Training, Language and Culture
doi: 10.22363/2521-442X-2020-4-3-66-76
Volume 4 Issue 3, 2020, pp. 66-76
rudn.tlcjournal.org

Original Research

Language and cognitive science: How language affects reasoning and memory

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Received 14.07.2020 | **Revised** 15.08.2020 | **Accepted** 18.09.2020
Recommended citation format: Langlois, J. (2020). Language and cognitive science: How language affects reasoning and memory. *Training, Language and Culture, 4*(3), 66-76. Doi: 10.22363/2521-442X-2020-4-3-66-76

In the last twenty years or so neuroscience and linguistics, language and culture have become increasingly interconnected, as we seek to understand the influence of language on behaviour and the way we think and express ourselves. Neuroscience is the study of how the brain and mind work and cognitive science applies that study to how we use language to express our thoughts and feelings and also how our mental faculties work. One of these faculties is memory. How do we recall and express what has happened in the past and even assuming we can remember it at all? The purpose of this paper is to examine how cognitive science has clarified the relationship between language and culture in particular in the way we remember things and express our recollections, using experiments based on facial recognition. In the process the paper demonstrates how language and culture influence our cultural processes and the importance of cognitive science as a part of language and cultural study.

KEYWORDS: *cognitive science, Verbal Overshadowing Effect, linguistics, logics, culture, memory, neuroscience*

1. INTRODUCTION

At the crossroads of studies on language and culture and studies in cognitive science, we propose in this paper to show how scientific research has been able to show that language (and in particular verbalisation) and culture (through the impact of values and grids of representations) have an impact on the cognitive processes of memory. This paper focuses on two case studies conducted by cognitive scientists: the Verbal Overshadowing Effect and on the study of the language describing colours used by different communities.

2. THEORETICAL BACKGROUND

Cognitive science constitutes an interdisciplinary scientific discipline which has as its object the description, the explanation, and the simulation of the mechanisms of human, animal or artificial thought, and more generally of any complex system that deals with the processing of information capable of acquiring, retaining, using and transmitting knowledge (Bazalgette & Langlois, 2020). Cognitive science is therefore based on the study and modelling of various phenomena such as perception, intelligence, language, attention

and, of course, memory. Cognitive sciences jointly use data from the six sub-disciplines that compose it: neuroscience, computational linguistics, cognitive anthropology, cognitive psychology, the philosophy of cognition and artificial intelligence (Bazalgette & Langlois, 2020).

Memory can be defined as the process that allows information to be retained for later re-use. Unlike behaviourist learning, the notion of memory emphasises the structures and processes that mediate between the acquisition of this information and its effects on behaviour. It is the subject of numerous works in cognitive science, from the point of view of psychology, linguistics and neuroscience (Frankland et al., 2019).

The scientific literature defines memory as a universal process. Memory is defined as a cognitive process which functions in the same way whatever the language or the culture of the individuals concerned. The strongly mathematised aspect of cognitive science studies, which require in-depth knowledge of statistics, seems to have limited the cultural and linguistic study of cognitive phenomena which would benefit from analysis in terms of these specificities (Frankland et al., 2019).

3. MATERIAL AND METHODS

Cognitive sciences are experimental sciences by definition. Postulating that language or culture has an impact on cognitive phenomena should therefore not be an injunction or a belief but a potential working hypothesis which obviously needs to be tested. The aim of this paper is to analyse a neuroscientific case study of a linguistic strategy called the Verbal Overshadowing Effect (VOE) and to explore differences in the way that different languages describe colour.

4. THE VERBAL OVERSHADOWING EFFECT

4.1. Background

In June 1990, in the academic journal, *Cognitive Psychology*, two cognitive neuroscientists from the University of California, Santa Barbara, Schooler and Engstler-Schooler (1990), described for the first time what would be soon coined by linguists and neuroscientists, the 'Verbal Overshadowing Effect' (VOE). In their paper Schooler and Engstler-Schooler (1990) presented a series of experimental studies where participants were asked to watch the video of a burglary. This was called the encoding phase. Half of the participants had to describe verbally the face of the burglar, the other half had to think up a distractive task (the control group). In the end, all the participants were asked to identify the burglar from among 8 facial photographs (the face of the burglar and 7 random faces).

The results showed a significant difference in the percentage of good recognition between the two groups: 38% in the participants in the verbalisation group versus 64% in the participants in the control group. Schooler and Engstler-Schooler (1990) explained the deleterious effect of the verbal description of a face on the process of remembering. The mere verbal description of the memory of the face altered its subsequent recall.

This spectacular result can be analysed in relation to the 'classic' nature of the situation. A witness of a crime is quite naturally led to describe verbally what he or she has seen. Thus, one possible application of this study could be to prevent any witness of a crime from describing in words the figure of the perpetrator or of the mischief the observer witnessed. According to Schooler and Engstler-Schooler (1990), the VOE effect results from the process of recoding the representation of the face. People are instructed to verbalise what is not a non-verbal stimulus from memory. The words 'cast a shadow over' the memory, making it less clear, producing, as the analysts described it, a 'verbal over-shadowing'.

Particularly striking, this study questioned the protocol of recognition of the suspect as it was used by US police officers. As a single scientific study is never enough to prove something, several scientists began to test the robustness of the so-called Verbal Overshadowing Effect. In a literature review of the various VOE studies, Meissner and Brigham (2001) have shown that the effect is generally marked and is present in adults, children, and adolescents (see also Dehon et al., 2013). Among these studies, an international replication of the experiment in 2014 gathered together a

large team of high-level researchers. The results were published in *Perspectives on Psychological Science*.

4.2. VOE and colour

An important question is whether the VOE phenomenon is confined to the memory of faces or whether it is a more general phenomenon. The literature shows that individuals have a specific memory for recognising human faces, and that these mechanisms differ in many ways from those implemented with other stimuli. To answer this question, Schooler and Engstler-Schooler (1990) tested the phenomenon with another stimulus: colour. In their experiment target colours (red, blue and green) were first presented to participants, for five seconds. Then, the participants were divided in three groups. They had to carry out a special task for thirty seconds. The first group had to write a precise description of the colour they saw. The second group had to simply visualise it silently. The last group had to write down the greatest possible number of cities in the United States. Finally, all the participants carried out a recognition test which consisted in identifying the memorised target colours presented from among five distracting stimuli sharing a great visual similarity with the target. The results of this study show that the percentage of good recognitions was 33% for the first group, 64% for the second and 73% for the last group. Thus, as with faces, the verbal description of the memory of a colour significantly reduces memory performance.

4.3. The 'cross-cultural' variation

Since the 1990s several cognitive scientists have analysed how language use can vary according to cultural background. The result is the development of the concept of 'cross-cultural variation'. The concept has been described in all areas of human cognition (Jahoda & Krewer, 1997). The cross-cultural differences in behaviour identified in the field of cognitive anthropology and psychology provide useful starting material for studies which test the hypothesis of the neural basis of cultural experience-dependent plasticity, in other words,

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the way that the linguistic expression of experience can be manipulated by variations in cultural background.

Language is definitely one of the most prominent domains of cross-cultural variation research. As Nida (2003) pointed out, there is not always a one-to-one relationship between language and culture but an individual's language(s) and cultural experience are inextricably linked. Language-specific phonology, syntax and orthography (McBride-Chang & Kail, 2002; McBride-Chang et al., 2005; Cheung et al., 2001) influence other aspects of language, such as language learning. By comparing pre-reading and literate children who speak alphabetic and non-alphabetic languages of different levels of phonological complexity, Cheung et al. (2001) found that both orthography and phonological complexity impact phonological awareness.

Several studies have started to identify the neural correlates of cross-linguistic differences (Kochunov et al., 2003; Bolger et al., 2005).

Colour categorisation has a predictable cross-linguistic structure related to the physiology of the human visual system despite the wide variation of colour categories in different languages (Abramov & Gordon, 1994; Kay & McDaniel, 1978). This would suggest that colour perception and categorisation is determined by physiology rather than linguistics. Several studies have suggested, on the contrary, that linguistic colour categories directly influence the processes of colour recognition, memorisation and discrimination (Roberson et al., 2005). This would mean that language could influence higher-order aspects of the process of colour perception.

Research into the impact of culture in cognitive processes provides further information about the malleability of the neural regions underlying the cognitive functions. As shown by Nisbett and Miyamoto (2005), perceptual domains such as context sensitivity and visual illusion susceptibility have also been found to vary cross-culturally (see also Segall et al., 1963).

Several studies in cognitive science have shown that the cognitive task of figure perception could be determined to a certain point by culture. For example, a famous study by Segall et al. (1963) tested individuals from 17 different cultural groups and found substantial differences between the different groups regarding geometric optical illusion susceptibility. The authors deduced that cross-cultural variation in susceptibility to the illusions could be related to certain perceptual habits acquired in different ecological and cultural environments. Rectangularity, for example, was arguably widespread in the urban environments common among the European groups. It was much less widespread in the plains and equatorial forest dwellers of several non-European groups.

Probably the most productive area of cross-cultural variations is social cognition. Two theoretical frameworks have dominated this sub-field: the classification of cultures as either individualistic or collectivistic (Triandis, 1995; Kagitcibasi, 1996), and the classification of individuals as having either an interdependent or independent selfconstrual (Markus & Kitayama, 1991; Killen & Wainryb, 2000).

4.4. VOE and the five senses

As Meissner and Brigham (2001) point out, several previous studies on VOE suggest that this effect appears to be specific to the verbal description of the face that must be recognised later. Brown and Lloyd-Jones (2003) showed that the task of describing any object would not result in changes to the facial recognition performance of the suspect. The phenomenon of the verbal overshadowing, initially discovered with tasks involving recognition of faces and colours, was replicated with other stimuli with strong perceptual dominance. In these studies, stimuli were presented in different perceptual registers: the auditory register with the recognition of voice or music (Perfect et al., 2002; Vanags et al., 2005), the visual register with the recognition of images of mushrooms (Melcher & Schooler, 2004) or the evaluation of distances (Fiore & Schooler, 2002), and the taste/olfactory register with the evaluation of the taste 'qualities' of fruits (Wilson & Schooler, 1991) or the recognition of the taste of wines (Melcher & Schooler, 1996). In the study by Wilson and Schooler (1991), for example, the two researchers asked participants to taste five strawberry jams and rank these jams according to their taste qualities. These five jams had previously been the subject of a ranking established by specialised tasters and recruited by a food magazine. Participants in this group were asked to justify their assessments by making a written list of the reasons why they liked or disliked these jams and to reflect on and analyse the reasons for their choices (experimental group). Participants in the control group tasted the different strawberry jams and then ranked them, but they did not list or analyse the reasons for their preferences. The results reveal that the participants in the control group proposed rankings that most closely match those established by professional tasters, compared to participants who verbalised the reasons for their choice. According to the two authors, the translation with words of the sensory experience would have degraded the memory trace of the initial perceptual experience. Thinking about the reasons for a choice would induce a focus of attention on certain irrelevant criteria, which would be detrimental to subsequent recognition.

4.5. Neuroscience and linguo-cultural theory

As well as analysing the impact of the Verbal Overshadowing Effect on the way language is used to describe experiences recalled from memory, cognitive science research has also questioned some of the commonly held principles of cultural difference. One example is the individualism vs. collectivism (IC) framework, which has been used to explain cross-cultural differences in causal attribution, motivation, emotion and even visual per-

ception. Research into IC has been frequently criticised because these concepts are applied too broadly and they are often not treated as independent constructs but as two ends of the same continuum (Schwartz, 1990; Fiske et al., 2002).

Oyserman et al. (2002) performed a meta-analysis of IC studies and found that individualism and collectivism are quite independent constructs. They do not seem to stand up to measurement technique variation. Last but not least, they are not closely aligned with the supposed East/West dichotomy (Westerners are not reliably more individualistic and less collectivistic than Easterners).

Despite these criticisms a large number of published articles on cross-cultural studies employed the IC hypothesis in their explanation of cross-cultural differences (Hui & Yee, 1994).

Recent publications in the field of neuroscience tend to indicate that the IC framework could continue to be a prominent paradigm in cross-cultural studies. Nevertheless, future studies in cognitive science could investigate with more precision plausible neural correlates of the impact of the cultural environment on language and behaviour by paying careful attention to the presentation of critical epistemological analyses of the IC framework (Bjornsdottir & Rule, 2018). The hypothesis of differences between interdependent versus independent selves has been supported by extensive behavioural data but also more recently with neural evidence (Heatherton et al., 2006).

4.6. Neural evidence of the impact of culture on cognitive tasks

Markus and Kitayama (1991) tried to show that people have either an independent or an interdependent self-concept. Individuals with independent or individualistic self-concepts have a certain way of defining who they are that is based on individual uniqueness and how they compare to others. In contrast, individuals who analyse their environment and social experiences with interdependent self-concepts define themselves through their membership and belongingness to the group. The language they use to do this is different and susceptible to misunderstanding.

People who come from rather independent cultures, such as the United States or the UK, tend to have a more independent self-concept, while those from interdependent cultures, such as in East Asia, tend to have a more interdependent self-concept (Markus & Kitayama 1991; Sui et al., 2007; Triandis, 1995).

According to several cognitive science researchers, the medial prefrontal cortex (mPFC) and the posterior cingulate cortex (PCC) are implicated in the self-referential network (Heatherton et al., 2006; Northoff et al., 2006). Cultural factors could have an impact on the modulation of activation in these areas of the brain.

Researches conducted with Chinese individuals show that both self-referential and mother-referential encodings activate mPFC in these participants. This strongly suggests that the Chinese concept of the self could include or overlap with that of the mother (Han & Northoff, 2009; Zhang et al., 2006). As Zhang and Zhu show in several studies (Zhang et al., 2006; Zhu & Zhang 2002; Zhu et al., 2007), these preliminary results could provide a potential explanation for the similar enhancements in memory for mother and self that occurs when Chinese individuals are tested and that does not occur when the individuals tested are Western participants. Westerners tend to demonstrate a quite different result showing increased mPFC activity for self-judgments and a reduced mPFC activity for mother-judgments (Zhu et al., 2007).

As often in science, other experiments have indicated the possible limitations of this neural evidence. Studies do not always support the hypothesis of a cultural difference in self-concept. Ray et al. (2010) conducted an fMRI investigation with American participants from various ethnicities. They had to complete an adjective judgment task (self, mother, valence and font). They were also tested using a self-construal scale measuring self-construal style in terms of independence and interdependence (Singelis, 1994). The study showed results that were contrary to expectations. Those with an interdependent self-construal style exhibited greater use of mPFC and PCC during self-relevant judgments than mother-relevant judgments.

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5. DISCUSSION

5.1. The interference hypothesis of the recoding process

As often in science, no explanation is perfectly consistent for the VOE in face recognition. A careful study of the literature reveals three main hypotheses (Chin & Schooler, 2008; Smith & Flowe, 2015):

– the interference hypothesis of the recoding process (Meissner et al., 2001);

– the hypothesis of the change in deionic criteria (Clare & Lewandosky, 2004);

– antagonisms between remembrance and recognition.

The interference hypothesis of the recoding process is originally a simple reflection of the article of Schooler and Engstler-Schooler (1990) in Cognitive Psychology. Meissner and his colleagues developed it in 2001 (Meissner et al., 2001). Later, Chin and Schooler (2008) tested the validity of this hypothesis. At the time they called it the 'content hypothesis'.

The hypothesis of re-encoding interference, or 'content hypothesis', describes the same attempt at explanation: the verbal process of the description of a face would result in a representation in the verbal memory (or 'verbal code') which would interfere with the original representation of the same face in the visual memory (or 'visual code') (Brandimonte & Collina, 2008; Meissner & Brigham, 2001; Meissner et al., 2001; Schooler & Engstler-Schooler, 1990).

What would support such an explanation is that during the stage of the verbal description, an individual has the possibility to make errors or give erroneous or approximate information during the process of the verbal description. The subsequent stage, the recognition performance of a target-face, would be greatly deteriorated because the individual would not remember enough of the original image and be able to describe the details (Finger & Pezdek, 1999; Kitagami et al., 2002; Meissner, 2002; Meissner & Brigham, 2001; Meissner et al., 2001; Meissner et al., 2008).

The interference hypothesis of the recoding process is reinforced by other results from recent studies. Meissner, Smith and Flow (Meissner, 2002; Meissner & Brigham, 2001; Meissner et al., 2001; Smith & Flowe, 2015) have shown, for example, that the degree of detail required in the verbal description would further accentuate the poor performance of subsequent visual recognition. The VOE is all the more important when participants make a detailed description and not a free recall where the mass of inaccurate information will tend to be higher.

As strong as this hypothesis might be, several studies have shown its limitations. It is based primarily on the link between the quality of the verbal description and the facial recognition performance after the description. As several researchers show, this correlation is not always found in VOE experiments (Kitagami et al., 2002; Schooler, 2002; Wickman & Swift, 2006). Moreover, the simple fact of asking a tested individual to describe any face (for example, 'describe me the face of a loved one') before proceeding to the recognition of the target face seems to generate significant performance decreases (Schooler, 2002; Brown & Lloyd-Jones, 2002, 2003; Dodson et al., 1997).

Some authors, such as Clare and Lewandowsky (2004), criticise the work on the VOE for basing their statistical analyses essentially on the number of correct identifications of the suspect and not considering the type and distribution of recognition errors made by the participants.

These researchers were therefore interested in the number of false acknowledgments in the responses collected (in this case, the 'distractors' were designated in place of the suspect) and the conditions of the experiment. Their results allowed

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them to propose a new hypothesis that would explain the VOE and which is more focused on participants' response patterns. This is the hypothesis of changing decision criteria (Clare & Lewandosky, 2004).

5.2. The hypothesis of the change of decision criteria

Directly inspired by Signal Detection Theory (SDT) (Tanner & Swets, 1954), Clare and Lewandowsky (2004) hypothesised that the VOE might correspond to the change in participant response criteria during the task of recognition. The verbal description of the target face would engender what cognitive scientists call a more 'conservative attitude' of participants in their responses, not only in terms of the choice of descriptive elements that define the suspect but also regarding 'what it is not'. Individuals would thus give less correct identification of the target (lower number of hits, revealing the VOE) (Clare & Lewandowsky, 2004; Mickes & Wixted, 2015).

In the hypothesis there is a re-encoding interference through which the individuals tested would have their visual memory deteriorated by the process of verbal description. In the hypothesis of the change of decisional criteria Clare and Lewandowsky (2004) propose to go much further since they try to analyse how the specificities of the verbal description will be used by these individuals as a new grid for reasoning and judgment during the visual stage. Individuals who have been subjected to the verbal description task would adopt these criteria during the subsequent visual stage.

The literature describes this hypothesis as the 'change' of criteria of decisions (Clare & Lewandowsky, 2004; Mickes & Wixted, 2015). Nevertheless, it is misleading since it is not really about 'change'. The hypothesis does not explain that the visual memory is changed radically but that there is a 'slip' and a 'superposition' that generates the antagonisms in the criteria. To describe this hypothesis, it is preferable to use the less ambitious but more exact application of 'the hypothesis of the evolution of the decision criteria'.

5.3. The hypothesis based on the antagonisms between the processes of remembering and recognition

As Davies and Christie (1982) explained, there are two different types of processes in verbal description and visual reconstruction tasks: remembering and recognition. The first process refers to the verbalisation of the memory of the witness or the victim. The second process involves building step by step the most optimal reconstruction of a key element (the crime scene, the face of the criminal, the cap he wore, etc.) by a series of adjustments. The robot portrait traditionally involves both types of processes. A description would be considered useful to build the sketch (more or less advanced) of the portrait of the criminal. The interviewee must then 'reconstruct', step by step, and in a composite way, the face of the criminal (Tanaka & Farah, 1993).

Remembrance and recognition of visual information are known to be eminently different mental processes. As Baddeley (1990) explains, the neural mechanisms corresponding to these two types of tasks are detected at different lobe levels. Face recognition is holistic in nature and tends to be improved if learned (or coded) in a holistic way, for example by attributing personality traits to that face. Conversely, the recognition is degraded when a face is encoded according to its physical attributes (Berman & Cutler, 1998).

Synthesising the contributions of the previous literature, Wells and Hasel (2007) explain that the recognition of a face would be optimised if the interviewee is asked to remember, beforehand, the

context in which this face was seen. In addition, the identification of individual facial features is facilitated by presenting these features on a full face (Tanaka & Farah, 1993; Tanaka & Sengco, 1997).

Information retrieval can also be improved. For example, the production of verbal descriptions is facilitated when a face is coded by its physical characteristics, rather than in the form of one or more personality judgments. In 2007, the Wells research team of the University of Iowa showed that recalling information on a face could be more accurate and complete if the interviewee does not experience a break when describing the subject face and can make multiple attempts at remembering (Wells & Hasel, 2007).

6. CONCLUSION

Language and culture have a consistent influence on the development of the self. Culture is often described as a lens for the apprehension of one's environment (Gutchess & Indeck, 2009; Markus & Kitayama, 1991). As shown with the VOE case-study, language plays a significant role in the process of memorisation and recognition. Individuals apprehend their environment with words and concepts. Words, grammar and the values we attach to them can explain the variabilities of representations between different individuals. People often speak the same language but they always do not mean the same precise things. This complexity of communication between people of the same language and culture is made even more difficult when the communication is between people with different cultural backgrounds. The cultural background informs our experiences and our cognitive functions, such as memory.

It is now impossible to ignore the impact of language and culture on cognitive processes. Research in neuroscience and cognitive science allows us to understand the psychological and physiological processes that underlie the cognitive tasks of individuals. Cognition is often viewed as a set of universal processes. However, it seems that this belief is largely unfounded.

Cognitive science, as an experimental science, is based on working hypotheses which combine successive observations of previous experiences and theoretical propositions. Considered for a long time by researchers as a simple intuition or as an original hypothesis, the impact of language and culture on cognitive processes has become a subject of great importance for cognitive scientists who can now soundly rely on evidence from neuroimaging.

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