical memory) will show smaller improvements than patients who “recall” pre-morbid autobiographical episodes.
- Patients will underestimate their objective performance after receiving hypnotherapy – at least if the script emphasizes automatic or unconscious processes.

Stroke and traumatic brain injury combined currently constitutes the second-largest health-related expense in the U.S. (Ma, Chan, & Carruthers, 2014) affecting around 1.5 million new citizens each year. Hypnosis presents itself as a cost-effective treatment modality for the cognitive sequelae experienced by these patients. I hope that the considerations in this article contribute towards the further optimization of the effect of hypnotic suggestion in neurorehabilitation.

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