TO BE OR NOT TO BE HYPNOTIZED: A LITERATURE REVIEW ABOUT HYPNOSIS AND COGNITIVE FLEXIBILITY

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Abstract: Cognitive flexibility is the degree to which an individual has and uses one of the several available types of information processing strategies or styles during different tasks (Battig, 1979), as well as different states of awareness or the ability to generate and modify responses according to the changing demands of the environment (Lezak, 1995). In the present literature review, we first focus our efforts on the conceptualization of cognitive flexibility, highlighting its conceptual history and potential problem areas, we evaluate the magnitude of the effect of hypnosis on an individual's cognitive flexibility and we cover the most relevant studies in this domain. A scientific background and the usefulness of a hypnotic approach in increasing an individual's cognitive flexibility were presented, since a lot of studies have shown that highly hypnotizable individuals can shift into alternate states of awareness more easily than low hypnotizable individuals (Crawford, 1989). Evidence to suggest that cognitive flexibility represents an important process factor in pain treatment was exposed and future implications are pointed.

Keywords: cognitive flexibility, hypnosis, pain management, hypnotizability

INTRODUCTION

The studies that have been performed regarding cognitive flexibility have been guided by the research of Hilgard and by the theoretical

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model of multiple control systems that he developed in 1977. The researcher focused on explaining why certain people can very easily alternate between a control system and another or form a conscious state or another, compared to individuals who cannot achieve these things so easily. The scientists' efforts were focused on finding out if there were any cognitive or physiological changes that accompanied these phenomenological changes and the results of these studies showed that highly hypnotizable individuals could enter a hypnotic state more easily, they responded better to suggestions and it was more likely for them to not be reality grounded during the trance state (Crawford, 1989).

The notion of general cognitive capacity has a long history in psychology, numerous researches claiming the fact that a series of general executive functions control cognition in a variety of tasks and contexts (Jurado & Roselli, 2007). Also, others have claimed the fact that executive functions incorporate a cognitive flexibility functions or "set shifting" (Miyake et al., 2000). An interesting hypothesis associated with this claim emphasizes the fact that executive functions are stable endogenous traits of individuals (Friedman et al., 2008). This could imply the fact that individual differences in cognitive flexibility should be constant regarding aspects like tasks, time or content. Some authors have claimed that these executive functions, including cognitive flexibility, mature and stabilize during early childhood (Davidson et al., 2006).

Cognitive flexibility, defined as an individual's ability to adapt his behavior to environmental changes, is essential to superior cognitive functions like decision making, problem solving, reward processing and emotion regulation (Davidson et al., 2006; Stemme et al., 2005). This variable has been measured with the help of numerous paradigms that involve changing the stimuli, the answers, the rules or the tasks. In the measuring of these paradigms, the brain regions that are activated during cognitive flexibility include the prefrontal ventrolateral cortex (VLPFC), prefrontal dorsolateral cortex (DLPFC), the associated parietal cortex and corpus striatum.

DEFINITIONS OF COGNITIVE FLEXIBILITY

Helen J. Crawford defines cognitive flexibility as the degree to which an individual has and uses one of the numerous types of available strategies to process information during different tasks (Battig, 1979), and also as the possibility to easily alternate between different states of consciousness.

Cognitive flexibility is also defined as the ability to generate and modify answers depending on the changing requirements of the situation (Lezak, 1995). Therefore, cognitive flexibility implies using numerous components of executive function, such as working memory, answer inhibition and rule changing.

Cognitive flexibility also represents an aspect or a component of executive function, being a characteristic trait or a general cognitive ability that will allow an individual to consider more ideas simultaneously, being able to change cognitive sets and prevent usual answer patterns when environmental circumstances are changing.

There are also researchers who claim that cognitive flexibility refers to a larger set of aptitudes or competences used in everyday life in order to adjust behavior to the changing conditions of the environment. These aptitudes have been associated to cortico-striatal brain regions modulated by biogenic amines like dopamine, serotonin and noradrenaline. The ability to change the task is an important component of cognitive flexibility, because it is essential to the ability to adapt the behavior to changes in internal or external needs. This ability can be quantified as the time period necessary to change the task compared to repeating the same task or, better put, the switch cost. Deficits of this ability are present in numerous neuropsychiatric disorders like ADHD, autism, obsessive-compulsive disorder, Parkinson disease and also in normal aging.

Cognitive flexibility implies modifying the cognitive process as an answer to environmental changes. As the situation evolves, the cognitive system can adapt by changes in attention, selecting information in order to guide further responses by formulating new plans and by generating new alternatives. If these cognitive processes function accordingly, then adapting to the modified situation is necessary and if the individual achieves that, (s)he can be considered cognitively flexible. Therefore, cognitive flexibility can be defined as the ability to see different aspects of an object, idea or situation and to alternate from one thought to another in order to obtain the best possible adaptation. The individuals who possess this ability can easily replace maladaptive thoughts with more adaptive and more balanced ones, they can create alternatives and evaluate difficult situations so that they can handle them more easily.

According to Cañas et al. (2003), cognitive flexibility refers to the ability to develop cognitive processing strategies in order to deal with new and unpredictable situations. This definition includes three aspects: firstly, cognitive flexibility is an ability that involves a learning process that can be obtained through experience; secondly, cognitive flexibility implies adapting to the strategies of cognitive processes (from this viewpoint, cognitive flexibility implies a change in complex behaviors and not individual reactions) and finally, cognitive flexibility allows adapting to unexpected changes in the environment, based on experience. Therefore, we can conclude that cognitive flexibility is a trait that can be learned.

Guilford, the founder of modern research on creativity, defined cognitive flexibility in 1967 as the ability to break old cognitive patterns, to overcome that functional stiffness, thus allowing the emergence of new associations or new connections between concepts (apud Crawford, 1989).

Cognitive flexibility has represented the interest point of much behavioral and neuropsychological research (Eslinger & Grattan, 1993; Cepeda et al., 2001) using a variety of tasks and contexts as well as wide age ranges (Ionescu, 2012). Cognitive flexibility can also be defined as the ability to modify working memory, attention and response selection as a result of changes in endogenous and exogenous task demands. Rigidity appears when the individual does not succeed in recognizing changes in environment or task demands and (s)he utilizes the same strategies despite the fact that they are inefficient.

METHODS OF MEASURING COGNITIVE FLEXIBILITY

An often used indicator of cognitive flexibility is represented by performance in task shifting. The period of time required to alternate between two different tasks can be used as an indicator of the efficiency in adaptation and in restructuring cognitive representations, so that lower switch costs can indicate a higher level of cognitive flexibility.

The task shifting paradigm was considered by numerous authors as a specific measure of cognitive flexibility (Monsell, 2003) and it is associated with a more distinct bilateral activation pattern in the frontal-parietal brain region, as well as in the prefrontal ventrolateral cortex (Buchsbaum, Greer, Chang & Berman, 2005).

In the task switch paradigm, participants are asked to categorize the stimuli based on different rules (Monsell, 2003). For example, participants can sort numbers based on their characteristics, like whether they are big or small, odd or even. The most used method to evaluate executive functions, especially cognitive flexibility, is the Wisconsin Card Sorting Task; during this task participants are asked to categorize certain stimuli based on certain rules, the active sorting rule being changed randomly; this way, participants cannot be sure what the card sorting rule will be for the next trial. Therefore, this task requires a certain degree of cognitive flexibility from participants, who have to switch between different categorization rules or task demands (Meiran, 2000).

There are two types of trials in the switch cost paradigm: trials where the active rule is the same as in the previous trial (rehearsal trial) and trials where the active rule is different from the one in the previous trial (changing trials). The researchers are generally interested in the participants' reaction times during these different trials, and they have noticed that the participants' reaction times tend to be longer during changing trials compared to rehearsal trials (Monsell, 2003). This difference in participants' reaction times is defined as a "switch cost" or as the additional time required to produce an answer because of the need to change tasks (Monsell, 2003).

The researchers have defined switch costs in different ways: being caused by the overlapping effects of the previous rule (Allport, Styles & Hsieh, 1994), by the reconfiguration or changing of the mental set (Monsell, 2003) or due to a combination of both factors (Meiran, 2000). Despite this, it is considered that those switch costs are due mainly to executive control processes tied to set shifting and therefore can serve as a measure of cognitive flexibility (Meiran, 2000; Monsell, 2003).

Clinicians like Spiegel & Spiegel (Spiegel & Spiegel, 1978 apud Crawford, 1989) have emphasized the fact that certain subgroups of individuals have this ability to switch from reality to a fantasy state, and in their case, these abilities have a flexibility so high that these individuals can even face difficulties in controlling them. For these groups, these abilities have more of a negative than a positive connotation. In 1976, Frankel (apud Crawford, 1989) noticed that individuals who manifested dissociated behaviors, like multiple personality disorders (the dissociated identity disorder) or different phobias, also had a higher degree of hypnotic susceptibility compared to the normal population or to the rest of the population.

After a few studies in this field, it has been observed that certain patient populations that suffer from neuropsychological disorders manifest certain deficits in measuring executive functions, especially cognitive flexibility. It has also been observed that patients who present lesions on their frontal lobe manifest deficits in cognitive flexibility characteristics evaluated by the Wisconsin Card Sorting Task (Eslinger & Grattan, 1993). Moreover, it has been observed that patients who present lesions in their frontal lobe manifest difficulties utilizing the alternative uses test, a trial in which participants are asked to generate as many uses as possible of a given object, evaluating their thought flexibility (Eslinger & Grattan, 1993).

Another series of studies, for example the one performed by Crawford in 1982 and the one performed by Crawford & Allen in 1983, shows the fact that highly hypnotizable people can easily alternate between different conscious states compared to low hypnotizable individuals; they also demonstrate a greater ease in changing cognitive strategies, for example switching from a reality-oriented strategy to one that is not reality-bound or from detail-oriented strategies to nonanalytic, holistic or imaginative ones (Crawford, 1989).

Another instrument that has been used very often to measure cognitive flexibility is the *Stroop Task* (1935), but which is as useful today - that is why it is used in numerous studies that measure this construct.

In order to measure the level of automation or de-automation of cognitive processes, a pencil-paper version of the *Stroop Task* or the computerized version can be used, with the help of which precise measurements can be made of the response time to the task. These versions are very similar to the original version administered by Stroop and most contain three tasks: color naming, reading the word and the interference task, but sometimes the number of the colors used or the number of words that must be read can differ.

Another widely used instrument to measure this construct is *The Cognitive Flexibility Scale*, developed by Martin and Rubin in 1995 and used to evaluate participants' perceptions regarding the available opinions and alternatives to everyday situations. Questions from this scale include: "I can find efficient solutions to apparently unresolvable problems." or: "In any given situation, I am capable of acting accordingly".

This questionnaire consists of 12 items that use a 6-point Likert-like scale and the answers are added up in order to obtain a total score, with a mean of M = 55.46 and a standard deviation SD = 7.34 (Martin & Rubin, 1995). This scale has shown an internal consistency of 0.76 and a test-retest reliability of 0.83 (Martin & Rubin, 1995).

THE INTERACTION BETWEEN HYPNOTIZABILITY AND COGNITIVE FLEXIBILITY

In 1982, Crawford studied the connection between hypnotic susceptibility, imaginative intensity, involvement in everyday activities (absorption) and the daydreaming styles. As a result of factorial analysis, a factor was identified that was characterized as a positive imaginative style and with a great absorption capacity, this factor containing hypnotic susceptibility, imaginative intensity, involvement in everyday activities (absorption) and daydreaming styles. In this study, following the regression analysis, they observed the existence of certain differences between men and women regarding hypnotic susceptibility and the other predictors.

One year later, in 1983, Crawford and Allen investigated the hypothesis according to which hypnosis had an effect of augmenting the imaginative processes, this being mediated by hypnotic responsiveness and by cognitive strategies. In order to achieve this, they performed four experiments to compare the performance of highly and low hypnotizable individuals or the performance of low, average and highly hypnotizable individuals in the waking state and under hypnosis to a successive visual discrimination memory task that required detecting the differences between pairs of photographs presented, one of the pictures in the pair being substantially modified. They noticed that the individuals who responded to hypnosis achieved better results under hypnosis compared to the others. Hypnotic responsiveness correlated with enhanced performance under hypnosis, but it did not correlate with performance in the waking state. The reaction time was not affected by hypnosis, even though highly hypnotizable individuals were faster compared to those with a low level of hypnotizability.

Just as the two authors anticipated, hypnosis did not have a significant effect on the discrimination task that required participants to determine whether or not there were differences between the two pairs of photographs presented simultaneously. Two cognitive strategies were reported that appeared to mediate the performance of visual memory:

a) a detail-oriented strategy, that implied monitoring and repeating some individual details in order to memorize them;

b) a holistic strategy, that involved looking at and remembering the entire picture. Both the low and the highly hypnotizable individuals similarly reported the predominance of a detail-oriented strategy in the waking state, but only the highly hypnotizable individuals switched to a holistic strategy during hypnosis. These results suggest the fact that highly hypnotizable individuals have a greater capacity for cognitive flexibility (Batting, 1979) compared to low hypnotizable individuals. The results of this study have been explained using two theoretic approaches: Paivio's dual coding theory (1971) and Craik & Tulving's depth of processing theory (1975).

Crawford, Nomura and Slater performed a study in 1983 that emphasized the fact that highly hypnotizable individuals mentioned that under hypnosis their cognitive processing became more holistic and more visual. These phenomenological descriptions suggest the fact that there could be a switch from a verbal coding system, oriented towards details during the waking state to a visual coding system, oriented towards images during hypnosis.

Another study that shows the existing link between hypnotizability and cognitive flexibility is the one performed by Benjamin Wallace in 1990, a study where he performed an experiment in order to determine if the subjects that were considered low hypnotizables could be taught more efficient searching strategies used by the highly hypnotizable subjects on a cognitive search task. During this experiment, the subjects were asked to find hidden objects in a variety of images. It was discovered that highly hypnotizable individuals obtained better results than low hypnotizable individuals on finding as many correct objects as possible. When the low hypnotizable subjects were taught the efficient searching strategies utilized by highly hypnotizable individuals, their task performance improved and it did not differ significantly from that obtained by the highly hypnotizable individuals.

THE INTERACTION BETWEEN PAIN, HYPNOTIZABILITY AND COGNITIVE FLEXIBILITY.

The studies which have shown the existing link between pain, hypnotizability and cognitive flexibility are very scarce. Yet, there is a study performed in 1998 by Danzinger and his collaborators, where they applied electrical stimulation to the sural nerve of the left leg during hypnotic analgesia to 18 highly hypnotizable subjects. They noticed that hypnotic suggestion for analgesia significantly increased pain tolerance for all the subjects. The data they obtained with the EEG showed the fact that, during hypnotic analgesia, different strategies to modulate the pain can be operational and these strategies are totally dependent on the subject. Even though all subjects can shift their attention from the painful stimulus, some of them can inhibit their motor reactions to the painful stimulus at the level of the spine, while in others, by contrast, the appearance of this reaction is facilitated by the painful stimulus.

It is well-known that people differ based on their hypnotic susceptibility, this variability often being attributed to differences regarding the way attention works, for example, an increased ability to filter irrelevant information and to inhibit the most common answers (Cojan et al., 2015).

As a response to suggestion, the highly hypnotizable individuals report and show a wide variety of interesting answers (Hilgard, 1979), like hallucinations, negative hallucinations (not seeing or not hearing a stimulus that is present) and statistically significant decreases in pain intensity. Also, other individuals show selective amnesia, partial paralysis or a very reduced decrease in the Stroop effect (Raz, Shapiro, Fan & Posner, 2002). Except for the modulation of the Stroop effect, it may seem that these are only answers that appear due to the characteristic of the perceived request of the experimental setting. Yet, all this being said, the behavioral and physiological data converge to indicate the fact that these reports and answers reflect real changes in the individuals' experience.

CONCLUSIONS

In the research literature, there are extremely few studies that examine the link between cognitive flexibility and pain perception, whether about the perception of pain intensity or the perception of pain quality. In this context there are just as few studies that examine the influence that variables like the level of hypnotizability or cognitive flexibility could have on the perception of pain intensity.

Generally, cognitive flexibility is necessary when individuals need to face some unpredictable situations, but the conventional methods to measure cognitive flexibility do not include unexpected situations that would reflect real life. Virtual reality could offer a way to overcome this difficulty by using techniques like captivating environments, tridimensional projection or interpersonal parameters.

In conclusion, it is possible for cognitive flexibility to result from the complex interaction of a few mechanisms and this idea is supported by the recent models that analyze the role of the prefrontal cortex in cognitive control. In other words, a single mechanism, either cognitive or neuronal, will not lead to a flexible behavior; it appears that an interaction is required between a few neuronal circuits that serve different cognitive mechanisms for this behavior to manifest itself.

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