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Draushika Mooruth

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THÈSE

Pour obtenir le grade de
Docteur

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Et de l'unité de recherche Epsilon (EA 4556)

Spécialité : **Psychologie Cognitive**

Présentée par **Draushika MOORUTH**

**Validation d'un programme de stimulation
sensori-motrice face aux situations de handicap
émergentes lors du vieillissement**

Soutenue le 17 Décembre 2021 devant le jury composé de

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“Until you step into unknowns, you don't know what you're made of” – Roy Bennett

August 2007, I left my hometown with a vague idea that there is a bigger purpose to my being. 14years later, in another country, a journey of obstacles, identity, and cultural crisis; failures, and successes, I have come to terms with that purpose. This thesis represents the culmination of my mission and legacy. Could there be any better way of accomplishing it than being at service to humankind? This journey would never have been the same without the support, encouragement, and contributions of exceptional human beings.

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*There are two statements about human beings that are true:
that all human beings are alike, and that all are different.
On those two facts, all human wisdom is founded.
(Mark Van Doren, American poet (1894–1972))*

*To my grandmother,
Whose life inspired me
And gave mine a greater purpose*

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Prelude

Exotic Aging

*Aging should be for the people we love
and not be destined to an institutional
setting defined by the system!*

Each cultural and social practice has a set of definitions, expectations, and assumptions about aging. Often, the elderly are given a powerful position in society, that of the beholders of history, with a richness of experience and acknowledgment for all the roles (parents, grandparents, employees) they have played in real life. Aging well is first and foremost a right, an objective and measurable condition at a given time; a state that should be considered above normal aging. However, the fact is that aging comes with a plethora of physical as well as cognitive changes. While aging is a universal truth, aging well is not within reach of all populations. This is even more real for individuals aging in minority societies.

As exotic as aging on an island may sound, it compromises many challenges. Indeed, coming from Mauritius island, my concerns about aging well in Mauritius was triggered from a very young age. Bounded by my own culture, the mere idea of keeping my grandparents or parents in a special home for the elderly was and is still an absolute no way. In Mauritius, most older adults are fortunate enough to have a long familial and social support tradition. Most probably at the expense of actual health issues that the elderly may face. If we do not see it, it does not exist – A certain mindset that has a firm foothold and, to some extent, also reassures families. Many factors contribute to this mindset: a broader socially recognized and accepted physiological aging; a lesser attribution and knowledge of cognitive changes inherent to aging; and finally, little to almost no sensibilization of aging issues to the general public.

Even if the general population considered aging a real matter of discussion, the care system regarding the welfare and living conditions of the elderly population is not at its optimum capacity. This fact, nevertheless, does not devalue the multiple programs and opportunities offered to elders for social connection or leisure. However, there are still shortcomings in the area of cognitive

aging. The Mauritian government is just beginning to address the growing prevalence of dementia among older adults, mainly as studies show its influence on comorbidities such as diabetes (Zilliox et al., 2016). According to the national NCD survey in 2015, 22.8% of the Mauritian population aged between 22-74 years are living with diabetes. So far, most of the recommendations for treating diabetes have been about nutrition, hypertension, glucose management, and prevention for other complications. Given these facts, it appears essential firstly to treat the problem of diabetes on a larger scale and to recognize its cognitive impacts on older adults.

This brings us to a second issue which concerns cognitive interventions programs designed for the elderly. While my concerns were about providing appropriate support to aging in Mauritius, similar ones were being raised by the TinHinan association, working with elderly immigrant women in France. Indeed, the main problem they encountered was language barriers felt by members of their associations during the cognitive workshops. A significant percentage of the members are Moroccan older adults who came from the second wave of immigration through family reunification or political exiles. Their educational background is highly diverse. Many did not have the opportunity to be at school for traditional and cultural reasons; others were perfectly capable of interacting in the French language without any academic background, and the rest could not even write or recognize Latin letters or numbers. TinHinan association made it a mission to empower these women by helping them learn French and by providing them with social and legal advice. Naturally, the question of how to give a more appropriate approach to the diversity of this population emerged.

Any intervention concerning the migrant population is often challenging given each person's cultural singularity and limited fluency in the local language. Even more so, when it concerns the aging migrant population since they face age-related changes in the same way as any

other individual, yet most of the time, they have difficulties accessing the health care system in their host country. Beyond the problem of access to health care, health professionals often do not have appropriate tools to assess a population limited by language barriers. A common practice, thus, is using translated versions of available tools. For example, one of the standard tools used to screen cognitive impairments in the elderly is the Mini-Mental State Examination test (MMSE, Derouesné et al., 1999). While the mini-mental state examination test is available nowadays in many translated versions and can provide a general view of an individual's cognitive profile, we wonder whether using a translated test is enough representative of the subjects' cognitive functioning? How ethical are we in using such assessments to fit a population that has different cultural background?

In such cases, it is essential to highlight that language and culture are inextricably linked. One cannot effectively communicate with someone from a different culture without understanding the cultural determinants. Any individual from a culturally diverse background has not only an imprint of their cultural values, but they manipulate and relive experiences based on their heritage. They create their dynamics, representations, and beliefs by further modifying their cultural environment. This view reinforces the notion that each individual has a personal relationship with the culture transmitted to them and that they express through language. Typically, cultural and language dynamic is highly overwhelming and precisely what complexifies any intervention provided to a minority population.

Nevertheless, the phenomenon of aging is universal, and the process through which every aging person goes is practically the same. The following question then naturally emerges: How can we, as researchers, help practitioners in their practice such that their interventions become more meaningful for a culturally diverse population? What type of theoretical approaches can be

adopted to prevent cultural drifts - often a source of misunderstandings, and reduce an individual to their cultural dimension alone? Can psychology, and more particularly cross-cultural psychology be an answer to explore these issues? Ultimately, can there be a possibility for a universal practice of psychology? Despite the subjective nature of every individual and the challenging cultural imprint, we believe that there are solutions to this problem that can be scientifically proven and assumed as a form of a universal approach to on-field interventions. These concerns have been the main driver of this thesis. In that respect, the current work we are proposing covers a scientific approach to problems encountered by practitioners in their practice faced with language barriers. Firstly, through a theoretical perspective, we will gather evidence from the literature to further detail our point of view on this issue. Secondly, we will expose our stance on a universal practice of psychology and the solutions that we consider viable through experimental justifications. In this thesis, the theoretical part will include three chapters regarding psychological ethics (Chapter 1). We will address the following question: Is there a possibility of having a universal practice of psychology? We pose here our concerns about ethics in practicing psychology within a culturally diverse population. If there is a principle of universality, what does it mean? In Chapter 2, we shall address the question of cognitive aging, the impacts of culture and language on aging, and how we can better explain age-related changes universally through an embodied framework. Finally, In Chapter 3, we will review cognitive interventions and propose an opening to sensorimotor cognitive interventions.

The second part of this thesis resumes our approach to provide a scientific approach to a universal practice of psychology through experimental studies. The first study demonstrates, within an embodied framework, how aging affects cognitive representations. This study led to an article that was submitted for publication and is in review. In our second experiment, we propose

a cognitive assessment battery that is language-free, specifically for assessing executive functioning. Finally, in our third study, we proposed creating and validating a sensorimotor stimulation program (PSSM) with minimal language requirements. The core of our work is to show that even though culture and language have a high imprint on an individual, there are commonalities between individuals. If a solution exists for the problem concerning cultural and language disparities, the answer is finding those commonalities and working with them.

II
THEORETICAL
PART

Chapter I

Towards the possibility of a universal practice of psychology

1.1 The practice of psychology: Universality and Diversity

1.1.1 Ethical considerations in the practice of psychology

Beyond the rules of professional conduct for psychologists, the Ethical Principles Of Psychologists and Code of Conduct affirms the founding values of our professional identity. Among the general principles, psychologists have to commit to that of Justice., i.e., they “have to recognize that fairness and justice entitle all persons to access to and to benefit from contributions of psychology and to equal quality in the process, procedures and services being conducted by psychologists. Psychologists exercise reasonable judgment and take precautions to ensure that their potential biases, the boundaries of their competence, and the limitations of their expertise do not lead to or condone unjust practices.”¹. Fundamentally, the principle of justice, calls for equality to all individuals irrespective of their socio-cultural background. While, as health care providers, we attempt to respect to these basic principles, there are a number of caveats in applying them. The reasons are as diverse as the extreme diversity in practices and patients, coupled with psychologists’ variability in theoretical considerations (Cohen, 2016) and the tools they use in their practice.

Every individual is different with their own linguistic and cultural background. These differences in identities shape how a person perceives, understands, and creates knowledge within his world (Berry et al., 2002). According to Geisenger (2003), cultural differences in personal styles and experiences are often more subtle than language disparities. The richness of such diverse

¹ American Psychological Association. [Ethical Principles of Psychologists and Code of Conduct. Including 2010 and 2016 Amendments](https://www.apa.org/ethics/code). Washington, DC: American Psychological Association 2020
<https://www.apa.org/ethics/code>

populations can rapidly become an issue in psychological evaluation or cognitive remediation therapies. More specifically, in a culturally diverse population, psychologists often have to deal with assessment and testing difficulties. Indeed, a common practice while using assessment tools for individuals who do not speak the same language is based on the use of forwarding and back-translations of the original tests (Tyupa, 2011). Using this process ensures that there are no discrepancies in the translated version and original versions since the most common problem while translating is losing the actual meaning of sentences. Even if this method is widely used in international research studies, Behr (2016) argued in empirical research that back-translations are not always equivalent or linguistically appropriate and might have a different impact on individuals in testing settings. As such, although this method has the merit of providing a more adaptive tool in a context where both the examiner and examinee do not share the same language, one may question the quality of the exchange. In such situations, our ethics are even more challenged.

Ethics should not be confused with deontology (code of conduct). Deontology is a set of rules that delimits what professionals can or cannot do. In comparison, ethics are concerned with what is morally right or wrong and are always present, even before our practice. More importantly, when it concerns working with patients in therapy or conducting research, including human beings. The core of our practice lies within the notion that we should and must put forward the patients' needs first. Given the diversity of people we encounter, more specifically in a cross-cultural context, how can we adapt our practice in the best possible way that tends towards a universal psychology practice? To answer this question, it is essential to understand that human beings are different, but also alike. In other words, there is a diversity and universality about all human beings and in the way psychological constructs can be considered.

1.1.2 Diversity in Psychology

It may be argued that psychological research and practice would be incomplete without understanding the diversity (e.g., gender, education, culture, or age) of individuals. According to the diversity vision statement and purpose of the City University in New York (CUNY, 2017)², diversity is defined as a concept that englobes respect and acceptance of the complete range of human characteristics in their socioecological, historical, and cultural contexts and understanding that each individual has a uniqueness. On the other hand, at its heart, psychology is about understanding human behavior within its complexity and variability. Given these definitions, if the community of psychologists ethically embraces the diversity of culturally different communities, it undoubtedly will lead to an informed perspective on the theories and methods that can be used for the practice of psychology.

During the APA annual convention, Psychologist Robert M Sellers (2015,7:44)³ encouraged psychologists to include more diversity in their practice. He advanced the following speech: "Psychological science must capture the full breadth of human experiences before it can truly say that it understands a particular psychological construct or phenomenon. If we are trying to develop laws of human behavior, it is imperative that those laws ... be based on data that capture that variability." Indeed, one of the goals of psychological studies is to explore psychological constructs in a given sample and extend the findings to the general population. Generalizing, without incorporating inputs from different perspectives and particularly, that of the populations themselves seems to be an unrealistic goal. The study of diversity in psychology is above all a process of who is being studied, who is doing the study, and what is being studied.

² <https://www.communitypsychology.com/the-concept-of-diversity-ceras-position/>

³ <https://www.psychologicalscience.org/observer/why-should-psychological-science-care-about-diversity>

Perez-Alvarez (2021, 2018a), in turn, mentions that diversity in psychology is ultimately a diversity inside psychological domains. He considers the different instances of innovations of the 21st century in psychology, such as Positive Psychology, which focuses on well-being and happiness; Neuroscience that explains neural correlations of psychological activity and Evolutionary psychology that concentrates on genetic predispositions for the behavior of individuals in society and culture. All of these domains of psychology deal with different aspects of the brain and behavior. Nevertheless, with their advantages and disadvantages, they reveal the diverse aspect of psychology that tends towards resolving the mystery of the human brain and mind. As such, it appears that the more diverse our approach and our study sample are, the more accurate our observations about the human brain can be.

It is not surprising that diversity in psychology echoes with the study of cross-cultural populations. The mere reason is that cultural diversity includes disparate populations with different languages, social practices, or belief systems (Norenzayan & Heine, 2005). Exploring these diversities can provide relevant information about the interaction between sociocultural inputs and psychological processes. That being the case, comparative studies carried out on different cultural populations, for example, between Americans and Chinese populations, have repeatedly concluded that American participants tend to put more effort into a given task if they were asked to perform it individually rather than in Group. Similar experiments in the Chinese population showed the contrary (Moghaddam, Taylor & Wright, 1993; Gao, 2016). Such experimentations highlight that a population from a different culture may perform differently for the same tasks, thus putting forward the diversity that results from a cultural affiliation. In this case, it was argued by the authors that Americans have an analytic cognitive processing style, whereas Asians have a more holistic manner. Notably, Nisbett et al (2002), through extensive experimentations between

Westerners and East Asians, concluded that these two distinct populations see the world entirely different due to their cultural imprints. Hence, this undeniable close connection between culture and cognition is worth exploring through cross-cultural psychology. Only then can we be better enlightened about the impact of cultural transmissions on cognition. From applying psychological diversity, we believe it can be possible to develop a conceptual framework to study culturally diverse populations if we value a variety of perspectives rather than simply assuming that behavior varies. It is of utmost importance to understand how and why these behaviors are different. Moreover, in an increasingly multicultural world, these culture-induced cognitive differences may have practical implications. For instance, clinical psychologists must be sensitized to each individual's uniqueness and history, and having a theoretical framework should allow them to provide and conceptualize adaptive interventions with their patients. The goal ultimately is not to suppress that diversity but to understand their origin and then find the commonalities that will help professionals discover common grounds and psychological universals applicable in diverse situations.

1.1.3 Universality in Psychology

If diversity holds a central place in the study of human behavior, the finality of psychology as an objective science is to understand mechanisms underlying human cognitive behaviors and generalize theories to a broader population. To do so, some authors came up with the concept of cognitive universals, considered as a heritage of all human beings. Cognitive universals has been described as “a foundational postulate of psychology” by Norenzayan & Heine (2005, p.763). According to Lonner (2011), it is based upon three specific features : (1) Process – which are psychological features that individuals use in their everyday life such as perception, learning, categorization. (2) Competencies are the features developed through cultural experiences such as

abilities, attitudes, and values. (3) Performance is the activities expressed as behaviors such as skills, project management, and social work. Berry (2015), moreover, affirms that “all psychological processes are present and available for development and use in all human beings; culture shapes the development (competence) and expression (performance) of these basis shared processes” (p.345).

From a universalist point of view, all humans share the same cognitive processes with different cognitive styles. This idea emerged centuries ago from two observations in psychology. Firstly, from a biological point of view (Benjamin,1988; Norenzayan & Heine,2005), itself originated from the evolutionary theory, which posits that human beings have passed on genetic characteristics for generations. These characteristics are essential for survival and reproduction for the human species (Newman & Newman., 2020). It supposes, then that there is a shared human genome which leads to a psychological universality amongst individuals (Barkow, Cosmides & Tooby, 1992; Pinker, 1997; Norenzayan & Heine, 2005). The second observation was provided by the cognitive science framework, where the brain was compared to a computer (Block, 1995; Norenzayan & Heine, 2005). In other words, the computer metaphor of the brain suggests that the brain has universal software, i.e., the psychological processes. The inputs would then depend on the environmental contexts (political, social, economic), and the outputs (beliefs, values, behaviors) would vary across cultures and history. However, this metaphor oversimplifies the diverseness and richness of the human brain and leaves almost no place for individual differences. While this metaphor has been revoked with new theories such as the embodiment theory, the latter foreseen a universal brain perspective. As most ideas ever developed, there is a starting point that provides grounding to future improvements. In this case, the conceptualizing of the computer

metaphor of the brain has provided with a perspective that there are psychological universals and differences that we observe in behaviors that are a result of the individual's human surroundings.

What is interesting to note is that all of these theories presuppose a universal phenomenon amongst individuals. This notion is fundamental, as it opens the possibility of a conceptual framework for universal psychology. Yet, such an affirmation appear realistically complicated to attain, mainly due to methodological limitations (e.g., sampling, experimental protocols) when comparing different cultures. This question stroke the attention of certain researchers, and so far, several strategies have been developed in the cross-cultural field. For example, Norenzayan & Heine (2005) discussed three approaches that claimed universality: Firstly, the *Two-culture approach* looks at similarities between two significantly different groups. Secondly, a *three-culture approach* explores commonalities between two psychological dimensions that are very different in all cultures. Finally, *the cross-cultural approach* covers the world's cultures and combines the two and three culture approaches. While cross-cultural strategy defined by the previous author seems to have great potentials, it is not necessary to empirically study the whole world's cultures. Rationally, it would be impossible to explore the world as such. However, comparative studies that are well designed with precision, relevant theories, and meaningful samples can provide precious insights into psychological universals. This level of accuracy in psychological research must then also include the study of the dynamics between culture and human psychological processes as well as the mediators (e.g., language, aging) that may affect this dynamic.

1.2 The practice of Psychology with respect to the culture

1.2.1 Culture, language and cognition

There has been a long historical debate about how culture and language influence our cognitive processes (Perez-Arce, 1999; Broditsky, 2011) and the perception of our world (Sapir, 1929; Whorf, 1956). For Sapir, culture influences language but not vice versa, whereas Whorf suggested that language and culture may interact, but language plays a more prominent role (Lucy, 1997). Other authors believe that language is a result of gene-culture co-evolution (Pinker & Bloom., 1990; Feldman & Laland., 1996; Rhode et al., 2016), while some hold the view that language is a result of human biological evolution and adaptation to its environment (Pinker, 2003) and that culture played an essential role in this adaptation (Tomasello, 2008; Kirby et al., 2017). While this debate appears endless, it also reveals different existing perspectives over the interaction between language and culture across time. These diverging perspectives reinforce the notion that the authors had different perceptions of the world, which could be otherwise, accounted as an influence of their cultural values. As such, the idea that language shapes our thoughts and that how we convey our thoughts are dependent on our cultural values and belief systems gets a solid standpoint here.

Admitting that culture and language influence our cognition (see, Brown & Lennenberg., 1954; Semin, 2009), we should instead ask how and to what extent different types of language affect cognitive processes differently? Indeed, an extensive body of literature provides solid evidence for language as the basis of human experiences in the way they view their world, internalize them, and make sense out of them (Boroditsky, 2011; Loftus & Palmer, 1974; Nisbett & Norenzayan, 2002). In other words, cognitive processes such as perception or memory are

tainted by one's experiences and the language the latter uses to express them. For instance, Loftus & Palmer (1974) demonstrated how language could alter memory by post-event information in a laboratory experiment. The experimental setup was similar to an eye witnessing testimony, where participants were misled by asking about a blue car involved in a car accident, whereas in the video, they were shown the car was a green one. The experimental group was more likely to remember the car when it was blue than the control group, where no color was mentioned. They even had lower recalls of the accident. Loftus (1977) explains the results in terms of language; in this case, the colors of the cars (green or blue) had different activations for the participant's ability to recall an event. When considering two kinds of verbal information that contribute to memory creation, small changes in these pieces of information can cause distortions in memory. These findings support the notion that the use of specific words via language indeed impacts cognition.

Moreover, through extensive experimental work and conceptual framework, Boroditsky (2001; 2009; 2011) has demonstrated that language and culture also influence the way we conceive time and space. Boroditsky's works had a lot of implications in the embodied and linguistic representations of metaphors we use in everyday life (Thibodeau & Boroditsky, 2011). She advances that people often speak of time using spatial metaphors (Casasanto & Boroditsky, 2008, Clark, 1973). For example, the authors when someone says: "They moved the meeting forward two hours"; there is concretely no way that the object (meeting) can be physically moved forward. However, it is understood through our inner motion and senses, that is, by placing ourselves along a metaphoric timeline. Therefore, depending on people's language, the present, past, and future can be different. For instance, English speakers conceive a future in front of them; the Aymaras - behind, and as for the Mandarin Chinese speakers, the future is below them. These examples show

that time is conceived differently depending on the cultural background and language (Lai & Boroditsky.,2013).

Rhode et al. (2016) explored the extent to which culture and language were related and how these two concepts could interact with processes such as cognition, perception, and information processing. They carried out an interesting study between two culturally different populations (English, Korean and Chinese) with different attention and information processing styles. Korean language structure predisposes the speakers to pay more attention to the ground (global context) than figures (salient objects). In their study, participants were asked to complete a picture description and a recall task. As hypothesized by the authors, Korean participants reported more ground information than figure information, followed by Chinese participants and English participants. The results, hence, suggest that the structure of language has an impact on visual attention tasks. Moreover, in another study, it was also demonstrated that East Asians usually process information in a holistic, contextual way, whereas western cultures do so in an analytic and feature-based style (Park, Nisbett & Hedden, 1999).

Overall, these studies, captured through the theoretical framework of embodied cognition (Borghini & Pecher, 2011), grounded cognition (Barsalou, 2008), and perceptual and conceptual systems (Goldstone & Barsalou, 1998), provide a more comprehensive approach to understanding the dynamics between language, culture, and cognition. It is particularly interesting when it concerns aging in a cross-cultural setting since based on current comparative literature, there are already evidences of a difference in information processing styles between East Asian cultures and Westerners depending on cultures. Such cultural differences may, as such, hinder cognitive functioning at its most basic level, particularly during aging.

1.2.2 Culture, language, and Cognition with respect to aging

Culture, as mentioned earlier, is deeply rooted in an individual's cognitive processes and behavior. Thus, there are reasons to believe that exposure to culture throughout aging will intensify its effects on cognitive processes. However, Park et al. (1999, 2002) argue on the contrary. According to the authors, the effects of culture on cognition are not generalized in aging. There are conditions where cultural effects on cognitive mechanisms are magnified, and others where it is minimized. The reason suggested by the authors is that the resource demands of tasks needed to be accomplished act as a mediating variable between cultural and cognitive relationships in aging (Park et al., 2002). Park & Gutchess (2002) explicit their reasoning by comparing tasks performances of young and older adults across cultures. They suggest that, while young participants would have cultural differences in performance on fluid skills (such as speed and working memory), older adults across cultures will have the same performances. The reason they suggest is that cognitive flexibility is significantly reduced in aging. In other words, cognitive resources and strategies are limited in aging; therefore, older adults have less cognitive flexibility. This fact appears as a universal truth for all aging individuals across cultures.

On the contrary, if a task demands fewer resources, such as crystalized /automatic tasks that demand lesser cognitive resources, cultural effects will be more salient due to the prolonged exposure to the environment and learning (Park, 2000, Park et al., 2002). Based on Park et al. (1999) theory, Hedden et al. (2002) investigated, through a cross-cultural study in Americans and Chinese aging participants, the cultural differences between the speed of processing and working memory on visuospatial tasks (Corsi Blocks) or numerically-based tasks (Digit comparison). They found out that, firstly, that there was no effect of the culture mostly on visuospatial tasks. However, the cultural differences were more pronounced on the numerically-based tasks, implying linguistic

effects. The linguistic properties of each culture and language were more salient on the backward digit span task than the forward task. Indeed, the backward tasks demand more cognitive load than the forward ones. Therefore, as per the authors' conclusions, this study illustrates that tasks visuospatial domains are culturally invariant, but number-based cognitive tasks biases performance levels between the cultures. Moreover, these differences are mainly explained through cognitive resource demands.

The cognitive resource theory, appears very plausible, particularly when it is well-known that as people age, their priorities also changes. In other words, they allocate more resources to tasks that are essential to their everyday functioning and well-being. Cartensen (2006) described this phenomenon as the Socio-Emotional Selectivity Theory. According to the theory, personal goals may influence the cultural contexts of aging. Even though the socioemotional selectivity theory does not focus on age-related losses, it suggests that older adults perceive future time left as limited. That, in turn, challenges older people to prioritize personal goals based on emotional meaning.

Fung (2013) carried out a review of empirical studies of aging based on the socioemotional selectivity theory and in different areas of personality, social relationships and cognition, in East Asians and Western Cultures. What the author concluded from the findings of the studies is that cultural differences in aging is not random, yet cultural values are found as deeply grounded in an throughout an individual's life. The author adds further that "when individuals from different cultures pursue their own internalized cultural values with age, cultural differences in aging occur" (Fung, 2013, p.371). In other words, for the authors, aging happens regardless of external factors, however, differences that are observed in cultural aging are mostly based on the cultural values that any individual decides to pursue. These studies propose different perspectives of the influence

of culture and cognition on aging. Specifically, they propose the idea that culture may influence cognition in aging, but it is not always systematic. Much of the differences that explain cognitive changes in aging can also account for age-related changes across cultures. This basically happens when aging people prioritize their well-being based on the cultural values they have internalized.

1.3 The practice of psychology *per se*: Conclusion

Throughout this chapter, we have shown our considerations about practicing psychology across cultures. Indeed, the study of the culturally diverse population calls for high ethics; in the way that we practice and also in respect to the individuals that we encounter. By acknowledging differences between individuals, we will be able use these differences as a strength and provide support in the best possible way.

Culture and language undeniably drive our behaviors. They define who we are and who we are, comes down to how our psychological processes function. Cognition is consequently at crossroads between culture and language. Both of which, not only answers the question of WHAT differences are present in human beings, but they also provide solid theoretical insights and a framework for the WHYs and HOWs human differ among themselves. They uncover the diversity of human cognition that allow generalizability of theories, and thus, are able reveal psychological universals. In fact, even if the potential interaction of these variables makes the practice of psychology highly challenging, it calls for skillfully applied ethics, knowledge and methods. More so if it concerns older adults. There is an unquestionable demand for psychologists to care for the well-being of older adults, given that the older population is rapidly growing and becoming even more diverse due to immigration. Hence, there is a sense of urgency to understand cognitive aging in a cross-cultural context to decrease health disparities amongst the minority population

Chapter 2
**Cognitive Aging: What
is it today?**

2.1 What is cognitive aging?

As a constant reminder of time passing by, aging is accompanied by a plethora of changes on both physiological, psychological, and sensorimotor levels (Van der Linden & Huppert, 1994; Lemaire & Bherer, 2005; Vallet, 2015). Due to its extreme variability of occurrence in individuals, aging has been an alluring field of research for many researchers. Many of which have demonstrated that during aging, there is an alteration in cognitive functioning (Craik & Jennings, 1992; Light, 1991; Salthouse, 1991; Zacks & Hacher, 2006). Precisely, normal aging has been associated with modest declines for cognitive domains such as memory, speed processing, executive functioning, while other domains remain almost stable. In contrast to pathological aging with impaired global cognitive functioning (Berchtold & Cotman, 2009). Although pathological aging such as dementia and mild cognitive impairment is common, not every aging person will experience these conditions. Some will go through normal cognitive aging. It is equally essential to understand how normal cognitive aging can affect the older adult's everyday life functioning.

As mentioned earlier, while undeniable cognitive changes accompany aging, certain aspects of cognitive processes are still resilient (for review, see Lemaire and Bherer, 2005). It is the case for crystallized processes such as vocabulary or knowledge tasks. They are usually referred to as skills, knowledge, and abilities that have been overlearned, well-practiced and familiar through the life-course (Lezak et al., 2012). In contrast, controlled or fluid processes are abilities involved in problem-solving and reasoning. They are less familiar and include the person's ability to learn new information, solve problems and manipulate their environment (Catell, 1963). Due to the flexible nature of fluid processes, executive functioning, processing speed, and memory are considered part of it (Harada et al., 2013). Cross-sectional studies have

shown a gradual change in fluid cognitive abilities from age 20 to 80 years as cognitive processing speed decreases. Whereas crystallized abilities generally improve until approximately 60 years and then plateau until around 80years (Salthouse, 2010; Horn & Catell, 1967) (see Fig 1.). The division of cognitive abilities as fluid and crystallized has largely yielded insights into what might account for discrepancies in the patterns of cognitive aging amongst individuals. It has also given rise to the notion that with age, other capabilities may increase to compensate for possible cognitive declines.

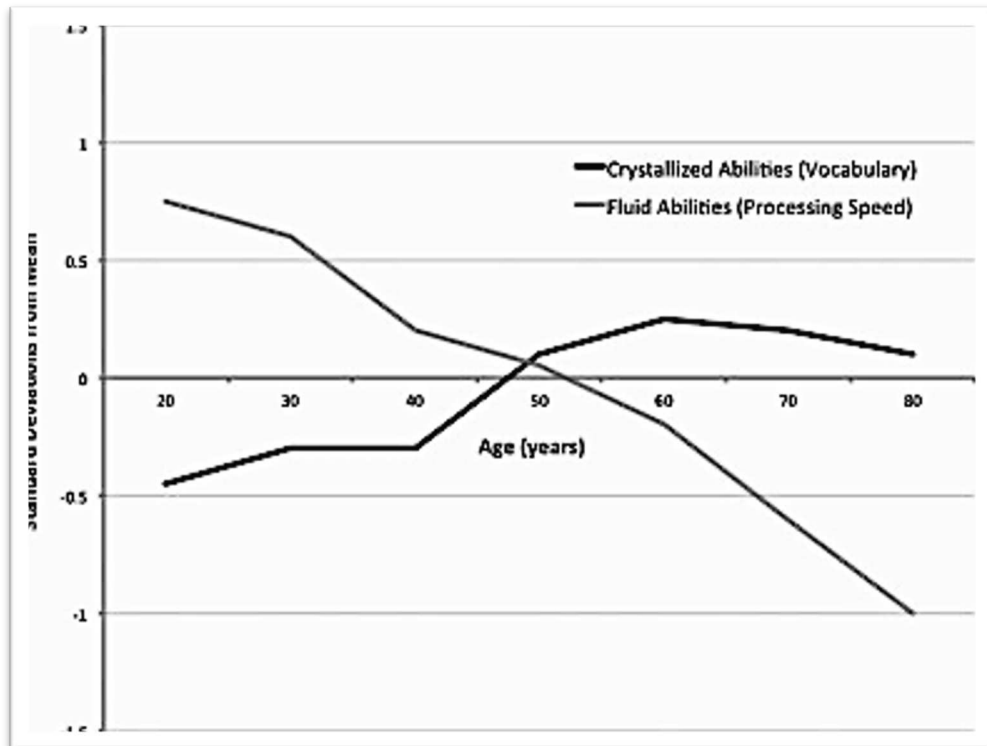


Figure 1 : Change in “crystalized” cognitive abilities, represented here as vocabulary, and “fluid” cognitive abilities, represented here as processing speed, with age in normal subjects. Graph is based upon data presented by T.A. Salthouse and colleagues. Zero line represents the mean or average performance on these measures, while values above zero represent better than average performance and below the line worse than average performance.

In fact, for a long time, aging was negatively connoted, and older adults have been victims of ageism (Abrams et al., 2007; Bratt et al., 2018) due to the plethora of cognitive ages occurring and reduced capabilities. On the other side of the coin, the extensive literature on aging also shows the cognitive potential in older adults. For example, Baltes and Baltes (1990) has designed a general adaptation model for successful aging: Selection, Optimization, and Compensation. Baltes (1997) considers cognitive resources in aging as an evolutionary process where individuals emphasize their attributes such as adaptability, motivation, and resilience as major determinants of aging. Not only do internal resources contribute to aging well, but the environment also has a key element (Wahl et al., 2012). Older adults rely much on their environmental support to compensate for the attentional resources that decrease with age. Not only do they do so in relation to the memory, but they use this strategy even for perceptual processing and goal-oriented actions (Craik, 1983; Lindenberger & Mayr, 2014). The connection between how the environment can support cognitive processes is well documented through embodied theories. According to the embodied view, the body's interactions with the environment contribute to the acquisition of cognition (Shapiro, 2014). If this statement is true, then bodily changes due to aging should also impact cognitive processes in older adults.

2.2 The Aging body and consequences of age-related changes

2.2.1 Sensorimotor changes in aging

Van Beek et al. (2016, p.3) describe that “the human body is affected by its hostile environment and slowly degrades, much like man-made objects, while on the other hand, it is the efficacy of maintenance and repair processes which determines how long it takes for this eventual degradation to occur.” Indeed, from a physiological perspective, and even as a normal part of aging, the body’s cellular composition changes. Often the first signs of aging involve musculoskeletal changes resulting in a multitude of functional consequences; for example, bones and joints become less dense, giving rise to osteoporosis or osteoarthritis; muscle tissue, muscle strength, and muscle mass tend to decrease (also known as sarcopenia); sight and vision become less clear; hearing high-pitched sounds also become more difficult (presbycusis); the ability to smell and taste starts to diminish; and typically the number of brain cells tend to decrease too. These various declines do not all happen at once, they are gradual and while they still have adequate functioning, these changes tend to affect their cognitive functioning. In the following sections, we will describe a few studies that demonstrate how bodily changes may affect cognitive processes in aging.

➤ *Physical and functional changes in aging*

Firstly, *sarcopenia* is defined as loss of muscle mass, strength, and speed (Evans, 1995), rendering physical movement more difficult for older adults. Commonly, older adults may experience problems with mobility and balance and, thus, higher risks of falling. The result of a

slow-down of gait speed is a problem as it presumes a loss of independence and autonomy for the elderlies (Grayston, 2018). In most cases, physical activity is advised to counteract the age-related consequences. There has been considerable evolution in research on aging and physical activity in recent years. Researchers advocate for improved physical and mental health along with cognitive functioning and quality of life of the older adults who engage in more exercise (Baker et al., 2009; Netz et al., 2005; Zimmer et al., 2021). Physical inactivity and obesity, in that sense, have been considered as high-risk factors for sarcopenia along with cognitive impairment in aging adults from different populations (Asians and Europeans) (Peng et al., 2019).

Physical and mental health are two leading indicators of the quality of life (QOL) in older adults (Akdag et al., 2013). Prasad et al. (2021) found a positive correlation between physical activity level and quality of life (QOL) in a cross-sectional analytical study amongst 89 participants aged 60-80 years old. In this study, they measured standing balance, walking speed, and grip strength. In their conclusion, they conclude that: “The common side effects of aging can be mitigated by increasing physical activity which not only reduces risk factors but also delays the onset or decreases the side effects of aging and improves QOL” (Prasad et al., 2021, p.5). Hence, not only physical activity is beneficial on quality of life, but it also has a role in preserving and enhancing cognitive functioning as well as reducing the risks of neurodegenerative diseases (Engeroff et al., 2018; Prakash et al., 2015; Blondell et al., 2014; Hamer & Chida, 2009; Sofi et al., 2011; Stenling et al., 2021).

➤ ***Sensorimotor changes in aging***

Along with physical changes, there is also modification of bodily senses in aging, referred to as sensory senescence (Nusbaum, 1999). The normal aging process causes gradual loss across

the five sensory domains: visual, auditory, tactile, olfactory, and gustatory. These losses can go unnoticed if, for example, a person with visual problems stops reading; then it is most likely that vision problems will no longer be an issue.

A longitudinal study relative to the functional consequences of everyday life competence of a dual sensory impairment (hearing and vision) in older adults over 70 years old was carried out by Brennan et al. (2006). Findings of this study carried out across different periods (from 1986-1990) gave evidence that decreased dual sensory resources have an impact on activities of daily life (e.g., dressing, bathing) as well as instrumental activities of daily life (e.g., managing money) (Brennan et al., 2006). According to Nusbaum (1999, p.272): "Sensory ability is strongly correlated with intelligence level in old age. One explanation is that the same central processes that lead to a change in sensory ability also may lead to a change in intellectual function". There is now ample literature that accounts for links between sensory impairments and a change in cognitive functioning (Salthouse, 1991; Lindenberger & Baltes, 1994 ; Baltes & Lindenberger, 1997).

For instance, Lindenberger, Scherer and Baltes (2001) have explored the connection between cognitive performance and sensory acuity in older adults. Their study was based on the hypothesis that individuals with impaired sensory abilities would perform fewer cognitive tasks that require intellectual functions. In other words, they suggested that for the same abilities needed to perform a task, such as a visual task, individuals with a poor vision will be disadvantaged compared to someone with normal visual acuity. They tested this hypothesis in 213 middle-aged (30-50) years old Berlin residents. There were four conditions in this study; visual and auditory acuity reduction, acuity reduction only, visual reduction only, and no visual reduction at all; to reach sensory reduction levels experienced by older adults. Participants were then tested with a

computerized cognitive battery test including perceptual speed, reasoning, episodic memory, pragmatic reasoning (Lindenberger, Mayr & Kliegl, 1993; Baltes & Mayer, 2001), and also working memory. The results of their study, firstly, speak against their hypothesis, i.e., simulated sensory reduction does not systematically have a negative impact on intellectual performances in older adults. They explain these results through what Duker (1963) described as '*reactive increase of attention and effort*'. In other words, individuals in an experimental setting, tend to compensate for sensory acuity by putting in more effort. Another interesting finding of their study was that middle-aged participants did perform lower on working memory tasks when auditory than when visual acuity was reduced. Indeed, a plausible reason advanced by the authors concerned online corrections of perceptual failures, i.e., visual rechecking is usually much easier than in auditory modality. Murphy et al.(2000) also explained that the auditory noise effect on short-term memory was similar to the effects of aging on short-term memory. Moreover, the results also seem to go along with the evidence that fluid abilities such as working memory are indeed sensitive to aspects of sensory inputs, in particular, auditory modality.

2.2.2 Cognitive Aging: what about Executive functions?

We mentioned before that aging, although being impacted by cognitive changes, is also a process where older adults tend to regulate their behaviors in accordance with the losses and gains they experience (Baltes, Staudinger & Lindenberger, 1999; Maury & Martin, 2010). And so, they rely much on their environmental support to achieve a goal-directed behavior. This demands, initiation of controlled processes. Craik (1986) claims that self-initiation of a cognitive act is closely linked to resources and environmental support. Two dominant theories have explained age-related changes in processing resources: Firstly, the processing-speed hypothesis (Salthouse, 1991,

1996) where the author explains that older adults are slower than younger adults in processing information (Cerella, 1990; Myerson et al., 1990). Caveats are that older adults process information according to their priorities, and thus, they are more interested in the quality of performance rather than speed as they get older (Castel, 2007; Baltes, Staudinger & Lindenberger, 1999; Maury & Martin, 2010).

The second theory concerning processing resources in aging is process-specific (Verhaeghen & Cerella, 2002). Process-specific theory, according to the authors, is mostly based on the process that is involved in a specific task. Basically, it involves executive control processes such as selecting information among different sources and switching between tasks. The problem inherent to these processes and backed up by several studies is that executive processes such as inhibition, task-switching, and working memory are particularly disturbed in aging (Hasher & Zacks, 1988; Mayr, 2001; Verhaeghen & Cerella., 2002). Both of these theories, i.e., processing-speed and process-specific, are central to executive controlling processes; either for self-initiated actions or selecting activities that are important to an individual. More generally, they appear to derive from executive functions.

Throughout the literature, Executive functions (EF) has had a large array of definitions along with different theoretical approaches and models. Each of which, was based on previous findings proposed by authors, reevaluated and redesigned with different approaches. For example, Normal and Shallice's model (1980) of EF was mainly based on an attentional control with the presence of a "supervisory attention system" for purposeful and goal-directed behaviors. In their model, they used the notion of learned thoughts and actions schemes with a varying degree of attentional recruitment to account for behaviors in familiar and non-familiar situations. As for Baddeley (1996), his theories of EF were based on a attention, particularly, as a resource

management component of the working memory, which he named “the central executive system”. The latter involves a phonological buffer for maintaining verbal information, a visuospatial sketchpad for maintaining visual and spatial information, and the episodic buffer which integrates short/long term memory. Both of these theories helped in the comprehension of the mechanisms underlying the EF. However, the way they were conceived, supposed a unitary vision of the EFs. Yet, clinical observations of patients with frontal deficits, showed that EF processes were impacted differently. For instance, Allain et al (2004), reported that patients had different levels of difficulties in sequencing, prioritizing, and managing actions, even in familiar situations. If EF was a unitary system, then a dysfunctional EF would impact all of the processes similarly, however, findings from Allain et al (2004) study suggest a more fragmented view of EF.

Years later, Miyake et al (2001) proposed a definition of the EF by considering it as both a unitary and diverse process. They suggested a definition limited to three components: *Cognitive flexibility or shifting* – refers to the ability to reason and solve new problems, and more precisely to the ability to alternate, to change cognitive strategies according to the needs of the task in hand, when for example the path or strategy used by the subject proves ineffective; *Inhibition of irrelevant responses*: It refers to the ability to prevent, in a controlled way, automatic or pre-established responses from being activated; *Updating information in working memory*: the ability to remove/reprocess previously relevant information when necessary. According to their model, each of these three components is related, yet is a distinct entity. The figure (fig 2) below shows a schematic representation of the framework of Miyake & Friedman’s conception of EF(s) as both a model of unity (Common EF) and diversity (updating/shifting specific) model.

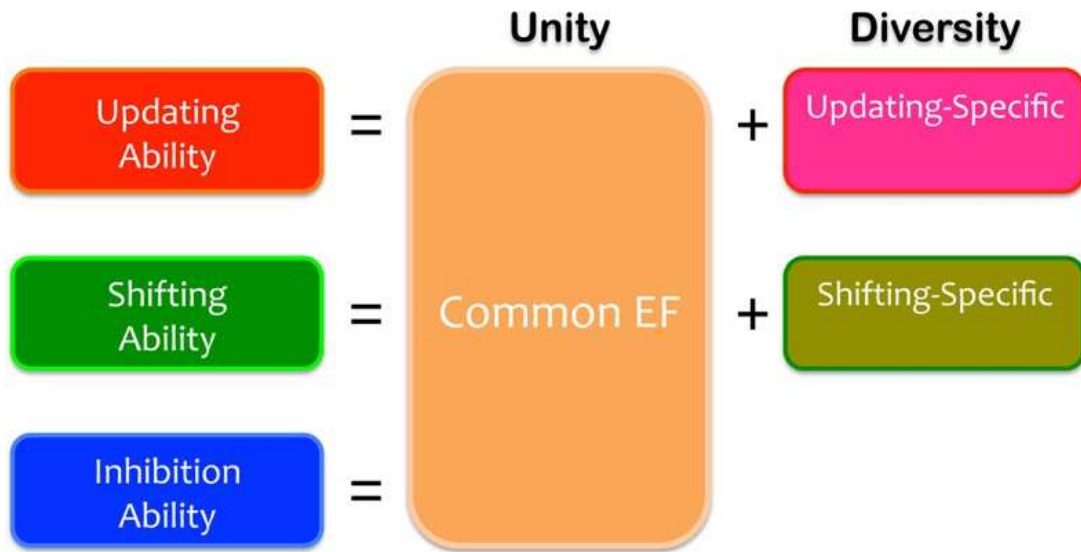


Figure 2: Schematic representation of the unity and diversity of the three executive functions (Miyake & Friedman., 2012)

Based on the model of Miyake et al (2001), several researchers have demonstrated that aging can affect all three components at once, but also one component can be more at risk than another one. Let's take the example of inhibition. According to some researchers there is a taxonomy of inhibitory processes (Chuderski et al, 2012; Friedman & Miyake, 2004; Pettigrew & Martin, 2014; Stahl et al, 2014; Rey- Mermet & Gade, 2018). In other words, with the unitary construct of inhibition, there is a diversity occurring. Here, the authors mention the ability to suppress dominant information from the ability to ignore distracting information and response interference. Rey-Mertet & Gade (2018), explored the probability of the taxonomy of inhibitory processes in a meta-analysis of 176 studies involving older adults. The authors tested the hypothesis of inhibition and whether they were general or task-specific. The findings of this meta-analysis establish that inhibitory deficits were task-specific and dependent on the ability needed by the tasks, however, inhibition was not always systematic in older age. Such results challenge the notion of inhibitory processes, more generally, EF, as widely admitted for many years now. EF is a dynamic process and constantly interacts with an individual's environmental resources, needs, and

priorities. The question that we raise is, is it still worth considering EF as a process, or should it rather be defined as a product of our interactions?

2.2.3 Executive functions to Executive Functioning

In a global conception of human cognition, distinguishing between cognitive functions may appear absurd since the brain always functions as a whole. Indeed, even if executive functions have been conceptualized through different processes such as inhibition, flexibility, and working memory, they are all integrative parts of the brain that work together to generate a desired and adaptive behavior in a given situation. Behaviors that have also been linked to emotions, motivations, and affect (Haber & Rauch, 2010; Ardila, 2008; Koziol et al., 2012). In the presence of such evidence, we may wonder if it is of any relevance to compartmentalize processes given that they act in conjunction to guide our everyday behaviors and actions? The point is, the longer we shall dissociate brain functions or compartmentalize EFs, the more our habitual way of thinking will remain and the more it will constrain our investigations about the human brain and behaviors (Cromwell & Panksepp, 2011; Koziol, 2012).

Our ultimate goal as human beings is to be able to interact in and with our environment successfully. Such interactions require cognitive flexibility and ongoing sensorimotor learning in a dynamic environment. Pezzulo (2011) proposes three distinct arguments to understand the dynamics between human behaviors and sensorimotor representations. Firstly, he claims that "an organism's knowledge and representation ability originates from and is grounded in anticipation of sensorimotor actions" (Pezzulo, 2011, p.80). Explicitly, any representation of an object is grounded in the action of the latter. For example, a glass of water will be coded procedurally by its weight, grasp, and lift. The second argument is that "anticipatory mechanisms, as used in situated action execution and control, produce procedural knowledge; their re-enactment (in a

simulation of possible situated action) can produce declarative knowledge" (Pezzulo, 2011, p.81). Here, the focus is mainly on the sensorimotor traces that we build up while carrying actions. These traces are then reactivated when similar or almost close situations are later encountered. And, thirdly, "embodied representations afford a form of internal manipulation that can be described as internalized situated action." (p.81). This third argument aligns with Clark's (1998) conception of cognition as an internal manipulation of sensorimotor representations.

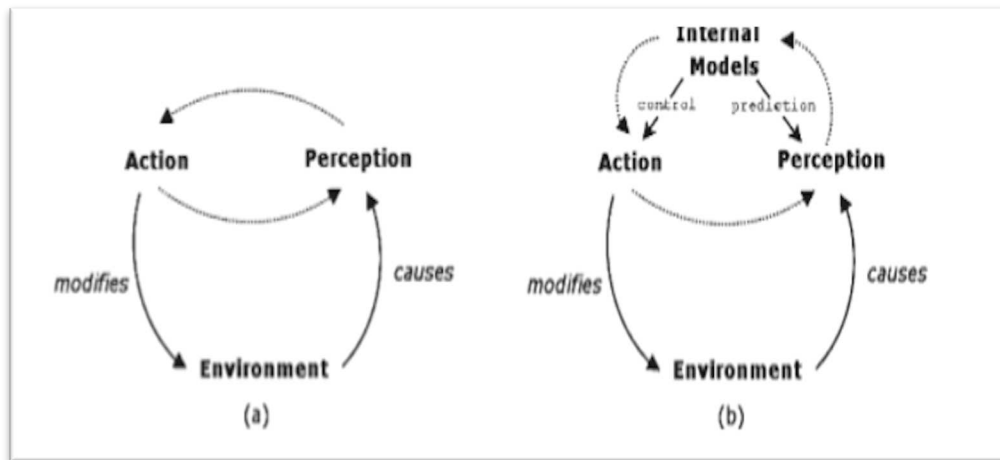


Figure 3 (a) the action-perception loop in the sensorimotor view; (b) Action-perception loop augmented with prediction in action-based view. Solid edges stand for double causal impact between an organism and its environment: the organism modifies its environment by acting, in turn, the environment causes the organism's perceptions. Dotted edges represent the fact that actions and perceptions influence each other indirectly; for example, an organism's actions partially determine its next stimulus. Overall, the sensorimotor view de-emphasizes representations and reduces them to internalized sensory stimuli.

Indeed, according to the sensorimotor view, most of our knowledge exists as sensorimotor format (Harnad, 1990), and that all for situated action and cognition, enacting or mastering skills with little (or no) internalization of the external world is sufficient (Gibson, 1966; O'Regan and

Noe, 2001). To simplify, there is a feedback loop between action-environment, i.e., when organisms interact with their environment, they create a knowledge-based on their perceptions. These perceptions through sensorimotor contingencies are encoded as traces, triggered in certain conditions, and reactivated in future situations. The figure (fig.3) below explains this feedback loop between action, perception, and environment and the implication of internal models.

The concept of internalized manipulation of sensorimotor knowledge is regarded as a form of executive functioning (Koziol et al., 2012). Indeed, reusing encoded sensorimotor memory and applying it to our everyday lives calls for higher-level cognitive functioning (i.e., EF). At this point, we introduce the notion of *functioning* instead of function. The difference may seem subtle; however, executive functions, in our view, suppose the presence of a definite system or process from which information will be extracted and used. In other terms, it is comparable to a box, where we store information and retrieve them as and when needed. *Executive functioning (EFg)*, as per our view, is a *product* or, put differently, a consequence of all the internalized sensorimotor processes. It is constantly interacting with all the parts of the brain (e.g., perception, action) to reach a result. Many of our everyday behaviors and activities are regulated by such implicit and automatic processes. These are highly efficient, economical, and adjustable to contextual changes (Imamizu et al., 2009). Saling and Philips (2007) advanced that automatic behaviors are not mindless and essential to executive functioning.

Ionescu (2012) also agrees that the efficiency of cognitive systems can be compared to cognitive flexibility. He differentiates between the cognitive system as processes (e.g., shifting, memory, categorization) versus the cognitive system's properties (e.g., agency, prospectivity, flexibility, creativity; see Gibson, 1994) and agrees mainly with the second definition. If the cognitive system by nature is 'flexible' then, why should we still adopt the view of a static system?

The view that we are adopting is that of embodied cognition (EC). Bruin & Kastner (2011, p. 553) define it as the following :

« Dynamic Embodied Cognition: Cognition is (developmentally) grounded in the agent's coupling to her surroundings. This coupling is dynamic insofar it allows agents to (a) rely on direct online cognitive processes or (b) decouple from their environment and engage in offline cognitive processing. Online processing is 'cheap' and efficient as it allows the agent to avoid building up 'costly' internal representations, which would require additional processing resources; however, it comes at the cost of limited and inflexible responsiveness. Offline processing provides agents with more flexibility (autonomy) regarding their direct environment but is also cognitively more demanding. For a system to engage in decoupled offline processing, it has to (a) inhibit automatic behavioral responses to environmental features and (b) be able to elicit the behavior formerly coupled to the presence of a certain stimulus independently of environmental stimulation. »

Indeed, Embodiment, in this view, suggests that cognition has a dynamic role. Much like this view, we also believe that EFg is multifaced and in dynamic interaction with our environment and thus considering executive functioning instead of executive functions to explain age-related consequences appears as a better approach.

2.3 Embodied cognition as an explanatory basis for cognitive processes in aging

Traditional cognitive theories have so far explained age-related changes in terms of speed-processing deficits (Salthouse, 1991) or inhibitory/process-specific deficits (Verhaeghen & Cerella, 2002). While these theories have contributed to describing the phenomenon of aging, they have omitted to a certain extent the dynamic and functional role of the body and cognition in aging. Usually, when people talk about aging across cultures, the first thing they say is: "I now have wrinkles or grey hairs; I am getting old!". As such, the perception of aging depends on what people value first: Physical appearance, intelligence, or both?. Yet, it is undeniably true that the bodily perception and awareness of one's physical or intellectual capacity changing has a central role in human sensation, action, and cognition (Gallagher, 2005; Pfeifer et al., 2007; Kuehn, 2018).

Indeed, a growing body of literature on embodied cognition (EC) theories for the past decades has provided strong evidence of the sensory, motor, and perceptual alterations linked to age-related cognitive impairments (Lindenberger & Baltes, 1994; Baltes & Lindenberger, 1997; Lindenberger, Scherer & Baltes, 2001). The association between sensorimotor alterations and cognitive impairment was explained through four hypotheses (Versace, Brouillet & Vallet, 2018). Firstly, based on Baltes & Lindenberger's (1997) theory, the authors described these age-related changes as a cognitive load hypothesis. They suggested that altered perception exerts a higher cognitive load on the older adult in this theory. In other words, cognitively demanding tasks such as non-automatic tasks (e.g., decision making) require information processing through different perceptual mediums. Thus, in cases where older adults have perceptual alterations, where

resources of older adults are already limited, they are more likely to fail in accomplishing those tasks.

Secondly, Valentijn et al. (2005) proposed the theory of sensory deprivation. The authors claim that a prolonged lack of sensory input results in cognitive deterioration due to neuronal atrophy. We have cited the study of Lindenberger, Scherer & Baltes (2001) earlier, which demonstrates this theory. Thirdly, the common cause theory (Lindenberger & Baltes, 1997) postulates a common factor responsible for both sensorimotor and cognitive age-related declines. This common factor could be attributed to a general deterioration of brain functions. In other words, there is a shared variance between age, cognition, and sensorimotor functions (Kiely & Anstey, 2015; Vallet, 2015). Finally, the fourth hypothesis suggests that individuals with sensory impairments do not perform well on psychometric tasks as they are disadvantaged due the difficulties in sensory perception (Valentijn et al., 2005; Vallet, 2015). All these theories demonstrate the importance of sensory and motor alterations and their impact on aging and thus open up new perspectives of care according to the embodied approach.

In fact, a novel theoretical model that demonstrated the impact of sensory difficulties in aging was introduced by Kuhen et al. (2018). In this model (see figure 4), the authors have shown links between (NFL) neural mechanisms (N), functional consequences (F), and daily life relevance (L) in aging according to the embodied perspective. The NFL framework highlights the interactions between "age-related neuronal changes, age-related changes in perception, motor control and cognition" (Kuehn et al., 2018, p.208); that have often been studied separately in the literature. According to the authors, the main issue in aging concerns the efficient utilization of sensorimotor percepts. Thus, this model demonstrates the links and potential outcomes of age-

related cognitive changes, bodily perception, and action that have implications as far as it concerns intervention strategies for older adults in practice.

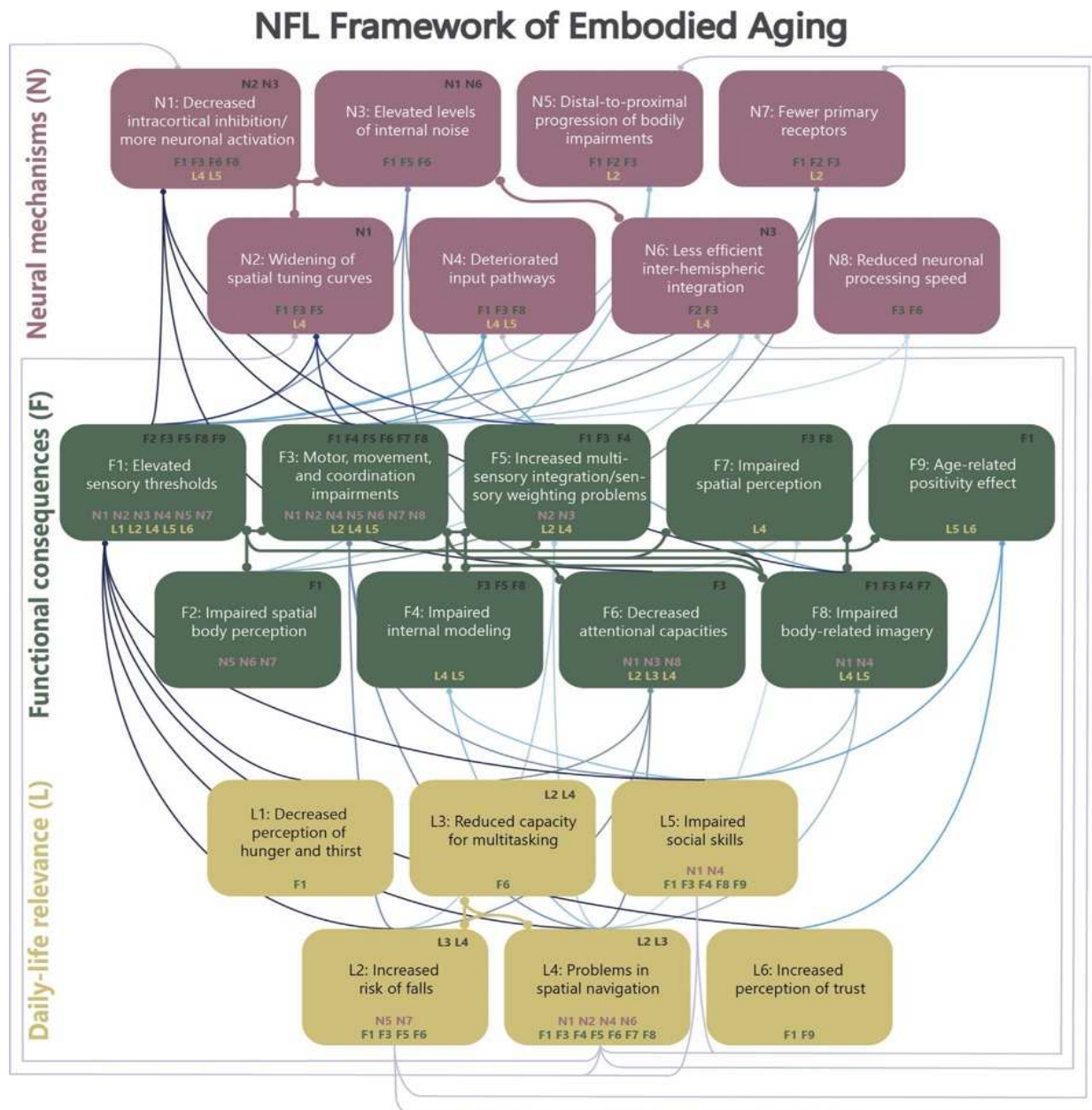


Figure 4 : NFL Framework of Embodied Aging. Displayed are interactions between neuronal mechanisms (N), functional consequences (F), and consequences for every-day life (L) of body-related impairments in older adults. Similar to the colored lines, the small letter-number pairs inside the boxes indicate relationships between different elements, which are explained in the text. Black pairs = relationships between elements within same level; red, green, yellow pairs = relationships between elements across levels.

One of the biggest challenges of using Embodied perspective may be in the Clinical Practice of Neuropsychology. At its origin, neuropsychology has significantly been influenced by a disembodied and localizationist-connectionist approach (Cardona., 2017). Generally, clinical neuropsychologists tend to rely on the cognitive models of the brain for developing diagnostic evaluations and cognitive remediation programs. For instance, memory was characterized as multiple systems, and each specific system, dedicated to a brain structure (Gounden et al., 2017; Tulving, 1985, Shallice, 1988). Advocates of embodied theory, on the other side, suggest that memory is the product of an accumulation of memory traces that are sensorimotor, emotional, or event contextual

(Versace et al., 2014; Vallet, 2011). In that sense, memory is instead of a unified and dynamic system, and thus, recall of an event would mean reactivation of sensorimotor traces of that event (Vallet et al., 2011). Therefore, the embodied view of cognitive processes shows that human cognition is dynamic and cognitive functions cannot be seen as different systems.

Integrating the embodied point of view in clinical practice appears as a complex task since, firstly, it means that practitioners have to shift from the dominant conception of cognitivism while the majority of tools are based on the latter theories. Secondly, it also changes the modalities of assessments (diagnostic evaluations) and the design of cognitive interventions. Evaluating is the first step towards understanding the complexities of aging and its impact on cognition but, the next step, cognitive remediation, is even more crucial. One way of carrying out cognitive remediation in an embodied perspective can be done by stimulating the link between memory traces and perception, such as training mental imagery across different modalities (Vallet et al., 2011).

Applying embodied theories to practice is relatively recent, and there is still a lot to be done in this field. Recently, Turo, Collin, and Brouillet (2020) highlighted that visuospatial working memory span is influenced by gesture laterality compatibilities between practitioner and patient. Hence, it can be noted that body implications are essential to consider in an evaluation setting and affect individuals' performances. If embodied theories allow a better understanding of human cognition, adopting such theories should not only be looked at as an option but as a necessity in clinical practice.

Chapter 3
**Cognitive interventions in
aging:
from a traditional to
sensorimotor approach**

3.1 Cognition-based interventions: The context

Human beings have always been able to adapt themselves, consciously or not. The human brain is exceptionally adaptative, and evolution shows that we have an unrivaled capacity for flexibility. The brain's capacity to constantly evolve, i.e., brain plasticity, has been the core premise of the cognitive-based approaches (Cajal, 1894, 1933; Azmitia, 2007; Mahncke et al., 2006). In fact, it has been proven that the nervous system can adjust its structural organization in response to the environment, even in older adults, although aging causes a disconnection between neurons (Bennett & Madden, 2014). The principle that individuals have an inner resource to compensate for their deficits with new strategies is central in designing cognitive interventions in aging.

There is a certain degree of confusion in the literature about the terminology used to describe cognitive-based approaches. Rehabilitation, Remediation, or Revalidation? Not only are the terms different but, some authors have also referred to cognitive interventions as retraining, stimulations, reeducation. Often used interchangeably, they do not always refer to the same interventions (Woods et al., 2009). As put forward by Baltes & Danish (1980) and McDougall (1999, p.2), interventions in psychology are classified as "concrete technologies involving such parameters as the goal (enrichment, prevention, or alleviation), the target behavior (attention, cognition, memory, perception), the setting (family, classroom, community, or hospital), and the mechanism (training, practice, or health delivery)."

Solhberg and Mateer (1989) define cognitive *rehabilitation (CR)* as a therapeutic process that aims to improve an individual's capacity to process and use incoming information that will increase functioning in everyday life. The aim of considering this perspective of CR is to improve

quality of life rather than cognitive performance by developing strategies to compensate for decline. As for Franck (2012), *Cognitive Remediation* is an approach to improve cognitive functioning, either by training impaired functions or by enabling patients to acquire different strategies that allow them to use their 'residual' functions at their best. The difference between these two definitions is that in cognitive remediation therapy, the focus is based on the principle that any individual has a set of processes that allows them to compensate for any given impairment and that it is not necessary to repair those deficits per se (Franck, 2012). Finally, Van der Linden (2016) proposed the term *cognitive revalidation* since they consider that the term *rehabilitation* has a corrective and pedagogical connotation. In their *Clinical Neuropsychological Revalidation* textbook, they review modifications in cognitive interventions that took place in the past decade towards a more goal-oriented approach to daily life functioning while taking into consideration the whole environment of the subject (Seron & Van der Linden., 2016; Wilson, Evans & Gracey, 2009; Evans, 2012; Prescott, Fleming & Doig, 2015).

Cognitive interventions can modify brain plasticity by engaging patients by stimulating sensory and psychomotor activities (Olesen, 2004). For example, in a cognitive remediation therapy (CRT) study by Nemeth and Janaseck (2011), the authors found that poor brain plasticity is related to poor consolidation. Indeed, they compared young participants to older ones, a skill learning, and a consolidation task. For the skill learning tasks both groups had the same performances but not on the consolidation task. While their findings show a task-specific difference, the fact that older participants could still perform as well as younger ones in skill learning proves that brain plasticity is still present in older adults and, to some extent, it can account for new neural connections in older adults if specific strategies are applied.

Cognitive-based approaches, mainly cognitive remediation (CR) usually involve, restoring cognitive functions, teaching compensatory techniques, or behavior management. Several reports in the literature showed that cognitive-based approaches (training) have some benefits on cognitive processes such as attention and concentration, sensory perception, executive functioning (planning and organizing, and information processing) on one side and the other, on emotional, behavioral, communicative, and social interactions (Cicerone et al., 2006; Clare, 2003, Kudlicka et al., 2019). According to Wykes (2004), there are three possible ways to treat cognitive deficits: Firstly, by providing cognitive treatment to improve base-line cognitive skills that may overcome several cognitive obstacles; Secondly, by modifying rehabilitation programs according to the cognitive profile so that the intervention enhances the individual's strengths instead of on focusing on their weaknesses and thirdly, adapting the environment to lower its effects on cognition and making it less demanding. This last option was successful in the Cognitive Adaptational Training program developed by Velligan (2000) in Texas (Roussel et al., 2011).

Improving cognitive functions via cognitive interventions gained momentum with the growing number of aging population across the world, especially since memory loss in aging and its consequences in everyday life became a general concern for many societies. Even though the issue of aging has a long history, it was not until the 1950s that cognitive interventions and their effectiveness were documented in the literature (McDougall, 1999). In fact, cognitive interventions literature is still emerging with the growing awareness of the interdependence between physical and psychological health of older adults. Without claiming an exhaustive review, we review specific cognitive-based approaches that have been experimentally studied up until now. We will expose mainly cognition-based approaches for memory and executive functions and interventions based on sensorimotor stimulations.

3.2 Cognition-based approaches: Their effectiveness

As mentioned earlier, the range of literature and experimental studies concerning cognition-focused interventions has widened for the past decades. Cognitive Interventions, mainly rehabilitation programs in ecological settings, are known to give better results since the whole environment of the individual is taken into account. Different studies came to the same conclusion, i.e., using a broader approach, for example, including caregivers during cognitive interventions showed that patients had better outcomes on mood and fluency compared to those who did the program without caregivers (Ermini- Funfschilling & al., 1995; Meier & al., 2000, Clare., 2003).

These results suggest that a tailored cognitive rehabilitation program and a broad-based approach (with caregivers and families) can provide more meaning to the patients, thus improving their implication in the programs. Talassi et al. (2007), through a case-control study, demonstrated the effectiveness of a cognitive rehabilitation program in mild dementia and MCI patients. They used two types of treatments: cognitive rehabilitation (computerized training, occupational therapy) and a physical rehabilitation program. They found out that even though both of these programs helped stimulate the patients, but significant results on a cognitive and affective level were obtained only in the group that underwent a cognitive rehabilitation program rather than occupational therapy.

The concerns for cognitive changes in neurodegenerative disease, particularly dementia, have urged the development of practical techniques for maintaining and facilitating cognitive abilities in patients (Clare, 2003). The Alzheimer's Association report (2021) claimed that the clinical hallmarks of early stages of dementia, such as mild cognitive impairment (MCI), were

memory impairment and executive functioning deficits. To address the issues regarding AD, the World Health Organisation⁴ has proposed a global action plan (2017-2025) to improve support and improve the lives of patients, their carers, and families. Infact, Clare (2003) highlighted that early intervention could positively affect people with dementia (Clare, 2003, Clare et al., 1999). A large number of cognitive interventions have been mainly focused on memory and executive functions. These two domains are also of our interest; as such, we will review some main interventions and their effectiveness in the following sections.

3.2.1 Cognition-based approaches for memory

Among the cognitive approaches for cognitive interventions, retraining memory by applying memory strategies or repetitive cognitive exercises is widespread (Clare, 2003; Gates et al., 2011). This is mainly due to the belief that the more we train our memory, the better our memory will be. The consequence of this skewed belief is that the vision of an impaired memory can be restored simply by learning lists of words, pictures, or other material. This reasoning assumes that memory is a "mental muscle" and can be trained with practice (Van der Linden, 2010). However, repetitive practice of meaningless material (e.g., repetition of word lists or other material) has little or no generalizability in people's everyday lives (Glisky, 1997; Tate, 1997). Tulving (1972, 1995) and Squire et al. (1993) suggest that memory is a functionally different and independent system. Based on their definition, two main strategies of performing cognitive rehabilitation for memory impairments were identified:

- **Memory training:** This method consists of building techniques in which the goal is to regain memory function through repetitive training paradigms (Camp et al, 2000; Clare et al.,

⁴ <https://apps.who.int/iris/bitstream/handle/10665/339846/9789240019966-eng.pdf>

2001; Clare, 2003). Different memory training methods exist: *Internal mnemonics* (Van der Linden et al., 1989) in either verbal or imagery forms - It consists of story-making, building acronyms, rhyme mnemonics, or using simple cuing aids to facilitate recall. Intensive training of internal mnemonics strategy may lead to a generalized application of this strategy and improve memory functioning (Cicerone et al., 2005). However, this technique is limited for a certain number of tasks, such as remembering a shopping list or in situations where written reminders are not available.

Another example is the Neuropsychological Training - NPT software (Tonetta, 1998). The NPT is an individualized computer-based program which consists of 30-40 min sessions, 4 days a week for 3 weeks, and where domain-specific exercises are targeted: *Attention* by proposing spread attention or divided attention tasks through acoustic and visual inputs; *Memory*: short-term and long-term visual memory exercises, working memory, spatial memory, combined verbal and spatial memory, acoustic information learning; *Perception*: visual presentation exercises, visual exploration, face recognition, visual discrimination, object identification, visuo-verbal association, and auditory identification; Exercises of bi-dimensional picture reproduction stimulate visuospatial cognition; *Language*: rapid single word presentation, sentence global perception, phonological discrimination and recognition, verbal comprehension and written denomination. Patients are then assessed using neuropsychological tests. However, computerized interventions are always delicate when dealing with older adults as they are not very familiar with their use.

The second strategy of memory rehabilitation is ***Memory compensation***: The latter deals with ways to compensate memory difficulties, such as using memory aids or adjusting the environment so that the demands on memory are reduced (Clare 2000; Kurlychek, 1983; Bourgeois, 1993). Memory compensation aids focus on providing external help to the patients to

compensate for prospective memory loss. Notebooks and calendars are good ways to keep impaired individuals oriented to date, daily schedules, and personal information. For example, *The Memory Support System - MSS (Sohlberg et al., 1989)* is a 2-page pocket notebook divided into three sections where the individuals should note specific events like appointments, daily events, "to-do" items, and one section concerning events that happened on a day. There are three learning stages: the *acquisition phase*, the patients are made familiar with the system. Trainers explain how they should fill the sections. During the *application phase*, in a role-play session, the appropriate use of the MSS is exercised. Finally, in the *adaptation phase*, the patients have to apply MSS in their everyday lives. The *Goal-oriented cognitive rehabilitation* (Clare et al., 2009) is a client-centered rehabilitation program that identifies and addresses individual needs and goals, that requires strategies for taking in information (mnemonics, spaced-retrieval) or methods for compensating such as memory aids (notebooks, calendar).

Memory rehabilitation or compensation practices have evolved considerably in recent years. These programs are now more oriented towards ecological, person-centered, and holistic approaches (Seron & Van der Linden, 2016).). With such a goal in mind, the resources available to an individual at cognitive, behavioral, emotional, and motivational levels become essential factors to consider in designing cognitive stimulation programs and evaluating their effectiveness.

3.2.2 Cognition-based approaches for Executive functions

Rehabilitation of Executive functions (EF) is challenging due to its multifaceted nature and extensive range of executive disorders (e.g., inhibition, planning, organization)(D'esposito & Gazzaley., 2006). EF disorders, as such, may result in various behavioral deficits such as poor motivation, mood disorders, and lack of self-awareness and have implications over long-term social reintegration. Nevertheless, two primary interventions have been referred to in the handbook

of D'esposito & Gazzaley (2006). They included improvement for real-life skills in a *particular setting* for the first one, such as driving skills, and the second one, a rehabilitation program based on a *particular type of executive deficit* (e.g., selective attention). These interventions, according to the authors, fall under three categories: *Environmental Manipulations* that focuses mainly on simplifying the external environment of the patient (e.g., decrease distracters, reduce tasks demands); *Compensatory Techniques* where patients are proposed different strategies to accomplish a particular task; *direct interventions* with repetitive training for functions that are impaired. The end goal of all these strategies is to improve skills and allow individuals to regain an optimal everyday life functioning.

Recently, Nejati et al. (2016) investigated the effectiveness of executive function training and its effects in older adults with normal aging. Participants were aged above 65years, and they have proposed an Attentive Rehabilitation of Attention and Memory training (ARAM). ARAM is a computer-based training where tasks are presented to the participants with a gradual increase in difficulty. In one of the tasks, participants were asked to arrange faces in different categories based on a given rule and three properties: emotional expression (sad, angry, and neutral), hair color (green, white, and black), and skin color (yellow, white, and black). Each face had one property from each category, and the subject had to assign it to just one category. This task involved inhibition and selective attention during ten training sessions that lasted 1hour, three times per week. Participants were assessed on a continuous performance task (CPT) assessing attention/executive functions, the Wisconsin sorting card test, and the Stroop color-word test. The results of their study showed that there was a general improvement in EF, particularly attentional control, sustained attention, inhibition, and cognitive shifting.

The question that often arises with EF intervention programs is whether there is a skill transfer in everyday life post-interventions. In research on cognitive training, Ball and colleagues (2002) found a lesser possibility of skills transfer after cognitive interventions when domains such as memory, attention, or even problem solving are trained separately. Recent studies propose that this transfer is possible if the training paradigms used are *flexible* (Bherer et al., 2005; Kramer et al., 1995) or *integrated* (Craik et al., 2007; Winocur et al., 2007). Indeed, it was demonstrated by Basak et al. (2008) that flexible and integrated training positively affects attentional control and improves dual-task/shifting performances. In a real-time strategy videogame training, the authors integrated these two paradigms (flexible and integrated) to train EF (such as working memory, task switching, short-term memory, inhibition, and reasoning) in older adults. Their study showed that participants improved significantly EF domains measured via a cognitive battery of tests, suggesting the possibility of transferring training skills in everyday life functioning for older adults.

3.3. Sensorimotor-based Approaches

While cognition-based approaches have been used for many years now, another type of intervention found in literature is based on sensorimotor stimulations. The general idea behind sensorimotor interventions is to stimulate the different senses to help overcome sensory processing issues, i.e., to help the brain process sensory information that is under/over-stimulated (Schaaf & Miller, 2005; Smith & Koenig, 2005). It is widely admitted that sensory and sensorimotor deterioration may precede and predict cognitive decline according to the common cause hypothesis (Lindenberger & Baltes, 1994; Schäfer et al., 2006). Therefore, if the biological and physiological mechanisms of aging affect the functional integrity of the brain, then stimulating these very

mechanisms may improve cognitive functioning. Schafer et al. (2006) proposed at least two possible reasons that can account for the hypothesis. Firstly, they believe that increasing efficiency in either sensorimotor or cognitive domains should decrease competition for attentional demands and, therefore, be beneficial to either domain. Secondly, they advanced that sensorimotor and cognitive domains influence each other and depend on a common substrate, i.e., the pre-frontal cortex. Hence, working on either of them can positively impact the functioning of each of the domains.

Sensory-based methods, particularly sensory-integration approaches, have been applied as part of occupational therapy by practitioners. Ayres, in the early 1960s, challenged the principles of purposeful activities during interventions as she believed the goal of intervention should be above all perceived as beneficial by the individual receiving the latter (Ayres, 1960). Moreover, she firmly believed in the concept that motor functions could not develop independently of sensory systems (e.g., visual or auditory processing), and therefore, incorporating multisensory interventions will influence an individual's learning and behaviors. Bundy et al. (2002) also corroborated this statement of Ayres by saying that: "Learning is dependent on the ability to take and process sensation from movement and the environment and use it to plan and organize behavior" (p. 5). Ayres (1960), as such, proposed the sensory-integration theory (figure 5) and suggested that sensory functions are the foundation of motor ability, social and behavioral skills; hence any disturbance in the basic sensory functions will affect the other domains (Camatara et al., 2020). The Ayres model was first developed for children with developmental disabilities such as autism and hyperactivity, and thus, it was focused on improving their learning abilities via sensory stimulations. However, this model has now been extended to adults also given the evidence of decreased integration and processing of sensory inputs in aging. The programs

proposed for older adults essentially involve skilled use of sensorimotor activities and equipment such as intensified physical activity or activities that promote motor planning, organization of time and space or mediated tactile experiences such as cooking.

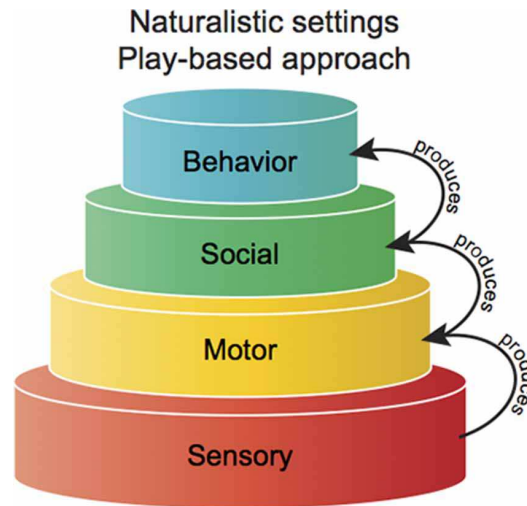


Figure 5 : Model of the theory of change for sensory integration described by Ayres

(1969)

Other types of sensorimotor interventions for older adults found in the literature are Physical Exercise, Multi-sensory stimulation (Snoezelen), and the Montessori Method. We shall review these three methods in the following sections.

3.3.1 Physical Exercise as a mind and body approach to Sensorimotor Intervention

The benefits of physical exercise (PE), physical activity, or fitness on mental health, in general, is not new and known to play an essential part in healthy aging. In fact, it has been demonstrated that PE affects brain plasticity, therefore, enhancing cognitive functions (such as memory abilities, attentional processes, and executive-control processes) in old and young adults (Fernandes et al., 2017; Lista and Sorrentino, 2010). Many cross-sectional and experimental studies were conducted, specifically with old-age participants exploring the link between physical

fitness as a form of sensorimotor intervention and cognitive performances (Cheval & al., 2020; Stenling et al., 2021; Sofi et al., 2011; Colcombe & Kramer, 2003) settled on the same conclusions. For example, Colcombe and Kramer (2003), Kramer and Colcombe (2018) carried out a meta-analysis of 18 interventions between 1966 to 2001 on older adults, and they found that aerobic fitness had a potent but selective effect on older adults. In other words, the effect of exercise on cognition in older adults was moderated by several factors such as inter-individual variabilities, such as gender, type of training, duration, and the number of sessions. Most of the cognitive benefits were found in executive control processes such as planning, working memory, or multitasking.

Moreover, Stenling et al. (2021) examined the role of specific moderators, such as age, physical fitness level, and intellectual engagement (e.g., education). In their study, they measured between and within-person effects. Between-person effects refer to interindividual variabilities and involve stable attributes over time, whereas within-person effects capture intraindividual variations assessed over a period of time. Their study included 1719 participants and the latter were assessed on a self-reported physical examination questionnaire with measures for episodic memory, verbal fluency, and visuospatial ability. The findings of this study suggested a positive outcome in the within-person level group on the three cognitive domains. In particular, people having a higher physical baseline had better performances on the questionnaire. They also found out that age moderated the relation between the three cognitive outcomes and the level of physical activity, i.e., more physically active older adults at baseline performed better than those who were less active. Overall, the findings of Stenling et al. (2021) confirm that the relation between physical activity and cognition is moderated by age, level of physical activity, and years of education. A continuous engagement in physical has a more protective effect on cognition.

3.3.2 Multi-sensory Stimulation programs (MSS) in aging

Multi-sensory stimulation, MSS (known as Snoezelen), was initially designed as a leisure facility for people with learning disabilities (Hulsegge & Verheurl., 1987; Baker et al., 2003). MSS is based on proposals for sensory stimulation and exploration, favoring the notion of "taking care". It is hence, considered than a method, it is a support process, a state of mind, a listening and observational stance, by respecting the person's experiences and rhythm. The principle of MSS is a nonsequential and unpatterned stimulation of different senses that are experienced moment by moment and without relying on memory to link earlier events (Baker et al.,2001). They can be in the form of MSS environments, tools, and group therapies. The application of MSS with people with dementia is gaining a lot of momentum as empirical evidence have pointed out that older adults have sensory impairments (e.g., loss of smell, decreased vision, sound, touch), and the consequences of these impairments are observed at a behavioral and cognitive level (Solomon et al., 1961; Sanchez et al., 2016). Older adults usually may lack sensory stimulation, especially those in the final stages of dementia, are extremely sensory deprived, and it is difficult for them to be involved in cognitive activities (MacDonald, 2002; Nairn, 1995; Baker et al., 2001). Therefore, applying MSS could be a solution to support the loss of these sensory stimulations.

MSS intervention was explored in a randomized controlled study by Baker et al. (2001) in a multi-centered approach compared to previous studies where only small groups were explored (Lancioni et al., 2002). Baker and colleagues investigated the effects of MSS on dementia with no psychiatric disorders and whether it effectively changed the behavior, mood, and cognition. Their study had 8 MSS sessions during which all the senses were stimulated (except for taste), and they compared it to a control group where participants played cards, quizzes, and looked at photographs. For the MSS environment, "light effects used were bubble tubes, fiber-optic sprays and moving

shapes beamed across the walls. Sound effects included ‘new age’ or pseudo-classical music, which did not distract individuals from exploring other stimuli as familiar music would. Tactile stimulation used satin, cotton wool, shells. Tactile boards used had different textures: rough/smooth, warm/cold, and hard/soft. Sense of smell was stimulated using aromatherapy and lavender bags. All these elements provided an atmosphere of trust, warmth, and confidence, where patients could tell staff about their inner worlds through subtle responses such as facial expressions and touch” (Baker et al., 2001, p. 467).

Their study shows that there was a limited short-term improvement for both MSS and the controlled group activity. In other words, MSS did not appear more effective on either of the three investigated domains (behavior, mood, or cognition), even though in both interventions, there were improvements to a certain extent at a behavioral level. In contrast to these findings, Sanchez et al. (2016) demonstrated significant improvement in all of these domains in patients with severe dementia. This may suggest that the stages of dementia may affect MSS interventions. Nevertheless, in both studies, the authors highlight that the effects of MSS are not sustainable long term and that a continuous intervention is necessary to maintain the positive effects. Finally, snoezelen as claimed by Orain (2008, p 161) “is the result of a multidisciplinary approach, a mature and coherent reflection, a clear desire on the part of the teams, and a variation of a life project based on ethical and founding principles known and recognized by all”.

3.3.3 Montessori for elderly people: a breakthrough?

The Montessori method has been known for its success with children since the 20th century. It was developed by Maria Montessori (1958), considering the capabilities and needs of the children and allowing children to learn subconsciously through lucrative methods. For example, children are usually in creative classrooms with different toys or tools, and they are encouraged to explore the textures and be as creative as they want. Unlike the classical learning context, teachers offer guidance, but the child is ultimately the only one responsible for developing his learning skills.

Based on this fundamental principle of being the agent of one's growth, the Montessori method for the elderly aims to enhance older adults' sense of self-esteem and autonomy. Montessori-based activities for elderly with dementia englobes rehabilitation principles, i.e., breaking down tasks, including progressive difficulty level, guided repetitions, self-corrections (Sheppard et al., 2016; Camp et al., 2010; Malone & Camp, 2007; Orsulic et al., 2001). However, the proposed activities are within the person's interest, skills, and ability of active engagement and are entirely tailored for that person. This is one of the fundamental reasons why there is no single way of proposing a Montessori-based program.

Given the alluring popularity of the Montessori Method, some researchers were interested in exploring its benefits on cognitive functioning (Shepard et al, 2016 ; Camp, 2010 ; Mahendra et al., 2006). The issue with the Montessori Method is that since there is no single protocol for its design, it is complicated to have quality and reliable research on the effectiveness of this method. Nevertheless, Shepard et al. (2016) gathered a systematic review where cognitive domains such as language, attention, and memory were tested after a Montessori-based training was provided to the participants. In one study mentioned by the authors, it was found out that 11 out of 15 patients

experienced an improvement in Montessori-based scores. Vance and Porter (2001) defined this score based on the frequency of improvements and no changes in cognitive assessments post-training. Generally, this particular study demonstrated that participants required fewer prompts to focus on activities, were more engaged, and showed improvements on attention and memory tasks.

So far the benefits of the Montessori method on cognition are scarce. However, this method proves that working on a tailored program for individuals based on their interests and skill can raise their level of engagement, affect, and social interaction. Moreover, this is especially true for older adults with dementia (Mahendra et al., 2006). The Montessori Method is gradually finding more and more stakeholders, especially in nursing homes with people with moderate to severe dementia. According to Camp et al. (1997), Montessori for the elderly seduces its clientele due to its structured, simple, attractive material. In a study carried out by Giroux et al. (2010), participants were observed during Montessori activity, regular activity, and no activity. They measured the affect and participation of subjects. Their results align with the hypothesis they made, i.e., that when activities designed are compatible with one's interest, the positive effects can be seen on a behavioral level. Yue-lai Chan et al. (2021) equally found out in a culturally adapted context with the Chinese elder population that the Montessori method shows similar effects on engagement and pleasure during the sessions.

3.4 Conclusion

We have seen in this chapter that cognitive interventions are proposed to palliate for age-related deficits. Indeed, the cognitive and neural variations in aging are highly dynamic (Pieramico et al., 2014). Older adults still experience brain plasticity and even an enhanced neural activity in

response to cognitive training (Park & Bischof, 2013; Noack et al., 2009; Brehmer et al., 2012). These findings have led to a paradigm shift in how aging was considered earlier, mainly as a decremental process to a state where cognitive functioning can be improved. Various interventions available now for aging people attest that the application of cognitive interventions employed proactively can delay further cognitive decline and promote positive and efficient coping skills for everyday adults.

While on one side, cognitive training, for instance, for memory and executive functions, is recommended, we also observe that they mostly use language as a means to retrain these functions. On the other hand, sensorimotor-based approaches mainly focus on stimulating the body and different senses. While conclusive results are mostly found for physical training, other sensorimotor-based programs still lack empirical validations. Moreover, their effect on cognitive functioning is not straightforward.

Cognitive intervention, irrespective of how it is conceived, appears beneficial to the elderly, either on the functional, behavioral, or emotional levels. If such is the case, then these interventions should be proposed universally to all aging people. However, we have observed in research and practice that there is a lack of adapted programs and instruments for culturally diverse populations, especially for the aging population. Either in the form of cognitive assessments or cognitive intervention, the central issue remains the barrier of language and culture. In that sense, one question emerges: What are the alternatives and possibilities of providing a universal care program for older adults of different backgrounds?

Thesis Problematic

The present thesis has its origin in the problematics regarding interventions to maintain cognitive efficiency in older adults from diverse cultural backgrounds. Indeed, our on-field observations have led us to reconsider the actual methods of cognitive evaluations and intervention programs for a culturally diverse elderly population. Specifically, we have identified a significant issue that concerns the language barrier as the context of evaluations and interventions is exceptionally language-dependent. In the previous chapters, we have discussed how cognitive functions are influenced by the dynamic interplay between culture, language, and the effects of aging. We have questioned whether or not it is possible to have a universal practice of psychology that would limit disparities in the presence of people with diverse characteristics.

From our point of view, the solution to these issues lies within the embodied framework. Mainly, since sensorimotor interactions, on one hand, are considered as the elementary functions present universally in all individuals, on the other hand, they provide a more comprehensive range of explanations for cognitive changes related to aging as a result of sensorimotor alterations. Indeed, how we act and think about our external world is deeply rooted in our sensorimotor representations. Several studies have demonstrated that sensorimotor decline in aging impacts cognition (Lindenberger et al., 2001; Vallet et al., 2011 ; Vallet, 2015; Valentijn et al., 2005). We, therefore, propose, in this experimental part, three studies that put forward the theories of embodied and situated cognition in aging and that we consider as a universal approach limiting language problems.

In the first study (*Study 1*), our objective was to investigate whether physical changes relative to aging could change time representations in older adults. According to several authors (Boroditsky, 2011; Clark, 1973; Kranjec et al., 2011), time is conceived in terms of spatial

representations (past, present, or future). These spatial representations are embedded in one's bodily representations, described as deictic and non-deictic frames of reference (Clark,1973). The second aim of this study was to explore whether events that are viewed through one's bodily representations, thus sensorimotor activations, were better encoded or not in memory. We expected to see an easier recall of events congruent with the bodily representations and that this trend would decrease as one age.

In *study 2*, we also raised the concern of performing cognitive evaluation in cross-cultural settings. If sensorimotor interactions can explain mechanisms in aging, then this fact should be valid for all aging people, irrespective of their cultural backgrounds. The basis of a psychological evaluation is not to label the persons evaluated but to develop a profile of their abilities and the disability they may experience. However, evaluation is challenging when cultural characteristics such as (language and writing, level of education, diversity of the environment, etc.) influence an individual's psychological, social, and even neural construction (Bellaj, 2011). Hence, given the universal aspect of sensorimotor functioning, designing an evaluation based mainly on the latter could have universal applicability. Executive functioning (EFg), as described earlier, is a consequence of all the internalized sensorimotor actions beneficial to any individual to function in their environment. Several works also suggest that memory issues related to aging appear to be mediated by EF (Troyer et al., 1994; Versace et al., 2018, p.139). Therefore, in our conception of executive functioning, we believe that everyday life difficulties faced by older adults fall under executive functioning deficits. Regarding our problematic, it seemed relevant to us to propose an evaluation of executive functioning that would be language-free and based on sensorimotor properties to minimize the effect of language (*Study 2*).

Finally, following the evaluations, our third issue concerned cognitive intervention programs. Indeed, once an assessment is carried out, the next logical step is to make recommendations to a patient. Particularly for older adults facing cognitive difficulties, cognitive interventions programs are the go-to's. While this step is crucial as part of cognitive health prevention or solutions to palliate for cognitive deficits to older adults, not all of the interventions proposed are applicable in a culturally-diverse population.

Indeed, during an on-field assessment, we found out that the cognitive stimulation program initially proposed to the Moroccan Elderly Women was unsuccessful. The program proposed was the PAC-EUREKA/PAC-SENIOR (De Rotrou et al., 1996), which is essentially based on applying cognitive strategies in response to a goal. Most of the exercises in the PAC included the organization of information processing, such as categorization of objects. However, for a population that had language difficulties, it is unlikely possible for them to know how to categorize the concept "table" under "furniture" if they are not familiar with the words in that specific language. Moreover, in the Moroccan Elderly population, none of them had an issue with the comprehension of the translated words. Hence, it raises a significant concern, are we not creating a situation of disability by proposing tools that are not appropriate? Because these populations are aging and facing age-related cognitive changes like any other European elderly, how can we better adapt our interventions?

To provide a possible answer to this question and align with our perspectives on sensorimotor theories, we believe that a sensorimotor motor intervention could be the answer. We have designed a sensorimotor stimulation program based on the evidence that sensorimotor interactions and stimulating different senses can enhance cognitive functioning (*Study 3*). Our sensorimotor stimulation program was named PSSM (*Programme de Stimulation SensoriMotrice*)

included an 8-week intervention at a frequency of 2 sessions of approximately one and half hours per week, where we stimulated different aspects of the cognition (audio, visual, tactile, EF). In order to appreciate the effects of such an intervention, we evaluated cognitive performances at baseline and post interventions using a cross-cultural neuropsychological battery -CNTB- (Nielsen & collaborators, 2019). The CNTB was designed to diagnose dementia in the elderly minority population and is considered relatively unaffected by educational level. CNTB appears to be one of the first neuropsychological assessments for different ethnic groups with promising cross-cultural diagnostic properties. While the validation of CNTB was done in many Western European countries, data from France is lacking and even less so within a population from an Island. Hence, in Study 3, one of our objectives was to test the CNTB in these three distinct populations. Secondly, our objective was to explore the applicability of the PSSM cross-culturally.

III
EXPERIMENTAL
PART

STUDY 1

(submitted in Current Aging Science)

Grounding of Abstract Concepts in Aging - An extend to Kranjec and McDonough Study 2011

Embodied cognition argues that cognitive processes are rooted in sensorimotor representations and that the body and mind are intertwined (Foglia & Wilson, 2013). Therefore, one can assume that any physical changes should have an impact on cognition. In fact, given the large array of physical and cognitive changes that manifest, aging appears to be a natural fit for the embodied framework (Vallet, 2015; Roberts & Allen, 2016).

Based on this premise, this first study aimed to investigate whether aging changes time perception through an embodied perspective. We have considered the concept of time, as it is considered an abstract concept. Abstract concepts are usually conceptualized through bodily axes, known as deictic and non-deictic frames of reference (Clark, 1973; Lakoff & Johnson, 1999, Gentner, 2001; Kranjec, 2006; Boroditsky, 2000). Time, therefore, is represented through a spatial frame of reference around one's body: Future is usually in front, the past behind, and the present as co-locational (figure 6). Therefore, if the representation of time is anchored in the body, then physical changes occurring during aging should impact the way time will be represented. Hence, in this study, we studied this hypothesis on two groups (young and older adults), and we expected to observe a gradual decrease in the way older adults conceived time due to the sensorimotor declines they experience as they age.

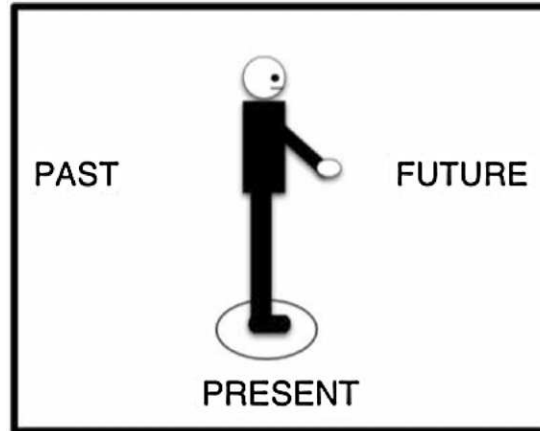


Figure 6 : Schema depicting how a deictic temporal frame of reference can ground the past/future concept. In most languages the future is mapped as in front and the past as behind. With deictic schemas, forward temporal motion can be in the direction of the future (the Moving-Ego model) or the past (the Moving- Time model).

The second objective was to explore whether an event that is represented in the body with a congruent movement is better encoded and recalled or not. We hypothesized that if an event is represented in the body, then the encoding or recall of the latter would be more significant, and this should be even more true if the congruent gesture accompanies the direction of the event. Since this study was submitted in the Current Aging Science Journal, we will present it in the submitted version.

Grounding of abstract concepts in aging: An extend to Kranjec and Mcdonough study 2011

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- **Abstract Aim** : Firstly, to explore the embodiment of abstract concepts, such as Time, across life-span. Secondly, to investigate whether an embodied concept is better recalled or not in aging.
- **Background** : Few studies have explored abstract concepts from an embodiment perspective in aging.
- **Objective** : To evaluate the embodiment of abstract concepts in aging through the study of spatial and temporal conceptual frameworks and the effect of a compatibility effect on memory recall.
- **Method** : In a "parapsychological task", participants were asked to indicate whether the stimuli presented depicted either past/future or earlier/later concepts. Secondly, in an incidental memory task, we noted the number of items recalled from the previous task.
- **Result** : The results show that abstract temporal concepts are grounded in bodily representations, however with age, these representations become less salient. Moreover, the results of the incidental task show that when a gesture performed is compatible with the spatial and temporal frames of an embodied abstract concept, participants recalled more items than when the gesture is incompatible.
- **Conclusion** : Embodiment is a better predictor of issues concerning aging. Studying aging through an embodiment perspective gives a more comprehensive understanding of the mechanisms that are implied and how they affect elder populations.

Keywords: Embodiment, abstract concepts, aging, time, recall, compatibility effect

- **Résumé** : Premièrement, explorer l'incarnation de concepts abstraits, tels que le temps, au cours de la vie. Deuxièmement, étudier si un concept incarné est mieux mémorisé ou non dans le vieillissement.
- **Contexte** : Peu d'études ont exploré les concepts abstraits du point de vue de l'incarnation dans le vieillissement.
- **Objectif** : Évaluer l'incarnation des concepts abstraits dans le vieillissement par l'étude des cadres conceptuels spatiaux et temporels et l'effet d'un effet de compatibilité sur le rappel de la mémoire.
- **Méthode** : Dans une "tâche parapsychologique", on a demandé aux participants d'indiquer si les stimuli présentés représentaient des concepts passés/futurs ou antérieurs/postérieurs. Ensuite, dans une tâche de mémoire implicite, nous avons noté le nombre d'éléments rappelés de la tâche précédente.
- **Résultat** : Les résultats montrent que les concepts temporels abstraits sont ancrés dans des représentations corporelles, mais qu'avec l'âge, ces représentations deviennent moins saillantes. De plus, les résultats de la tâche implicite montrent que lorsqu'un geste effectué est compatible avec les cadres spatiaux et temporels d'un concept abstrait incarné, les participants se souviennent de plus d'éléments que lorsque le geste est incompatible.
- **Conclusion** : La cognition incarnée semblerait être un meilleur prédicteur des difficultés relatives au vieillissement. L'étude du vieillissement à travers une perspective d'incarnée permet ainsi une compréhension plus complète des mécanismes impliqués et de la façon dont ils peuvent affecter les populations âgées.

Mots-clés : Cognition incarnée, concepts abstraits, vieillissement, temps, rappel, effet de compatibilité

1. INTRODUCTION

According to the embodied approach of cognition (Barsalou, 1999; Glenberg, 1997; Casasanto, 2009; Varela, Thompson & Rosch, 1991), Borghi (2014) proposed that abstract concepts, such as "Time," are grounded in our sensorimotor experiences. In other words, abstract or concrete concepts are not only mapped onto concrete domains through metaphors; they are also grounded through perception, action, and situations. However, if abstract concepts are rooted in our bodies, one might ask how the sensorimotor modifications occurring in aging affect their comprehension. While the link between the body and mind in young adults is now well

documented (Lakoff & Johnson, 1999, Borghi, 2014), only a few studies have considered the consequences of aging from an embodied perspective. Vallet (2015) has explored the value and interest of embodiment in normal and pathological aging and its theoretical and clinical applications. He suggests that studying aging through an embodied perspective is interesting given that the latter is accompanied by a myriad of sensorimotor and cognitive function changes. The present article aims to explore the effects of aging regarding an abstract concept, time. Particularly, we have investigated how time is perceived across a lifespan and how an action that simulates time, or not, enhances recall; Or in other words, the memory of the related concept

1.1. Embodied Temporal Concepts

As an abstract concept, time is often expressed in terms of spatial frames and linguistic conventions across cultures (Boroditsky, 2000; Clark, 1973; Kranjec, 2006). Several theories in embodied cognition suggest that abstract concepts are grounded in concrete concepts. One of the most predominant theories is the Conceptual Metaphor Theory of Lakoff and Johnson (1999). This theoretical approach posits that the knowledge of abstract concepts is acquired through image and motor schemes of experienced domains (Johnson, 1987; Mandler, 1992, Lakoff & Johnson, 1999, Talmy 2000; Kranjec, 2006). In other words,

we think and talk about abstract domains (such as time) by relating them to other experienced concrete ones (like space). Conceptualizing time through Spatio-temporal metaphors are classified as the moving-time (MT) and moving-ego (ME) metaphors (Clark, 1973; Lakoff & Johnson, 1999; Gentner, 2001; Kranjec, 2006). Both are considered a deictic spatial frame of reference as they are based on an ego-centered or grounded perspective. According to this perspective, the location of an object is always determined by one's bodily axes. Hence, any event that occurred in the past is considered as "behind," the future is situated "in front," and the present

is situated as “co-locational” to our body (Clark, 1973; Evans, 2003; Lakoff & Johnson, 1980, 1999, Kranjec, 2006). Let us consider the following sentence along a timeline: “Christmas holidays are approaching.” Schematically, the holidays might appear to be in front for a subject, but for another one, the holidays may be behind depending on where they position themselves along this timeline. However, a deictic spatial frame as a point of reference is not always systematic. For example, understanding a sentence like “the chicken and egg situation” would instead be based on the semantic or sequential relationship between the events themselves and counted in terms of “earlier” (egg) and “later” (chicken) occurrence or vice versa. The point is, neither of these events depends on our own spatial and temporal references.

Kranjec and his colleagues (Kranjec, 2006; Kranjec et al., 2010; Kranjec & McDonough, 2011) were interested in understanding how spatial relationships could map temporal concepts and to what degree they were embodied. In a novel experimental design, Kranjec and McDonough (2011) used the concept of embodied time regarding the deictic spatial references (where “past” is “behind” and “future” is “in front”) compared to a non-deictic spatial reference (where earlier is “left” and later is “right”), to investigate the extent to which temporal concepts were grounded in sensorimotor representations. Their goal was to show that “abstract concepts find structure in the body and environment, and not merely in semantic relations among particular lexical items” (Kranjec & McDonough, 2011, p.747). The results were as expected and demonstrate that the contrast between positive results for the front/behind and negative ones for earlier/later axes prove the importance of bodily axes in conceptualizing an abstract concept.

Other embodied approaches support the idea that there is an easier integration of an abstract concept if the latter has a certain fluency/congruency with the motor properties that it activates. For example, *positive* is often considered *up* or *right*; *unfavorable* as *down* or *left* (Casasanto &

Dijkstra, 2009; Davidson, 1992, Borghi 2017). Precisely, motor compatibility generates a fluency that leads to a sense of familiarity, therefore a judgment of recognition (Brouillet et al., 2011; Cannon, Hayes & Tipper, 2010). This type of categorizing concept is known as the action compatibility effect (ACE, Glenberg & Kaschak, 2002). Several ACE experiments provided evidence that there is facilitation in understanding, judging, or executing a motor response when the action-related words or stimuli are presented (Glenberg & Kaschak, 2002, Zwaan et al., 2012, Dienfenbach et al., 2013). The context and environment in which a bodily action takes place to enhance later retrieval of related information. Indeed, “enacting action phrases produces better free recall than only learning verbally” (Engelkamp, 2003, p.829). Cook et al. (2010) also showed that action leads to a stronger memory than talking about these actions.

To summarize, in the field of embodied cognition, theories converge towards the idea that knowledge of abstract concepts is grounded in sensorimotor and experience-based domains. Consequently, the question that arises is how would sensorimotor modifications and subjective experiences occurring during aging change one’s knowledge of abstract concepts across a lifespan?

1.2. Embodied Aging

Embodied cognition appears to be a natural fit to review age-related effects, given that the body and mind are interconnected (Vallet, 2015; Roberts and Allen, 2016). Aging typically affects three domains relevant to embodied cognition: "Sensory processing, mental imagery, and the perception-action link" (Costello et al., 2017, p.2, Lindenberger & Baltes, 1997). Firstly, in multisensory integration (MSI), the visual and tactile modalities provide important information about the environment in which a body is located (Calvert et al., 2004). Studies indicate that in unimodal conditions, older participants perform similarly to young ones (Peiffer et al., 2007;

Freiherr et al., 2013). However, older participants' performances drastically decrease when it comes to multimodal or conflicting situations (Poliakoff et al., 2006). Secondly, mental concepts are considered as directly related to the sensorimotor system (Glenberg, 2015). In fact, mental imagery allows an internal representation of one's own body in a Spatio-temporal dimension. Both young and older adults have mental representations that are grounded in sensorimotor processing. However, in a recent work, it was demonstrated that there was a higher cognitive demand for spatial processing by older participants, which accounted for their poor performances in mental rotation tasks (Vallet et al., 2011). Moreover, concerning motor imagery, Saimpont et al. (2013) showed that the complexity and perspective of imagery in older adults led to poorer performance, while they performed equivalently to younger adults under simple motor tasks.

Thirdly, in embodied literature, it has been long theorized that "action alters perceptual judgment, and research has confirmed that perceptual judgments of object size and distance correlate with our capacity to act upon the object" (Costello et al., 2017, p.7). Maguinness et al. (2013) used a perceptual weight judgment task in which participants visualized either a full body or a hand lifting a weight. Older participants were lesser sensitive and accurate in judging the weight than younger participants. The limited physical capacities relative to aging appeared to be a reasonable explanation to the perceptual judgment bias of older participants due to their own's bodily capacities. Moreover, these perception difficulties were shown to have a significant impact on one's life purpose. So, Carstensen et al. (2006) and Fung et al. (2016) argued that older adults were less future-oriented and more present-oriented since they perceive future time as shorter and more limited.

1.3 Problematic

In the current study, we have been interested in exploring how abstract concepts, particularly, time was conceptualized across the lifespan. Despite an increasing interest in embodiment, abstract concepts applied to aging are still limited even if Borghi (2017) claims that: "the representation of abstract concepts changes from adulthood to older age." Kranjec and McDonough (2011) are amongst the pioneers in studying abstract concepts in ecological design. Consequently, our primary objective in this present research was to extend Kranjec and McDonough's (2011) study across the lifespan: Adulthood, Middle-aged and Elderly. We hypothesized that grounding of abstract concepts (time) would occur at all stages; however, age-related changes would have an effect on this grounding. Secondly, Kranjec and McDonough's (2011) study used a "pointing task" implying body movement. In fact, embodied studies suggest that one's capacity to act and integrate an abstract concept depends on their sensory and motor actions. Hence, we investigated how far a compatible motor action could influence the way the concept is stored in cognition (memory) through an incidental memory task. We hypothesized that a spatial and temporal frame of reference compatible with an embodied abstract concept would result in a better recall, and this effect would decrease in the aging population.

2. MATERIALS AND METHOD

2.1 Participants

Forty-eight healthy individuals (25 male; 23 female) from the North-East area of France (Moselle) agreed to participate in this study. Participants were divided into three groups respectively : 16 younger adults aged from 19 to 35 years ($M = 26.3$, $SD = 2.7$), 16 middle-aged aged from 50 to 68 years ($M = 58.7$, $SD = 4.96$) and 16 older adults aged above 68 years ($M = 76.8$, $SD = 5.4$). Inclusion criteria were scoring above 25 on the Mini-mental state examination

(MMSE, Folstein, et al.,1975); low scoring levels (<50) on the State-trait Anxiety Inventory (STAI, Spielberger, et al., 1983); scores <20/60 on the Montgomery-Asberg depression rating scale (MADRAS, Montgomery & Asberg, 1979). These neuropsychological tests were administered as part of screening for psychiatric or neurological risk factors that might affect participants' cognitive performance. All participants had no visual, auditory, or physical impairments. Participants were informed about the purpose of the experiment only after the experimental and post-task interviews were completed. All of the participants gave written informed consent prior to participation. The study was approved by our laboratory ethical committee.

2.2 Material

In order to find words relative to deictic items representing past/future items or non- deictic representing earlier/later items, we had a brainstorming session with an expert committee consisting of 3 members to decide which type of items and couples were the most salient to the general population. This was an essential step since we had different age groups, and we had to ensure the items were known. After several debriefs, 76 items representing either past/future or earlier/later items were retained for a pretesting. Specifically, this survey aimed to evaluate the extent to which the items selected were related to the past and future. Secondly, we wanted to measure the strength of temporal relationships between them to ensure that these items were related and referred to the supposed events. Then, we carried out an online survey based on a Likert scale ranging from 1 to 5. This survey was created through the “Google forms,” which are freely available online and generate automatic calculation of the responses received.

For this survey, first-year psychology students of the University of Montpellier were solicited, and the questionnaire was distributed via a social network. At the end of one week, we

collected 188 responses, 123 female and 64 male participants ($M = 26.4$, $SD = 7$). We firstly analyzed the results relative to the extent to which items were classified as past or future to the general population. We chose to keep items that had greater scoring with respect to our initial predictions. In the end, 40 items were selected, representing either deictic relations for past items (e.g., *Big Bang*) and future items (e.g., *Life on Mars - Vie Sur Mars in french -*) or non-deictic relations for earlier items (e.g., *Caterpillar-Chenille in french*;) and later items (e.g., *butterfly, Papillion in French*). The stimuli were discriminated relative to their link to deictic and non-deictic events. Precisely, for deictic relations, items retain their temporal status even if they are presented separately. This is because they depend on the observer's temporal location and point of view. For example, *Big Bang* is considered past whether or not followed by *Life on Mars*. However, in non-deictic relations, items depend on each other. If a *caterpillar* or *butterfly* is presented alone, they do not afford any earlier or later relations designation. Identifying earlier/later items depends on the semantic links between the events and the concept of transformation (*caterpillar/earlier, butterfly /later*) that they hold or relative to human actions (*raw meat/earlier, cooked meat/later*). (Table1)

Table 1: French word/Stimulus tiles used in the guessing task. There are 40 stimuli/trials total. 10 Past/10 Future; 10 Earlier/10 Later.

Deictic Items			Non-deictic Items		
	Past	Futur		Earlier	Later
1	Big Bang	Vie sur mars (<i>Life on mars</i>)	1	Construire (<i>Construct/built</i>)	Détruire (<i>Deconstruct</i>)
2	Locomotive (<i>Locomotive/Train</i>)	Téléportation (<i>Teleportation</i>)	2	Décollage (<i>Take-off</i>)	Atterrissage (<i>landing</i>)
3	Régime de vichy (<i>Vichy Regime</i>)	6ème république (<i>6th republic</i>)	3	Chenille (<i>Catapillar</i>)	Papillon (<i>Butterfly</i>)
4	Calèche (<i>Carriage</i>)	Vaisseau Spatial (<i>Space Ship</i>)	4	Poulain (<i>Foal</i>)	Cheval (<i>Horse</i>)
5	Tchernobyl (<i>Tchernobyl</i>)	3ème guerre mondiale (<i>3rd world war</i>)	5	Viande Cru (<i>Raw meat</i>)	Viande Cuite (<i>cooked meat</i>)
6	Minitel (<i>Minitel</i>)	Robot Humanoïde (<i>Humanoid robot</i>)	6	Pomme (<i>Apple</i>)	Trognon (<i>Apple core</i>)
7	Lampe à pétrole (<i>Petrol lamp</i>)	Arbres luminescents (<i>Bioluminescent trees</i>)	7	Oeuf (<i>Egg</i>)	Poussin (<i>Chick</i>)
8	Télégramme (<i>telegram</i>)	Hologramme (<i>Hologram</i>)	8	Eau (<i>Water</i>)	Vapeur (<i>Steam</i>)
9	Vélo Roulette (<i>Bicycle with training wheels</i>)	Vaisseau Spatial (<i>Space Ship</i>)	9	Enfant (<i>Child</i>)	Adulte (<i>Adult</i>)
10	Cadran solaire (<i>Sundial</i>)	Holorge atomique (<i>Atomic clock</i>)	10	Bulbe (<i>Bulb</i>)	Fleur (<i>Flower</i>)



Figure 1: Schematic diagram of the testing situation. The boxes were not labeled in the experiment

2.3 Procedure

As this study aims to replicate the experiments of Kranjec et al. (2011), we followed the same procedure. We had a French population; hence our stimuli were French words that were pretested. Participants were unaware of the purpose of the experiment during the task; at least, care was taken to avoid mentioning temporal concepts. To distract participants, the task was presented as a “parapsychological task” (see instructions below). Once at a time, participants entered a small room (10m²) and were seated in the middle (*figure 1 and annex 1*). Preparatory instructions were then given. Two random picture tiles (approximately 3.80cm x 5.08cm) made of thick cardboard with color images of a “banana” and a “unicorn” glued on one side were shown to the participants. They were told that these were only examples taken from a previous study and that they would not be used in the current experiment. Participants were shown 40 such tiles with different pictures. Table 1 shows the complete list of items used for the experiment. Items were pseudorandom and counterbalanced. The experimenter then left the room and entered an adjacent one, out of sight but within earshot of the participant. He then mixed the picture tiles loudly in a plastic container and then randomly poured, in exact proportions, into two opaque cardboard boxes (2.54 x 21.59 x 6.35) cm. The experimenter then reentered the room and placed at equal distances (19.54cm) of the seated participant, one opaque box in front and the other behind the latter. Participants were also told that the experimenter was unaware of the location of the tile. After which, they were given the following instructions aloud:

“One at a time, I will read from a list of the tiles used in this experiment. Your task is simply to point at the box (either in front or behind you) where, according to your best guess or intuition, you think a particular tile is located. Try to imagine the thing and make a picture of it in your mind before pointing. OK? Just guess”

During the task, the experimenter was seated slightly behind the participant in order to avoid unconscious cuing. The experimenter then recorded the direction of pointing for each item, i.e., for past/future items, schema-consistent responses were scored as 1 if the participant pointed *in front* for future and scored 2 for *behind* past item. For earlier/later items schema-consistent responses were scored as 1 if the participant pointed *in front* for later items and scored 2 for *behind* earlier items. No feedback was given to the participants.

3. RESULTS

We first will present analysis of the responses regarding the “parapsychological task” by item type (past/future items) and age. Secondly, we will show results regarding the incidental memory task by gesture and compatible items. We carried out all analysis on STATISTICA 8 package (Tulsa, Oklahoma).

3.1 Results on the parapsychological task

Responding by item type and age : The mean number of schema-consistent responses for each participant were entered into a 3 X 2 age (Young, Middle, Old) and Item Type (deictic, non-deictic) analysis of variance (ANOVAs). The result show a significant interaction between age and item type [F (2, 45) =3.53, $p < .03$, $\eta_p^2 = .14$] which means that the impact of the type of item differed depending on the age of the participant (see fig.1). The results also showed a main effect of the item type on the number of schema-consistent responses [F (1, 45) =24.11, $p < .001$, $\eta_p^2 = .35$] : responses for past/future (60,1%) items are more correct than for earlier/later (47,18%) items. Chi-square analyses comparing the responses to chance (50%) showed that participants responded at above chance levels for past/future items [$\chi^2 =$, $p < .01$] but not for earlier/later items [$\chi^2 =$,

ns]. In order to reveal internal differences between the item types (past/future/earlier/later), we carried out planned comparisons for each groups.

Planned comparisons for young participants demonstrated a more schema-consistent responses for past/future items (67,18%) than for earlier/later items (45%) [F(1, 42)=23.71, $p < .001$, $\eta_p^2 = .36$]. Chi square analyses comparing the responses to chance (50%) showed that young participants responded at above chance level for past/future items [$\chi^2 = 37,84, p < .01$], but not for earlier/later items [$\chi^2 = 1.01, ns$]. Descriptively, 81.25 % of young participants responded above chance for Past/Future items, and only 12.5% for Earlier/Later items. Moreover, a Wilcoxon Signed-Ranks test indicated that Past/Future responses were statistically significantly higher than those on Earlier/Later responses $Z = 3.21, p < .003$.

Planned comparisons for Middle age participants demonstrated a more consistent schema responses for past/future items (60%) than for earlier/later items (48,75%) [F (1, 42) =6.09, $p < .01$, $\eta_p^2 = .12$]. Chi-square analyses showed that middle age participants responded at above chance level for past/future items [$\chi^2 = 12.85, p < .001$], but not for earlier/later items [$\chi^2 = 0.2078, ns$]. Descriptively, 75 % of middle age participants responded above chance for Past/Future items, but only 31.25 % for Earlier/later items. Moreover, a Wilcoxon Signed-Ranks test indicated that Past/Future responses were statistically significantly higher than those on Earlier/Later responses $Z = 2.17, p < .001$.

Planned comparisons for older participants show no difference for past/future items (53.12%) and earlier/later items (47.81%) [F (1, 42) =1.35, $p = .24, \eta_p^2 = .03$]. Chi-square analyses showed that older participants responded at chance level both for past/future items [$\chi^2 = 1.25, ns$], and earlier/later items [$\chi^2 = 0.66, ns$]. Descriptively, 43,75 % of older participants responded above chance for Past/Future items, and 18.75 % for Past/Future items. But, a Wilcoxon Signed-Ranks

test indicated that Past/Future responses were statistically significantly higher than those on Earlier/Later responses $Z = 1.16, p < .001$.

Altogether, these results indicate that the three age groups responded differently to the type of items that were presented to them. Responses were more schema-consistent for Past/Future items than Earlier/Later items and this is true for young participants more than middle group participants and more than older participants. These results validate our first hypothesis and suggest that there is a grounding of temporal concepts in bodily axes, however, this grounding seems to decline with age.

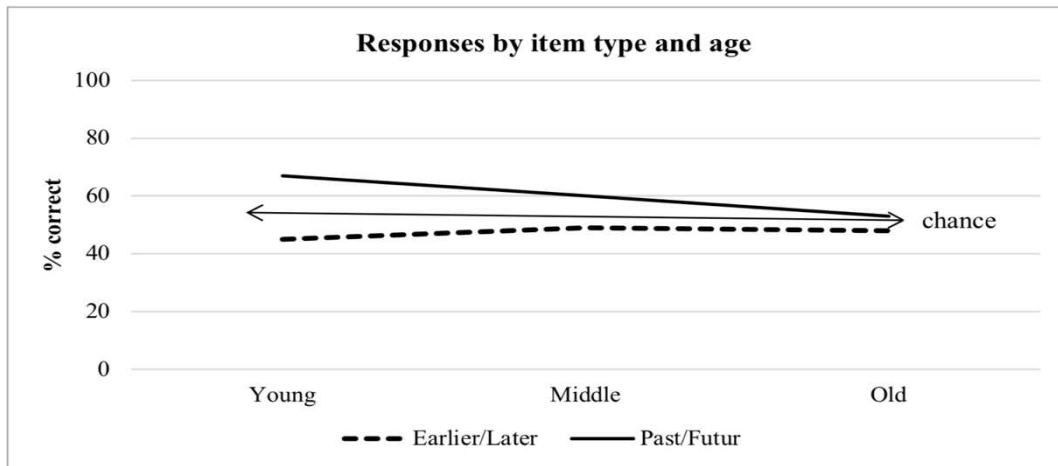


Fig.1 : Percentage of schema consistent responses to PAST/FUTURE and EARLIER/LATER items for all participants

3.2 Results on the incidental memory task

In the same vein as Kranjec and Mcdonough's study (2011), our results show that earlier/later items were not sufficient for participants to be aware of the temporal nature of the stimuli. Therefore, we have focused on past/future items to carry out the incidental memory task and deictic compatibility effect. Namely, for the compatible condition schema -consistent responses were, *behind/past* and *in-front/future* items and the incompatible condition included non-schema consistent responses, i.e., *behind/future* and *in-front/past* items.

We conducted a data analysis of variance (ANOVA) into a 3x2 age (Young, Middle, Old) and deictic compatibility effect (compatible vs non compatible). Results revealed no significant interaction [$F(2,45) = 1.28, p < .28, \eta_p^2 = .05$]. However, they showed a significant effect of dietic compatibility [$F(1,45) = 4.4, p < .01, \eta_p^2 = 0.08$], as well as a significant effect of age [$F(2,45) = 14.49, p < .01, \eta_p^2 = 0.39$]. Altogether, the data analysis reveal that a schema-consistent response is better recalled than a non-schema consistent response. Moreover, the results show that young participants recalled more words than middle age [$F(1,45) = 40.5, p < .01, \eta_p^2 = .47$], themselves recalling more words than seniors [$F(1,45) = 4.29, p = .04, \eta_p^2 = .08$]. To go further, we conducted planned comparisons for each group of age in order to explore specific compatibility effects. Results show a significant compatibility effect for young participants [$F(1,45) = 6.71, p = <.01, \eta_p^2 = .12$] but no significant differences was observed for middle aged participants [$F(1,45) = 1.9, p = .16, \eta_p^2 = .04$] and old participants [$F(1,45) = 0, p = 1$]. All together we showed that when a gesture is congruent to the concept that it refers to (e.g. pointing behind for past items and in-front for future items), there is a more efficient recall; but the embodied memory effect disappears with age.

4. DISCUSSION AND CONCLUSION

In the present study, we have examined age-related changes in time perception from an embodied perspective following Kranjec and McDonough's experimental protocol (2011). Literature shows that abstract concepts such as time are embodied, i.e., they are grounded in the body and environment (Boroditsky, 2000; Kranjec et al., 2011). Several of these studies were applied to a young and adult population; however, only a few evidence concerning an aging population is available (Vallet, 2015; Borghi & Setti, 2017). Our first objective was to observe

how the perception of time changes with aging. Hence, we extended Kranjec and Mcdonough's 2011 study across the lifespan.

Following our experiment, the results have shown there was a progressive decline of schema-consistent responses with age. That is, young participants were better than middle-aged participants, and middle-aged ones were better than older age participants. These results reveal that temporal concepts are embodied; however, the observed decline suggests that this embodiment is affected during aging.

Furthermore, we observed that the young and middle-aged groups appeared to be using the same grounding concepts and strategies, i.e., they responded better to deictic (Past/Future) events according to their bodily axes than for non-deictic (earlier/later) events, which depends on semantic processing of the relationship between items. Further analysis of our results shows that older participants gave more responses at chance level for deictic and slightly below chance level for non-dietic concepts. To sum, our results suggest that cognitive processing and sensorimotor modifications inherent to aging affect the processing of abstract concepts.

Common findings in embodiment theories also suggest that language comprehension requires action/motor stimulation (Zwaan et al., 2004). Hence, we were concerned with investigating how far a compatible motor action could influence its encoding in memory. To this end, we conducted an incidental memory task. We recorded the number of items that participants recalled and classified them as a compatible and incompatible deictic or non-dietic items. The incidental memory task results showed that an abstract concept that is coherent to its equivalent motor action has a greater probability of being recognized than one that is not coherent. Particularly, in our experiment, we observed that when spatial and temporal frames (*behind/in front*) was compatible with its concept (*past/future*), participants recalled more items in the

compatible condition (*past/behind; future/in front*) than in the incompatible condition (that is, *past/in front; future/behind*). However, we noted that recollection of temporal concepts declines progressively from young to middle-aged group participants. There were no other differences noted between the middle and older aged participants. This trend suggests a silver-lining of compatible motor action recollection of temporal concept, but it seems to disappear with age.

In summary, the results of our experiment reveal that the process of understanding an abstract concept, in this case, time, is highly dependent on one's bodily references. As Clark (1973) suggested in the moving-ego perspective, i.e., we mentally draw a timeline where we place ourselves in the middle to situate any event either in front or behind us. While this process appears to function well in young and middle-aged participants, the effects of aging impede the more senior participants. We think that if individuals construct their reasoning about time through their embodied experiences, the complexity of temporality will still be grounded in usual cognitive processes but will be subjected to sensorimotor declines. This idea is further supported by Casasanto (2011), Osiurak et al. (2014), and Vallet (2015), who ascertain that knowledge is deeply anchored in bodily interactions with the environment, however perceptual or physical changes relative to aging may account for the poor performances noted in the aging.

Moreover, according to our incidental memory task, we observed that a compatible motor action reinforced the recollection of an embodied abstract concept. These results are in line with several studies, such as Brouillet et al. (2016, p. 16), where they demonstrated that “an ipsilateral side response was easier to execute than contro-lateral responses, and that words which followed an ipsilateral response were more likely to be reported as recognized than words which followed a contro-lateral response.” Following Goldin-Meadow (1999), who claims that gestures provide

information about a speaker's thoughts and facilitate memory when produced at encoding or recall, we observed in our study that if memory recall is better when embodied, aging biases this effect.

So, we believe that embodiment is a better predictor of issues concerning aging. Studying aging through an embodiment perspective gives an alluring comprehension of the implied mechanisms and how they affect elderly populations. An interesting use of these results could be applied to the field of neuropsychological evaluations and cognitive remediation programs in the elderly, especially in amnesic or cognitive impairment cases. Assuming that the external environment and bodily functions support our core memory systems, then setting up cognitive remediation programs based on sensorimotor stimulations could be potentially more helpful, less laborious, and invasive for the elderly population. Bredesen (2014) claims that cognitive decline in dementia could be reverted by simply following a drastic change of lifestyle without any cognitive stimulation program or dementia-related drugs. Our study speaks to an increasing interest in embodied cognition of aging and is particularly challenging when it concerns abstract concepts. However, some measures could be addressed in future researches, such as recording the response time. This could provide precisions on the strategies used by participants to understand what has been implemented in the parapsychological task. At last, future research could include participants with body impairments to challenge the role of the body in such tasks.

5. REFERENCES

- Barsalou, L. W. (1999). Perceptual symbol systems. *Behavioral and Brain Sciences*, 22(4), 577–660.
- Borghi, A. (2005). Object Concepts and Action. In D. Pecher & R. Zwaan (Eds.), *Grounding Cognition: The Role of Perception and Action in Memory, Language, and Thinking* (pp. 8-34). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511499968.002
- Borghi, A. M., and Binkofski, F. (2014). Words as Social Tools: An Embodied View on Abstract Words. *New York, NY: Springer*

- Borghini, A. M., & Setti, A. (2017). Abstract Concepts and Aging: An Embodied and Grounded Perspective. *Frontiers in Psychology*, 8, 430. <http://doi.org/10.3389/fpsyg.2017.00430>
- Boroditsky, Lera, 2000. Metaphoric structuring: understanding time through spatial metaphors. *Cognition* 75 (1), 1–28.
- Bredesen, D. E. (2014). Reversal of cognitive decline: a novel therapeutic program. *Aging*, 6(9), 707–717. <http://doi.org/10.18632/aging.100690>
- Brouillet, T., Ferrier, L. P., Grosselin, A., & Brouillet, D. (2011). Action compatibility effects are hedonically marked and have incidental consequences on affective judgment. *Emotion*, 11(5), 1202
- Brouillet, D., Milhau, A., Brouillet, T., and Servajean, P. (2017). Effect of an unrelated fluent action on word recognition: a case of motor discrepancy. *Psychon. Bull. Rev.* 24, 894–900. doi: 10.3758/s13423-016-1160-0
- Calvert, G. A., & Thesen, T. (2004). Multisensory integration: methodological approaches and emerging principles in the human brain. *Journal of Physiology-Paris*, 98(1-3), 191–205. <http://doi.org/10.1016/j.jphysparis.2004.03.018>
- Carstensen, L. L. (2006). The influence of a sense of time on human development. *Science (New York, N.Y.)*, 312(5782), 1913–1915. <http://doi.org/10.1126/science.1127488>
- Casasanto, D. (2009). Embodiment of abstract concepts: Good and bad in right- and left-handers. *Journal of Experimental Psychology: General*, 138(3), 351–367.
- Casasanto, D., & Chrysikou, E. G. (2011). When left is “right.” Motor fluency shapes abstract concepts. *Psychological Science*, 22(4), 419–422. <http://doi.org/10.1177/0956797611401755>
- Clark, Herbert H., (1973). Space, time, semantics, and the child. In: Timothy, E., Moore, (Eds.), *Cognitive Development and the Acquisition of Language*. Academic Press, New York.
- Cook, S. W., Yip, T. K., & Goldin-Meadow, S. (2010). Gesturing makes memories that last. *Journal of Memory and Language*, 63(4), 465–475. <http://doi.org/10.1016/j.jml.2010.07.002>
- Costello, M. C., & Bloesch, E. K. (2017). Are Older Adults Less Embodied? A Review of Age Effects through the Lens of Embodied Cognition. *Frontiers in Psychology*, 8(657508), 1–18. <http://doi.org/10.3389/fpsyg.2017.00267>
- Diefenbach, C., Rieger, M., Massen, C., & Prinz, W. (2013). Action-Sentence Compatibility: The Role of Action Effects and Timing. *Frontiers in Psychology*, 4. <http://doi.org/10.3389/fpsyg.2013.00272>
- Engelkamp, J., & Seiler, K. H. (2003). Gains and Losses in Action Memory. *The Quarterly Journal of Experimental Psychology Section A*, 56(5), 829–848. <http://doi.org/10.1080/02724980244000648>
- Evans, V. (Ed.). (2003). *The structure of time: Language, meaning and temporal cognition*. John Benjamins Publishing.
- Fung, H. H., & Isaacowitz, D. M. (2016). The role of time and time perspective in age-related processes: Introduction to the special issue. *Psychology and Aging*, 31(6), 553–557. <http://doi.org/10.1037/pag0000119>

- Freiherr, J., Lundström, J. N., Habel, U., Reetz, K., Lundström, J. N., Habel, U., et al. (2013). Multisensory integration mechanisms during aging. *Front. Hum. Neurosci.* 7:863. doi: 10.3389/fnhum.2013.00863
- Gentner, D. (2001). Spatial metaphors in temporal reasoning. In M. Gattis (Ed.), *Spatial schemas in abstract thought* (pp. 203-222). Cambridge, MA: MIT Press.
- Glenberg, A. M. (1997). Mental models, space, and embodied cognition. In T. B. Ward, S. M. Smith, & J. Vaid (Eds.), *Creative thought: An investigation of conceptual structures and processes* (p. 495-522). American Psychological Association.
- Glenberg, A. M., & Gallese, V. (2012). Action-based language: a theory of language acquisition, comprehension, and production. *Cortex*, 48(7), 905-922. <http://doi.org/10.1016/j.cortex.2011.04.010>
- Glenberg, A. M. (2015). Few believe the world is flat: How embodiment is changing the scientific understanding of cognition. *Canadian Journal of Experimental Psychology/Revue Canadienne De Psychologie Expérimentale*, 69(2), 165-171. <http://doi.org/10.1037/cep0000056>
- Goldin-Meadow, S. The role of gesture in communication and thinking. *Trends in Cognitive Science*, 1999, 3, 419-429
- Johnson, M. (1987). *The Body in Mind*. Chicago: Chicago University Press.
- Kranjec, A. (2006). Extending spatial frames of reference to temporal concepts. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 28, No. 28).
- Kranjec, A., Cardillo, E. R., Schmidt, G. L., and Chatterjee, A. (2010). Prescribed spatial prepositions influence how we think about time. *Cognition* 114, 111-116
- Kranjec, A., and McDonough, L. (2011). The implicit and explicit embodiment of time. *J. Pragmat.* 43, 735-748
- Lakoff, G., Johnson, M. (1980). *Metaphors We Live By*. University of Chicago Press, Chicago, IL.
- Lakoff, G., Johnson, M. (1999). *Philosophy in the Flesh: The Embodied Mind and its Challenge to Western Thought*. Basic Books, New York, NY.
- Maguinness, C., Setti, A., Roudaia, E., & Kenny, R. A. (2013). Does that look heavy to you? Perceived weight judgment in lifting actions in younger and older adults. *Frontiers in human neuroscience*, 7, 795. <https://doi.org/10.3389/fnhum.2013.00795>
- Mandler, J. M. (1992). How to build a baby: II. Conceptual primitives. *Psychol. Rev.* 99, 587-604
- Osiurak F., Morgado N., Vallet G. T., Drot M., Palluel-Germain R. (2014). Getting a tool gives wings: overestimation of tool-related benefits in a motor imagery task and a decision task. *Psychol. Res.* 78, 1-9. 10.1007/s00426-013-0485-9
- Pecher, D., & Zwaan, R. (2005). Introduction to Grounding Cognition: The Role of Perception and Action in Memory, Language, and Thinking. In D. Pecher & R. Zwaan (Eds.), *Grounding Cognition: The Role of Perception and Action in Memory, Language, and Thinking* (pp. 1-7). Cambridge: Cambridge University Press. doi:10.1017/CBO9780511499968.001

- Peiffer, A. M., Mozolic, J. L., Hugenschmidt, C. E., & Laurienti, P. J. (2007). Age-related multisensory enhancement in a simple audiovisual detection task. *Neuroreport*, *18*(10), 1077-108
- Poliakoff, E., Ashworth, S., Lowe, C., & Spence, C. (2006). Vision and touch in ageing: Crossmodal selective attention and visuotactile spatial interactions. *Neuropsychologia*, *44*(4), 507-517. <https://doi.org/10.1016/j.neuropsychologia.2005.07.004>
- Roberts, K. L., & Allen, H. A. (2016). Perception and Cognition in the Ageing Brain: A Brief Review of the Short- and Long-Term Links between Perceptual and Cognitive Decline. *Frontiers in Aging Neuroscience*, *8*, 289–7. <http://doi.org/10.3389/fnagi.2016.00039>
- Saimpont, A., Malouin, F., Tousignant, B., & Jackson, P. L. (2013). Motor imagery and aging. *Journal of Motor Behavior*, *45*(1), 21–28. <http://doi.org/10.1080/00222895.2012.74009>
- Vallet, G., Simard, M., & Versace, R. (2011). Sensory-dependent knowledge in young and elderly adults : arguments from the cross-modal priming effect. *Current Aging Science*, *4*(2), 137–149. <http://doi.org/10.2174/1874609811104020137>
- Zwaan, R. A., van der Stoep, N., Guadalupe, T., & Bouwmeester, S. (2012). Language comprehension in the balance: the robustness of the action-compatibility effect (ACE). *PloS one*, *7*(2), e31204. <https://doi.org/10.1371/journal.pone.0031204>

Annex 1: Setting of our testing situation. The boxes were placed at equal distances



STUDY 2

Evaluation of Executive Functioning through sensorimotricity in aging

Current assessment tools for measuring executive functions (EF), even the non-verbal ones, are a product of a given historical and cultural context and specific to a given population. The problem that arises is that we cannot assume that the standards or norms of these tests will also be valid for another population. Yet, due to the lack of appropriate tools for a culturally diverse population, this practice is still widespread. In designing a Sensorimotor Evaluation of Executive functioning (SEE), we wanted to provide a universal tool that would be more adapted, easily administered and understood by participants from diverse backgrounds without inducing a language barrier.

In order to achieve this objective, our first aim was to create an evaluation battery that would assess executive functioning through sensorimotor activations(SEE). The SEE battery was based on Miyake's (2001) model of executive functions, i.e., inhibition, flexibility, and working memory (updating). Among the EF tests currently used, we were inspired by those most known and adapted them to our problem. Furthermore, throughout designing these evaluations, care was taken in proposing tasks that would include a minimum of language, even as far as it concerns task instructions. We proposed six tests, 2 per executive function, as the idea was to provide a sufficiently wide choice of tasks to explore which one would work better. Moreover, to ensure that we were assessing the correct EF constructs, we compared the battery SEE with existing executive functions assessments such as the TAP (Zimmerman & Fimm, 2002), particularly - Inhibition

test(GoNogo); Updating (3 levels of the working memory tasks) and Flexibility (Shapes version task). We hypothesized that if our battery measured the same EF constructs, there would be a positive correlation between SEE and TAP tests.

Table 1 : Summary of EF evaluation tasks used to compare with the SEE battery

Executive Functions	SEE Battery	TAP
Inhibition	Local-global Stop Signal	Go-NoGo (2 and 5 stimuli)
Shifting	Smiling Faces Dots-Triangles	Flexibility (Shapes – 3 levels)
Updating	TicTacToe Sound Span	Working Memory (3 levels)

1. METHOD

1.1 Participants

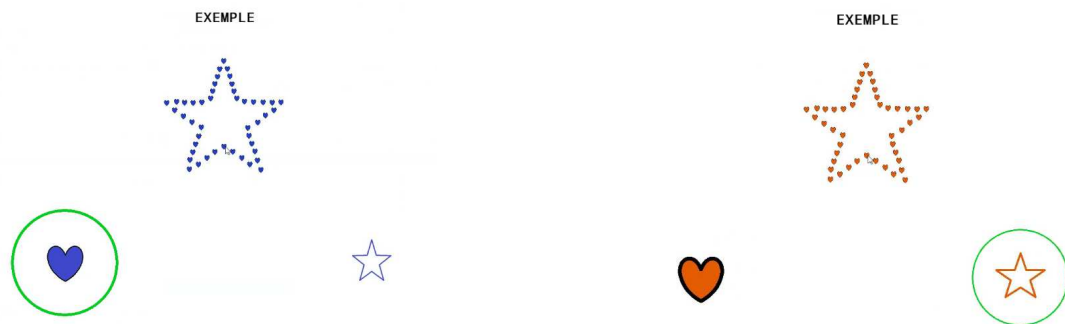
Thirty-nine healthy individuals from the North-East area of France (Moselle) and Montpellier agreed to participate in this study. Participants were divided into two groups respectively: 19 younger adults aged from 18 to 48 years old ($M = 22.6$, $SD = 7.2$) and 20 older adults aged between 65 to 87 years old ($M = 76.8$, $SD = 5.4$) for the first sessions. Inclusion criteria were scoring above 25 on the Mini-mental state examination (MMSE, Folstein, et al., 1975); low scoring levels (<50) on the State-trait Anxiety Inventory (STAI, Spielberger, et al., 1983); scores $<20/60$ on the Montgomery-Asberg depression rating scale (MADRAS, Montgomery & Asberg, 1979). These neuropsychological tests were administered as part of screening for psychiatric or neurological risks factors that might affect the participant’s cognitive performance. All participants had no visual, auditory, or physical impairments. All of the participants gave written informed consent before participation. The same participants were seen one month after the initial testing phase for the test-retest fidelity protocol. Unfortunately, 5 participants among the young adults could not attend this second session.

1.2 Materials

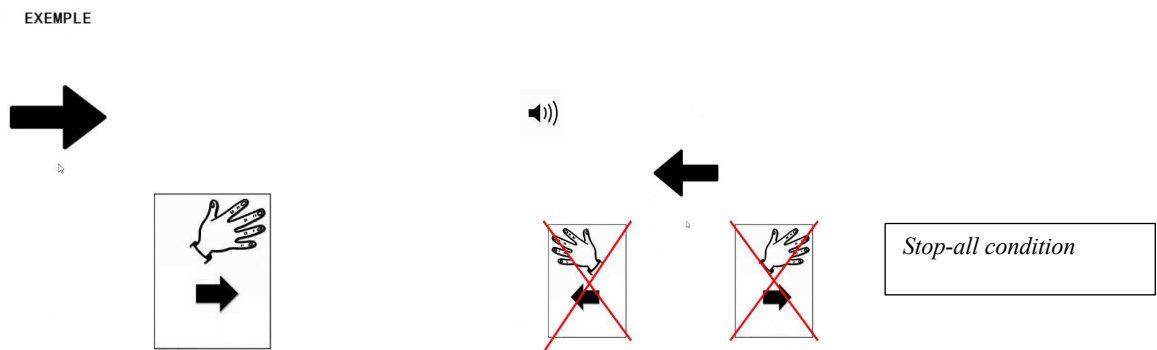
All tasks involved in this experiment were designed on the Opensesame Software. For most of the test adapted, particularly local-global, we asked for permission from the authors (Van der Ven et al., 2012; Huizinga et al., 2005) as they provided us with the primary images, which we further adapted to match our target population. Two computerized tasks per executive function were administered (Table 1).& Correct responses and response time were recorded for each trial on a keyboard designed with two touches (left and right) and a middle touch to move to another task (*see annex 1 for a picture of the keyboard*). A full description of each task follows with screenshots of each task included in the SEE battery

Inhibition :

Local-Global (Adaptation task of by Navon, 1977; Van der Ven et al., 2012): Geometric shapes were presented, which consisted of smaller different geometrical shapes. The shapes were presented either in blue or orange color. When the image presented was orange, the participants had to respond to the global shape. If the shape was blue, then it was the local shape. Two choices of answers were displayed on the screen. The participant had to answer by pressing the right or left keys on a keyboard. Response time and correct response were recorded. There was a trial phase so that participants could figure out the goal of the task. After which, they were presented to the real task. The shapes appeared on the screen in random order.



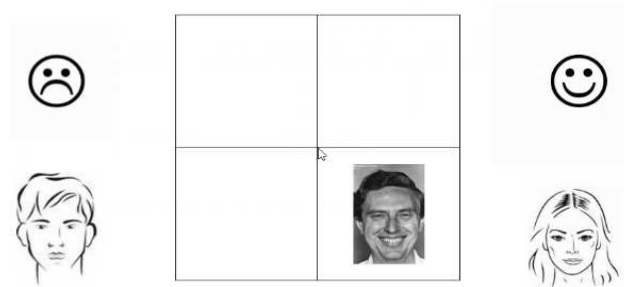
Stop Signal (Adaptation task of Logan, 1994): The Stop-Signal is a task where arrows (pointing left or right) are displayed on a screen, and participants are asked to press on the keyboard (left or right) according to the stimuli they see. A signal is then presented to participants to tell them to stop responding at the primary task. Our task was divided into 4 blocks. In the first block, the participants had to answer as quickly as possible by pressing the keys on the keyboard, according to the direction (left or right) of an arrow. In block 2 (stop-all condition), they heard a buzzer, signaling that they will have to stop their response for the next item. In block 3 (stop-change condition), a different buzzer was announced, and they had to respond in the opposite direction of the arrow. The last block (stop-mix condition) consists of a mix of both buzzers. The buzzers were only be presented in 25% of the trials. The participants had 1250ms to respond. The time interval between the response and the start of the next arrow on the subsequent trial varied randomly between 1650 and 2150ms.



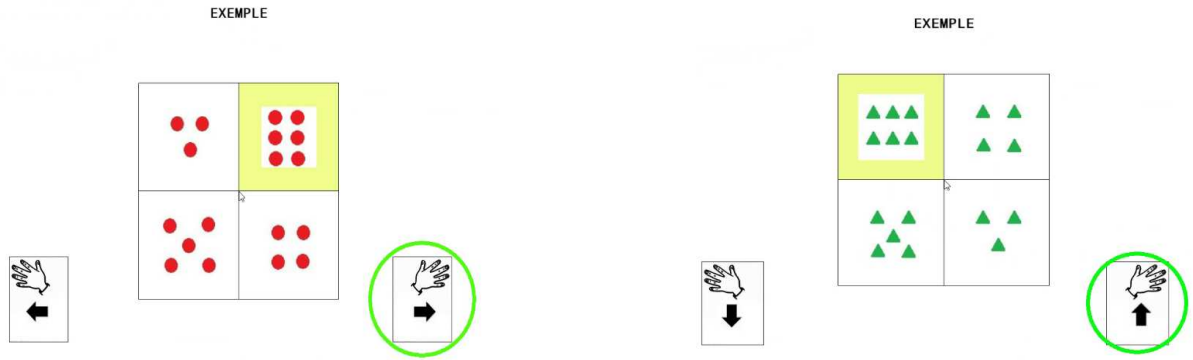
Shifting :

Smiling faces (adaptation of Rogers et Monsell, 1995, see also Span, Ridderinkhof et Van der Molen 2004): The stimuli used in this task were taken from the Ekman’s faces test, particularly, male and female faces, smiling or not. The images were displayed in a 2×2 grid. Participants are asked to respond to the gender if the face was presented in one of the two upper quadrants (Block

1), or to facial expression if it was presented in one of the two lower quadrants (block 2). Images were shown in random order and participants had 30 practice trials and 50 experimental trials per block. In the third block, the stimulus moved clockwise across the grid. It was a mix of the first two blocks. So the participants had to remember how they responded in the first two blocks. Block 3 contained 90 practice trials 150 test trials and participants had 3500 ms to respond. The time interval between the response and the subsequent trial stimulus varied randomly between 900 and 1100ms

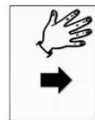


Dots-Triangle (Adaptation task of Rogers et Monsell, 1995): Varying numbers of red dots or green triangles were presented in a 4 x 4 grid on the screen (i.e., three eight dots or triangles equally distributed). In the “red dot” task, participants had to decide whether there were more dots on the left or right side of the screen (block 1: 30 practice trials, 50 test trials). In the "green triangles" task, participants have to decide whether there are more triangles at the top or bottom of the screen (block 2: 30 practice trials, 50 test trials). Blocks 1 and 2 were administered in random order. In the third block (90 practice trials, 150 test trials), "red dots" and "green triangles" were alternately presented to participants. Participants were given 3500 ms to respond.



Updating :

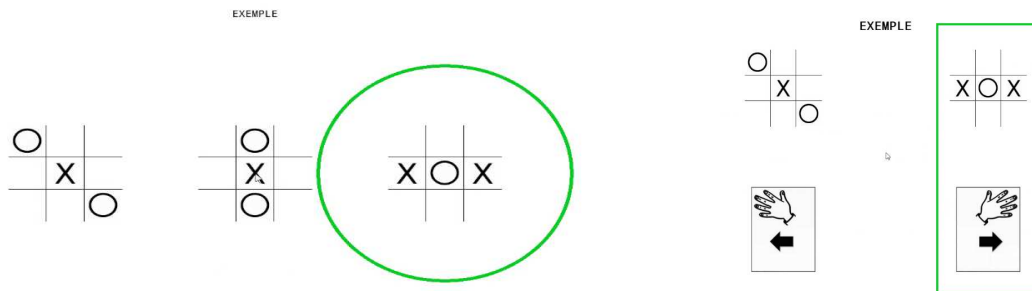
Sound Span: This task is an adaptation of the WAIS-III span task (Wechsler, 1999). Participants were presented with two blocks - direct and indirect order. Low-pitched and high-pitched sounds were associated to the left and right keys of the keyboard respectively. When the sound was low-pitched, the participant had to press the left key and for a high-pitched sound the right key. The participant's task was to listen to a complete sound sequence, remember it, and then press the sequence on the keyboard. The number of sequences increased as the participant completes the task. There were three trials each time, only when two successful answers the participant gave, they could move on to the next level. For the reverse order, the participant still heard a sequence of low and high tones, except that they had to respond in the reverse order of the sequence heard. There was no time limit for participants to respond.



Son Grave = Tap Gauche

Son Aigu = Tap Droit

Tictactoe (adaptation task of Milner, 1975): In this task, different configurations were displayed on the screen. The presentation time varied between 900 - 1100 ms. The participant had to remember the last spatial pattern in the grid. The task was divided into 3 blocks - the first block was low memory load with 3-5 patterns displayed, the second block was high memory load with 5-9 patterns, the third block was a random presentation of the grids (high/low memory load) and the participants had to answer item N-1 back item.



1.3 Procedure

Before proposing the SEE battery, we pretested the latter with 13 participants (mostly university students). The objective was to gather feedback about the clarity, procedures, task items, and stimuli displays. The participants' feedback (annex 2) allowed us to improve and settle on a version with enough comprehensible features for our target population.

Once we validated our experimental version, we recruited participants from Montpellier and Boulay-Moselle, France. Each participant was tested individually in a quiet room. After a brief interview, participants have explained the objective of the experimentation. Then, they were administered the MMSE, MADRAS, and STAI questionnaire as part of a screening test. Once this initial phase was completed, participants started the SEE tasks, which lasted for about two hours or less. The tasks were displayed on a MACOS 13 screen. Participants were instructed to stop or

take a break whenever needed to avoid fatigue and loss of concentration. After they had completed the SEE battery, participants took a 15min break before carrying on with the other neuropsychological tests (TAP – 3 executive function tasks were selected, Zimmerman & Fimm., 1994). The whole experiment lasted for about 3hours for each participant. After which, we asked participants' feedbacks about the whole experiment informally.

The participants were informed that there would be a second session (test-retest) and were asked whether they were willing to continue. Most of the participants agreed; however, few of the young ones could not follow up a month later due to contextual and organizational issues.

2. Results

For this study, and since we are mainly concerned with the issues regarding aging, we will present data concerning the aging group only. We carried out a Spearman's rank correlation with the correct responses firstly concerning all the tests for the two testing sessions (T1 and T2), secondly on tasks from the TAP that corresponded the most with the SEE battery. The Spearman, ρ (**rho**) correlation test is a non-parametric measure of a rank correlation (statistical dependence between the rankings of two variables) rather than raw data. Considering our data, we wanted to know whether a participant who performed well on one test was also as good on the others and for this purpose. Hence, we had to define a ranking order of their performances on different tasks, and since we did not expect the relationship between the variables to be linear, the Spearman correlational analysis appeared more appropriate. All statistics were carried out on RStudio.

Analysis concerning data at test-retest reliability :

Inhibition : The findings of the Spearman analysis comparing all tests at T1 and T2 for aging subjects shows a positive relationship between the Stop-Signal mix-condition(block3), ($r_s = 0.66$;

p= 0.001); local-global (block1), (rs = 0.65; p= 0.001); local-global (block 2), (rs = 0.664 p= 0.002); GoNoGo (2 stimuli), (rs = 0.53; p= 0.01); and GoNoGo (5 stimuli), (rs = 0.36; p= 0.08).

Updating : The findings of the Spearman analysis comparing all tests at T1 and T2 for aging subjects shows a positive relationship between TicTacToe(block1 – low memory load), (rs = 0.47; p= 0.03); TicTacToe (block2 – high memory load) (rs = 0.43; p= 0.05); Sound Span (Direct order), (rs = 0.70 p= 0.001); Tap Working memory (level 1), (rs = 0.37; p= 0.1); Tap Working memory (level 2), (rs = 0.43; p= 0.05

Flexibility : The findings of the Spearman analysis comparing all tests at T1 and T2 for aging subjects shows a positive relationship between Smiling Faces(block1 – Gender), (rs = 0.39; p= 0.09); Smiling faces (block2 – Expression) (rs = 0.62; p= 0.04); Dots-Triangle (block 2 - Triangles), (rs = 0.50; p= 0.02); Tap Flexibility (Shapes - level 1), (rs = 0.46; p= 0.3); and Tap Flexibility (level 3 – Alternate condition), (rs = 0.45; p= 0.04).

Analysis concerning data of SEE battery v/s TAP :

Inhibition : The findings of the Spearman analysis comparing all tests for aging subjects shows a positive relationship between Stop Signal (block3 – Mix condition) and TAP GoNoGO (5 stimuli), (rs = 0.43; p= 0.05) at **T1**. Moreover, at **T2** a positive correlation was found between Stop Signal (block2 – Stop condition) and TAP GoNoGO (5 stimuli), (rs = 0.57; p= 0.008); Stop Signal (block 2- Stop change condition) and TAP GoNoGO (5 stimuli), (rs = 0.71; p= 0.0004); and between Local-Global (block 1- global condition) and TAP GoNoGO (5 stimuli), (rs = 0.40; p= 0.07).

Updating: The findings of the Spearman analysis comparing all tests for aging subjects *show* a positive relationship between TicTacToe (block3 – Mixed condition) and TAP working memory (level 3), (rs = 0.53; p= 0.02) at **T1**. Moreover, at **T2** the same positive correlation between these

same tasks was found, i.e., TicTacToe (block3 – Mixed condition) and TAP working memory (level 3), ($r_s = 0.45$; $p = 0.03$).

Flexibility: The findings of the Spearman analysis comparing all tests for aging subjects *show* a tendential positive relationship between Smiling faces (block3 – Alternate condition) and TAP Flexibility (Alternate condition), ($r_s = 0.39$; $p = 0.08$) only at **T1**.

3. Discussion and conclusion

Our objective for the present study was to create and validate an evaluation of executive functioning through sensorimotricity for older adults. Following Miyake's model (2001) of executive functions (inhibition, updating, and flexibility), we have proposed a battery (SEE for Sensorimotor Evaluation of Executive functioning) including 2 tasks by executive functions. Inhibition tasks included local-global and stop signal exercises; TicTacToe and Sound Span for Updating and Smiling Faces and Dots-Triangle for Flexibility. In order to investigate whether this battery measured the three given constructs, we compared the latter to existing neuropsychological tests such as the TAP (test of attentional performances, Zimmerman & Fimm, 2002). We carried out this experiment with 20 healthy older adults at two different times for the Test-Retest Reliability. Our results show positive correlations for all tests (SEE and TAP) on the rest-retest reliability condition and for all constructs (inhibition, updating, and flexibility). Secondly, the results concerning the comparison between the SEE and TAP show positive correlations only for inhibition and updating but not for flexibility. This lack of results on flexibility tasks could be due to its high complexity, thus, suggesting a greater cognitive resource demand, which is known to be less available as one age.

Nevertheless, this study has some limitations. The first is the number of people evaluated. It should be necessary on one hand to have more people and on the other hand, it is necessary to

have a more homogeneous repartition of the participants according to age groups: -70, 70-75, 75-80, 80 et plus. The second limitation refers to the tasks themselves, particularly, some of the tasks, especially the third blocks (which included a combination of different EF) were too difficult. Hence, some participants could not finish those or stopped in the middle. This could explain the lack of correlations between those tasks and the TAP. However, according to the unity and diversity concept of the EF described by Miyake (2001), we believe that those tasks included a combination of two or more functions, and we could have made other correlations including all the three functions at once. For example, the Smiling faces (block3) included both gender and expression tasks, it called on both inhibition and flexibility, therefore analyzing block 3 with TAP inhibition and flexibility together could have provided more insights. Furthermore, another possible amelioration in the analysis of the results could be looking into the errors. Indeed, studies suggest that older adults are more prone to make errors in reaction choice tasks or in error monitoring (Hoffmann & Falkenstein, 2011; Band et al, 2000). Error monitoring, detection, and processing according to these authors, is essential for an efficient adaptation of one's behavior in a situational context. Therefore, analyzing errors committed could further explain the difficulties faced by the participants in adapting their behaviors in high cognitive demand tasks. But, nous n'avons pas pu procéder à cette analyse car le nombre d'erreurs n'était pas suffisant.

To conclude, to our knowledge, several non-verbal tests do exist for evaluating executive functioning, such as the TMT A/B. Although the SEE battery still needs to be evaluated on a larger number of people, it shows that EFg can be assessed through sensorimotor tests and therefore the SEE battery can be used by audiences with little education and/or lack of language proficiency.

STUDY 3

Validation of a sensorimotor stimulation program (PSSM) for older adults with diverse socio-cultural backgrounds

Article corresponding to this study (In process of submission) : Cross-Cultural Sensorimotor Stimulation Program : A preliminary study in Moroccan Immigrants, Mauritian and French Older Adults

In Chapter 3, we exposed that cognitive interventions are widely used to palliate for cognitive deficits related to aging. For the past decade, along with cognition-based approaches, sensorimotor stimulations are also proposed as part of cognitive interventions. The basic premise of applying sensorimotor stimulation is that sensorimotor deterioration due to aging may result in cognitive changes; therefore, stimulation of the sensorimotor aspects may help improve cognitive functioning. Another reason that we find particularly interesting while using sensorimotor interventions is that they are not language-dependent, and therefore particularly suited for a population who does not have a high level of language proficiency. In the next section, we will present a review of the context and steps that led us to the design of the PSSM, the results that we obtained, even though they should be interpreted with precautions, and we will present our second article, following the validation study of the PSSM.

1. The context :

Since September 2012, the Federation of "Familles Rurales de l'Hérault" has been offering memory workshops through partnership agreements with other organizations or internally with member associations. Nearly twenty workshops have been held since then. Following a "memory

workshop" action on the territory of the Ile de Thau in Sète, in partnership with the CLIC "Géronthau" of Sète (from January to April 2013), and within a public made up mainly of women of Moroccan origin (aged less than sixty years), it was observed that the "Cognitive Activation Program (PAC)" carried out by the "Fondation Nationale de Gérontologie" is not adapted to people who do not master the French language. It was concluded that: The PAC SENIOR FNG, which supported this workshop, was more of a tool for understanding the French language than a prevention tool, and it was not designed for this type of public (migrants who do not master the French language). In light of these observations, the need to provide a preventive action for cognitive health support to migrant seniors without age limitation, pathologies, and language requirements emerged.

2. The main objective project

- *Creation of a prevention cognitive intervention workshop adapted to migrant seniors, that relies on sensory-motor domains and where the use of language is not.*
- *Implementation of a feasibility study to demonstrate that the use of a sensorimotor intervention can be more adapted than current memory interventions.*

Since July 2013, *Familles Rurales* has brought together and worked with the institutional partners concerned by this issue. In terms of practical organization, the result was the creation of a steering committee whose mission was initially to establish a diagnosis, determine the protocol, the lines of work, and enrich the reflections with its expertise. For greater efficiency, it appeared necessary to set up a technical committee whose mission was to give feedback on intervention carried out with intervention programs (sensorimotor or memory-based), experiment, and create appropriate tools and supports. The following members were part of the technical committee and represented their associations or institutions:

- **ADOMA** : M. Alexandre LOPEZ

- **CARSAT** : Mme Monique ROSSINI
- **CLIC** : MM. Gérard BROUSSE, Jean-Jacques FAUCET
- **DDCS** : M. M'Hamed OUCHKER
- **Femmes du Soleil Association** : Mme M'Barka PETER
- **MSA (Mutualité santé Agricole)**: Mme Claire DE HADJETLACHÉ
- **TIN-HINAN** : Mmes Christiane CROS, Cathy SALZE, Laurène FOURNIER
- **University P. ValéryMontpellier III** : M. Denis BROUILLET (Professor of Cognitive Psychology, UM3, Epsilon), Draushika Mooruth (Doctorante)
- **Familles Rurales** : Mmes Odile BARETTE, Evelyne BONNEL

The project was taken over by the TIN-HINAN association in collaboration with EPSYLON laboratory in 2017.

Other partners were also approached for their expertise and financial support for this project. In particular, in 2019, we replied to a project call by the ARS (Allocation Regime Santé) for the Region of Occitanie, including different partners (CARSAT, MSA, SSI). The call concerned research studies and experimental projects regarding preventing active and healthy aging of seniors at risk. Mrs. Sophie Martin (University of Montpellier) submitted our project, and the latter was retained (see annex 3 for the project submitted). CARSAT provided financial support and help from their partners (Association le Clos de la Fontaine) for the constitution of part of our experimental population group.

3. METHOD

3.1 Design of PSSM

The PSSM was co-designed by different stakeholders of the project. The first step was to collect data and feedback on-field through the associations already applying for intervention programs as part of a 'successful aging program.' For example, at TINHINAN, they proposed a program named 'vieillir en bonne santé 2014-2015', whereas, at the MSA in Vaucluse, they used the PAC EUREKA. Recollecting feedbacks from these associations and a few others offered a

broader view on what was not working and what was in the actual interventions. Moreover, it provided new insights to design the sensorimotor stimulation program.

In order to create the PSSM, different domains for sensorimotor stimulations were identified, such as haptic memory, auditory, visual, gestural, and executive functioning. The technical committee gathered at different moments and shared the exercises they thought appropriate and could be included in the program. Tin Hinan came up with a first version of the program and pretested it with volunteers from their association. The aim at that point was to see whether the tasks were easily comprehensible, their duration, and ease of applicability (see annex 4 for the pretest feedbacks). Several other sessions of teamwork were needed in order to finalize the PSSM.

The initial final version included 10 weekly sessions of 1h to 1h30 per session. However, given the time and contextual constraints, we reduced the sessions to 8 sessions carried out twice a week. Most of the materials were handmade by members of the Tin Hinan Association (Mrs. Laurène Fournier and Mrs. Christiane Cros); for example, in the haptics stimulation sessions, participants were presented with an opaque box with 5 different objects of variable textures in it. The box had an opening where the participant could insert one hand to touch objects inside. The participants were asked to guess the object in the first presentation; after a while, they were presented again with the same box, and it contained an object that they were never presented. They had to guess which one it was. A description of the session will be presented below (Table 3). Details of the exercises will be presented in annex 5.

Table 3 : Summary of the 10 sessions included in the PSSM intervention. Each sessions were dedicated to work different types of memory. The sessions always started with some general movements of the body.

<p>Séance 1 : Mémoire gestuelle : 2 séries de 2 mouvements Mémoire haptique : 1^{er} exercice Mémoire auditive : 1^{er} module Mémoire gestuelle : Refaire les deux séries de 2 mouvements</p>	<p>Séance 6 : Mémoire gestuelle : 4 séries de 2 mouvements Mémoire visuelle : Memory niveau 1 : objets vie courantes ou animaux Mémoire olfactive Mémoire gestuelle : 4 séries de 2 mouvements</p>
<p>Séance 2 : Mémoire gestuelle : 3 séries de 2 mouvements (révision des 2 premiers) Mémoire haptique : 2^{ème} exercice Mémoire auditive : 2^{ème} module Mémoire gestuelle : 3 séries de 2 mouvements</p>	<p>Séance 7 : Mémoire verbale : 2^{ème} partie : replacer les éléments de la séance précédente et 2^{ème} partie de l’histoire Mémoire visuelle : Memory niveau 2 (formes) Mémoire verbale : retour sur le conte : replacer les deux séries d’éléments Flexibilité mentale : niveau 1</p>
<p>Séance 3 : Mémoire visuo-spatiale : Randonnée</p>	<p>Séance 8 : Mémoire verbale 3^{ème} partie : replacer les éléments de la 1^{ère} et 2^{ème} partie et raconter la fin de l’histoire Mémoire visuelle : niveau 3 Mémoire verbale : retour rapide sur le conte et les éléments à placer Flexibilité mentale niveau 2 et 3</p>
<p>Séance 4 : Mémoire gestuelle : 5 séries de 2 mouvements Mémoire visuo-spatiale : retour randonnée Mémoire gestuelle : 5 séries de 2 mouvements</p>	<p>Séance 9 : Mémoire sensorielle : choix Mémoire verbale 3^{ème} partie : replacer tous les éléments Mémoire sensorielle : retour Flexibilité mentale : niveau 4</p>
<p>Séance 5 : Mémoire verbale : 1^{ère} partie Mémoire haptique : 3^{ème} exercice Mémoire auditive : 2^{ème} ou 3^{ème} module (selon difficultés rencontrées séance 2)</p>	<p>Séance 10 : Mémoire sensorielle : variante Flexibilité mentale : niveau 4 Mémoire sensorielle : retour</p>

3.2 Procedure

In order to validate the PSSM intervention, we used a type ABA experimental protocol consisting of three phases: a baseline assessing the participants' performance before any intervention; a treatment phase where the sensory-motor workshop was implemented; and finally, a follow-up phase where the maintenance of the behavioral changes following the intervention was assessed. As such, we had two evaluation phases (T0 - pre-intervention and T1 post-intervention). As our problematic concerned a population that does not master language, we used as part of the assessment a cross-cultural neuropsychological battery (the CNTB) developed by Nielsen et al. (2019). The CNTB was proved to be relevant for assessing cognitive impairment in AD and other

dementia disorders. Moreover, it can be easily applied across different ethnic groups and languages without changing the content (Nielsen et al., 2019). Table 4 below shows a summary of the tests in CNTB. The battery takes about 1h15 to complete. The CNTB battery includes a series of 12 assessments of general cognitive functioning:

- the Rowland Universal Dementia Assessment Scale (RUDAS), which is a screening test that assesses different cognitive domains.
- tests of verbal fluency (Animals and Shopping List)
- tests of memory, inhibition, executive functioning, and visual-construction

Test	Description	Range of Scores
Global cognitive function		
Rowland Universal Dementia Assessment Scale (RUDAS) ¹⁰	Brief multicultural cognitive screening test containing six items that assess body orientation, praxis, drawing, judgment, memory, and language	0-30
Memory		
Recall of Pictures Test (RPT) ¹⁹	Learn and remember 10 colored pictures on three learning trials; the first trial consists of incidental recall of the pictures. Free recall and recognition of target pictures after a 10-min interference interval.	0-10
Enhanced Cued Recall (ECR) ²⁰	Sixteen colored pictures have to be recalled shortly after presentation, and a semantic cue is given for those pictures that are not freely recalled; the score is the total score of free and cued recall.	0-16
Recall of semi-complex figure ⁹	Copy of semi-complex figure and without forewarning recall it after a 3-min interference interval.	0-22
Language		
Picture naming ⁹	Naming of the 10 colored pictures in the first learning trial on the RPT.	0-10
Category verbal fluency ²¹	Consists of two components: Animals and supermarket items; 1 min for each.	Words produced
Executive functions		
Color Trails Test (CTT) ²²	Has two components: CTT 1 requires participants to connect numbered circles in ascending order; CTT 2 requires participants to switch between pink and yellow colors while connecting circles in an ascending sequence (ie. pink 1, yellow 2, pink 3, yellow 4, and so on).	Time in seconds
Five Digit Test (FDT) ²³	Has three components: FDT 1 requires participants to name a series of 50 digits; FDT 2 to count a series of 50 asterisks; FDT 3 to count a series of 50 digits in which the numeric value of the digits is incongruent with the number of digits.	Time in seconds
Serial threes ²⁴	Participants are required to count down from 20 by threes.	0-6
Visuospatial functions		
Copying of simple figures ²⁵	Copy of two simple figures; a Greek cross and a four-pointed star.	0-6
Copying of semi-complex figure ⁹	Copy of semi-complex figure; the figure used in recall of semi-complex figure.	0-22
Clock Drawing Test (CDT) ²⁶	Insert numbers and indicate the time 10 after 11 in a pre-drawn circle.	0-5
Clock Reading Test (CRT) ²⁷	Read the time on a series of 12 different clocks without numbers.	0-12

Table 4 : Tests in CNTB

3.3 Participants

The study sample consisted of three different populations. A more detailed description of the sample is given below in the article written concerning this study.

- *Moroccan Immigrant Sample in France* (Association TinHinan, Montpellier): Initially, 13 participants agreed to participate; however, 2 participants were excluded due to their low scoring on RUDAS, suggesting a more pathological cognitive profile. The 11 participants sample aged between 56 to 70 years old (mean = 64,6; sd = 5,9).
- *Mauritian sample in Mauritius* (Roche Bois, Welfare Center): 17 participants agreed to be evaluated after written informed consent. The sample aged between 55 to 83 years old (mean = 72,3, sd = 8,7).
- *French sample* (Association Le Clos de la Fontaine): Initially, 6 participants agreed to be evaluated after written informed consent. One participant could not continue due to medical reasons; therefore was excluded from the study. The sample was aged between 67 to 77 years old (m=71,6, sd = 6,35).

The PSSM intervention consisted of 8 one-hour sessions over 8 weeks. During each session, different types of memory are stimulated: olfactory, auditory, tactile, gestural, and also executive functioning. Overall, the pre-intervention assessments lasted one week for each group, and then we divided the groups into two parts (maximum 6 participants per group) as studies show that small group work is more effective and promote individual change (Horne & Rosenthal, 1997; Borek et al, 2018; Cole et al, 2021). Three trained animators led the 8 sessions for the three groups, respectively. After these 8 weeks, we carried out another evaluation (post-intervention) which also lasted 1 week.

4. RESULTS

This preliminary study aimed to examine, firstly to examine the acceptability of a sensorimotor stimulation program by comparing pre and post-intervention performance on the CNTB. As CNTB was never applied in our sample group, we investigated also whether its diagnostic properties would be maintained. In order to observe the acceptability of the PSSM, we measured scores obtained on the RUDAS scale which is part of the CNTB battery. Moreover, we measured the level of adherence to the program by comparing the rate of participation. On an exploratory basis, we conducted a qualitative analysis of the feedbacks of the animators to observe how participants felt and what representations they made of each session of the intervention.

4.1 Analysis of results according to CNTB for the 3 groups (Immigrants France, Mauritius, Control, France) :

The CNTB, as described above, is a battery of tests that assess different cognitive processes. In particular, tests of verbal fluency (Animals and Shopping List); tests of memory, inhibition, executive functioning, and visual construction. We conducted statistical analyses on the data set for each group. We found significant results on several cognitive processes found in each of the experimental groups as follows :

- For the elderly Moroccan immigrant group:

Concerning the memory tests: The participants perform better on the memory tests, especially on the REY Figure (total score on 22 items) in post-evaluation (M=12.1, SD = 6.53) than in pre-evaluation (M = 10.94, SD= 4.67). The Wilcoxon test, however, shows no significant differences between pre-and post-evaluation, $Z = ns$, $p = 1.0$. On the other hand, regarding the second memory

test, which is the Picture Recall Test (PRT, 10-item total score), the participants had a better score at post-evaluation (M = 9.7, SD= 0.67) than at pre-evaluation (M = 8.6, SD= 1.07). The Wilcoxon test, however, does not show that this difference is significant $Z=1.71$, $p=0.08$.

Concerning the executive functioning test, in particular the Five Digit Test (part 3 - interference): the results show a difference in scores with a better post-evaluation score (M = 94.9, SD= 45.7) than pre-evaluation (M = 82.75, SD= 24.54). However, the Wilcoxon test shows that this difference is not significant $Z = 0.42$, $p = 0.6$.

Concerning the Visiospatial test of Rey's Figure (total score on 22 points): The results show that the participants have a better post-evaluation score (M = 17.35, SD= 4.37) than pre-evaluation (M = 14.6, SD= 5.18). The Wilcoxon test indicates that this difference is significant $Z=2.36$, $p=0.02$.

- **For the Mauritius group:**

Concerning the memory test (RPT): the participants had a better score at post-evaluation (M = 9.46, SD= 0.77) than pre-evaluation ((M = 8.76, SD= 0.92). The Wilcoxon test, however, did not show that this difference was significant $Z=1.94$, $p=0.05$.

Concerning the executive functioning test, in particular the Five Digit Test (part 3 - interference): the results show a difference in scores with a better post-evaluation score (M = 68.5, SD= 35.3) than pre-evaluation (M = 64.8, SD= 20.7). However, the Wilcoxon test shows that this difference is not significant $Z = 0.3$, $p = 0.7$.

Concerning the VisuoSpatial Rey's Figure test (22-item total score): The results show that the participants have a better post-evaluation score (M = 20.8, SD= 1.02) than pre-evaluation (M = 19.11, SD= 5.2). The Wilcoxon test indicates that this difference is not significant $Z=0.1$, $p=0.9$.

- **For the Control group (France)**

Concerning the memory test (RPT): the participants had a better score on the post-evaluation (M = 10, SD= 0) than on the pre-evaluation ((M = 9.6, SD= 0.5).

Concerning the executive functioning test, in particular the Five Digit Test (part 3 - interference): the results show a difference in scores with a better post-evaluation score (M = 41.8, SD= 8.05) than pre-evaluation (M = 48.31 SD= 10.46). However, the Wilcoxon test shows that this difference is not significant $Z = 1.8, p = 0.06$.

4.2 Analysis of adherence to the intervention

In order to evaluate the acceptability of the intervention, we recorded the number of sessions attended by participants for the total duration of the intervention. We hypothesized that there would be a positive correlation between the number of sessions attended and RUDAS scores after the intervention. A Pearson Correlation was carried out to examine this relationship. Based on the results of the study for the group (Moroccan and Mauritian), as participants attended more sessions (M=7.5, sd = 1.02), they tended to have higher scores of RUDAS after the intervention (M=27.4, sd = 1.56), $r_s = 0.55, p < .05$. Regarding the results of the groups independently, for the Moroccan group, the Pearson Correlation was conducted between the number of sessions attended (M=6.9, sd = 1.3), and RUDAS scores after the intervention (M=27, sd = 1.544) was positive, $r_s = 0.74, p < .05$. Since all participants attended all sessions for the Mauritian group, we did not perform the Pearson Correlation. Same for the French group.

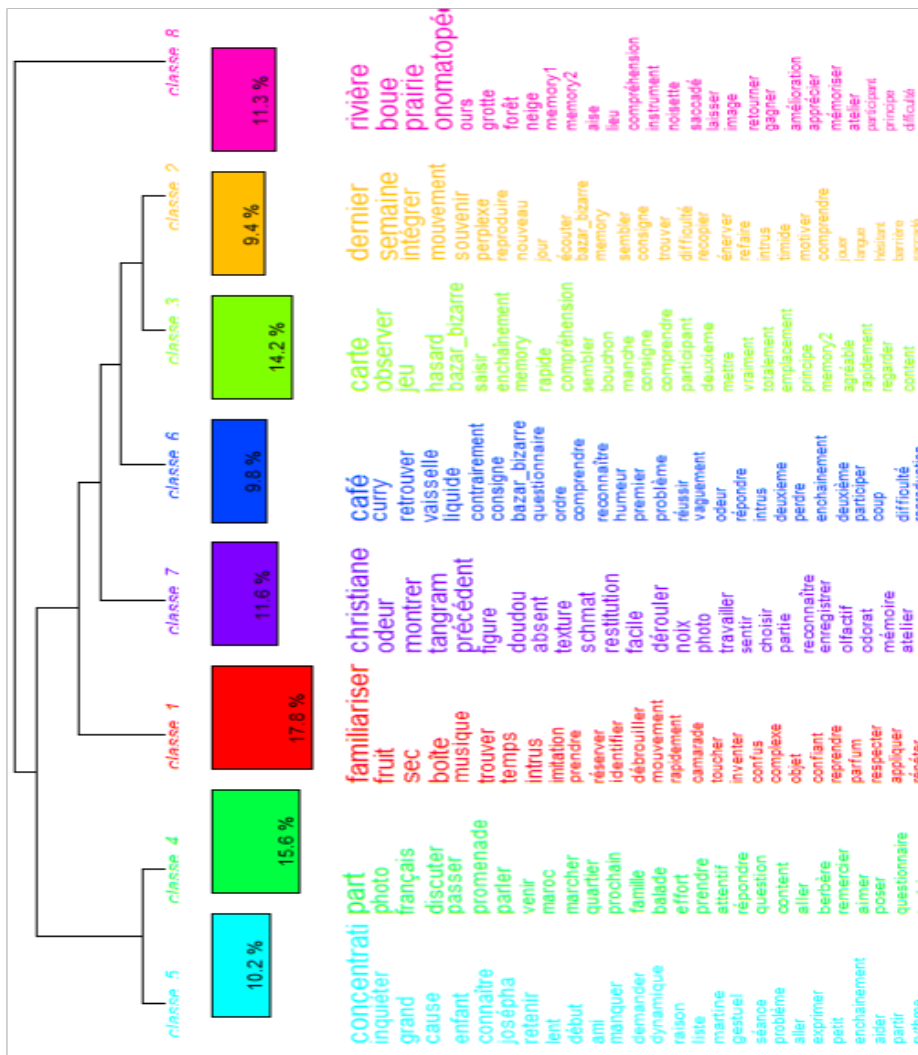
4.3 Analysis of feedbacks of animators for the three groups combined

A qualitative analysis is based on the idea that the verbal productions of individuals allow access to the representations they make of a particular situation or object. We carried out two further analyses using the Alceste software on Iramuteq: a CFA (factorial correspondence analysis) and an analysis of similarities between textual elements according to the feedback given by the animators during the workshops in the three experimental groups.

The analysis of the general corpus (*the CFA*) allowed us to highlight 8 different universes of reconstruction of the "PSSM workshop" object. The profile of each class is determined by a set of terms and variables used by participants during the PSSM intervention. In this case, the different sessions included in the intervention and the experimental groups (dendrogram 1). Class 1 represented 17.8% of the total discourse in session one and was marked mainly by "familiarization." Analysis of the first session indicated that participants needed to familiarize themselves with the animators and the presented exercises. Class 2 represented 9.4% of the total discourse of the session and is marked mainly by terms such as "integrate, movement, memories." Class 3 represented 14.2% of the total discourse in session 3 and is marked mainly by the terms "map, observe." Class 4 represented 15.6% of the total discourse in session 4 and is mainly marked by the terms "photo, discuss." Class 5 represented 10.2% of the total discourse in session 4 and is marked mainly by the term "concentration." Class 6 represented 9.8% of the total discourse in session 4 and is mainly marked by the term "coffee, curry, find." Class 7 represented 11.6% of the total discourse, especially in session 3, and is mainly marked by the terms "smell, show." Class 8 represented 11.3% of the total discourse in session 8 and is mainly marked by the term "map, observe."

Secondly, we carried out a *similarity analysis* based on the principle that a social representation can be considered a set of elements linked together (Flament et al., 2003). The links obtained between the words suggest socio-cognitive proximity between the elements. Figure 2 represents the links obtained after analyzing the IRAMUTEQ software for all the groups and according to the different PSSM sessions. For example, "intruder" was linked to terms like "find, quickly, repeat." These words were evoked and linked well to the sessions that correspond to these exercises independently of the groups. Another example is the word "find" linked to "memory, object, music," which are sessions where participants had to find objects and work on memory.

Altogether, and given the results of the textual analyses collected by the animators, we can say that the sessions and exercises proposed during the workshop activated links that we expected, independently of the experimental group, and therefore of the socio-cultural context of the participants. The particularity of the sample, as mentioned earlier, was that they were all from different cultural groups. Therefore, their language proficiency was different. Our aim in proposing a sensorimotor intervention program was to decrease as much as possible the weight of language so that all the groups could be considered equivalent. These qualitative analyses mainly were obtained from the animators' feedbacks and observations during the sessions. Even though language proficiency was at different levels in all groups, these findings suggest that the representations made by participants indeed matched each of the sessions proposed.



Dendrogram 1: Graph representing the different word classes after analysis of the qualitative feedback of the PSSM workshop sessions, all groups combined.

STUDY 3

(in the process of submission in the Cognitive therapy and Research)

Cross-Cultural Sensorimotor Stimulation Program : A preliminary study in Moroccan Immigrants, Mauritian and French Older Adults

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ABSTRACT

Cross-cultural adaptation of assessment scales has gained significant interest in the past decades; however, cognitive interventions are still behind. The current study explores a cross-cultural sensorimotor stimulation program (PSSM) to address cognitive issues relative to aging. Our main goal is to evaluate the acceptability of such an intervention in three culturally diverse populations (Moroccan immigrants, Mauritians, and French). An 8-week intervention was designed were 29 healthy elderly participants. Cognitive assessments were carried out using a multicultural cognitive scale (RUDAS) and correlated to the participation rate, indicating adherence to the program. Our results show that RUDAS scores are higher as the number of participants increases. These preliminary results support the view that cognitive, sensorimotor stimulation program is acceptable in a culturally diverse population and can be a valuable alternative and comprehensive approach to cognitive interventions for the elderly facing effects of aging.

Keywords : Cross-cultural, sensorimotor, cognitive intervention, aging

RESUME

L'adaptation interculturelle des échelles d'évaluation a suscité beaucoup d'intérêt au cours des dernières décennies; cependant, nous ne pouvons pas en dire la même pour les interventions cognitives. L'étude présente explore un programme de stimulation sensorimotrice (PSSM) pour aborder les problèmes cognitifs liés au vieillissement en situation interculturelle. Notre objectif est avant tout d'évaluer l'acceptabilité d'une telle intervention dans trois populations culturellement diverses (immigrants marocains, Mauriciens et Français). Une intervention de 8 semaines a été conçue auprès de 29 participantes âgées. Des évaluations cognitives ont été réalisées à l'aide d'une échelle cognitive multiculturelle (RUDAS) et corrélées au taux de participation, qui indiquerait l'adhésion au programme. Nos résultats montrent que les scores RUDAS sont plus élevés lorsque le nombre de participations augmente. Ces résultats préliminaires soutiennent l'idée que le programme de stimulation sensorimotrice cognitive est acceptable dans une population culturellement diverse et qu'il peut constituer une alternative valable et une approche globale des interventions cognitives pour les personnes âgées confrontées aux effets du vieillissement

Mots-clés : interculturel, sensorimoteur, intervention cognitive, vieillissement

INTRODUCTION

Cross-cultural psychology studies variations in human behavior that occur in a cultural environment (Sam & Berry, 2015). According to Martineau et al. (2019), culture is considered a core variable shaping cognitive processes and neural organizations. The role of culture cannot be overlooked while assessing cognitive deficits concomitant to aging. Researchers have made a significant effort in developing appropriate assessment scales within a culturally diverse approach (Nielsen et al., 2018; Mazzocco et al., 2015; Jacobs et al., 1997). While these cross-cultural assessments are becoming popular, we believe it is equally essential to have adaptive cross-cultural cognitive remediation programs. To our knowledge, this issue is yet to be addressed in cross-cultural literature. As a matter of fact, our objective in this preliminary study is to explore the acceptability of a culturally independent cognitive intervention based on sensorimotor stimulation for the aging minority populations..

By definition, "Culture is a broad and overarching concept that refers to a body of customary beliefs and social norms that a particular group of people shares" (Wong et al., 2000, p.4). Culture shapes an individual's experiences, thoughts, and behaviors in a given environment and gives meaning to situations, events, or objects encountered (Sapir, 1921; Whorf, 1956; Ardila, 1996, Casasanto 2008 Boroditsky 2011). For example, in French, "une couverture" is translated as "a blanket" in English. However, the same word translated into the Mauritian language would be referred to as "a lid." Hence, depending on the cultural context, the significance of a word changes. As stated by different authors such as Tomasello (2008), Kirby et al. (2009), or Rhode et al. (2016), language is contextually dependent and reflects one's linguistic and cultural immersion and/or appropriation. Recently, Rhode et al. (2016) showed an influence of language on a visual attention task between East Asians and Westerners. They explain these results as a holistic

attentional bias in Asian Culture, as Asians pay more attention to the global nature of a context and Westerners are more analytical.

These cultural disparities are important factors to be considered while assessing for cognitive behaviors in a cross-cultural setting, especially when it concerns age-related deficits. Indeed, there is a plethora of studies and theories on aging asserting for changes in different cognitive spheres: memory, language, speed of information processing, visuospatial functioning, while others explain the theories and dynamics of aging (Versace et al., 2018; Park et al., 2000, Vallet, 2015; Li et al., 2015; Maury & Martin, 2010; Salthouse, 1996; Clare et al., 2001; Martin et al., 2011, Franck, 2012). Nevertheless, literature on cross-cultural trajectories of the effects of aging is still scarce, despite the notion of culture, aging, and cognition being interrelated (Park et al., 2000). According to Park et al. (2002), a sustained impact of the environment, precisely culture, may result in effortful cognitive processing regarding automatic processes.

However, in aging, cognitive resources are limited, and older adults act according to the significance of their goals and motivations in completing a task (Maury & Martin, 2010). In a psychosocial approach known as the Selection-Optimization-Compensation (SOC) by Margaret Baltes and Paul Baltes (1990), the authors highlight these main components contributing to successful aging. As one age, resources allocated to tasks are prioritized and depend highly on individual objectives (Selection); the application of these objectives in best conditions (Optimization), and finally, adoption of an alternative means when the initial means are unavailable (Compensation) (Baltes et Baltes, 1990; Maury & Martin, 2010; Martineau, 2019). Therefore, aging can be considered is a dynamic process occurring in a specific context relative to oneself. For the elderly migrant population they are ensnared in a contextual situation of disability, where their current environment is failing to provide them with adequate health care.

Furthermore, the Disability Creation Process (DCP, Fouygerollas, Noreau, et al., 1998) is a social model of disability that supports this statement. The DCP is an explanatory model taking into account an individual's interaction with his environment and the causes and consequences leading to trauma, disease, or any other damage to human integrity (Levasseur et al., 2007). Another model found in the literature to understand disability is the Embodied Model, which "reformulates disability as grounded in an ontology that rejects the separation between body and mind and views the mind as fundamentally rooted in both body and environment" (Shakespeare and Watson, 2002; Edwards et al., 2014; Fougeyrollas, 2019, p26). Indeed, these models are considered culturally sensitive (Fougeyrollas, 2019) and indicate that there should be a shift in the way support services are conceived for a culturally diverse population in a disability situation. According to Fougeyrollas (2019), there should be an assessment of social participation, operationalized through the concepts of life habits, daily activities, and social roles valued by a person.

In the past decades, there has been a tremendous effort towards a cross-cultural approach for assessments with the translation of various assessment scales and psychometric properties (Ardila,1996). In a systematic review carried by Uysal-Bozkir et al. (2013), the authors concluded that cognitive functioning scales were the most adapted cross-culturally (Uysal-Bozkir et al.,2013). The Mini-Mental State Examination (Folstein, 1975) is a cognitive screening test for older adults. The MMSE is translated in almost over 18 different languages, and the best adapted and validated version was carried by Tiwari et al. (2009) for a Hindi-speaking population. Translated assessment scales do not solve the issue of language barriers, let alone that of illiteracy pointed out in first-migrant generations (Uysal-Bozkir et al.,2013; Martineau et al., 2019).

One possible solution to overcome this issue is to have nonverbal assessment scales. Some authors have looked into this approach, amongst Storey et al. (2004), who developed a multicultural cognitive test known as the Rowland Universal Dementia Assessment Scale (RUDAS). The RUDAS is a screening test comparable to the MMSE and used to address cognitive issues in the aging minority population. The test can be easily administered in 10mins and contains items relative to different cognitive domains: Orientation, Memory, Attention and perseveration, Visuospatial construction, Praxis, planning, language, and judgment. The maximum score on this scale is 30 and a cut-off at 23 points. Compared to MMSE, the RUDAS is considered a scale that excludes items that could be culturally biased (Escobar et al., 1986; Storey et al., 2004). In a systematic review and meta-analysis carried out by Naqvi et al. (2015) on at least 11 studies on RUDAS compared to MMSE. The authors concluded that RUDAS was not only as accurate as of the MMSE in screening for dementia in older populations, but it was also less affected by language and educational level. Identical results were obtained in a recent validation study of the RUDAS in the Brazilian language by de Araujo et al. (2018).

Older adults have functional neural plasticity suggesting there can still be some potential gains in performances under optimal conditions (Winocur et al., 2007; Dinse et al., 2005, 2006; Clare et al., 2003; Kattenstroth, 2013). Built on these findings, many cognitive remediation-training programs have been introduced to help maintain or enhance cognitive functioning in the elderly (Wilson 20002). These therapies are practiced individually or in groups; most operate based on weekly or bi-weekly group sessions, under various forms (computerized or pencil-paper versions). Their level of difficulty can be graded following individual abilities (Clare 2003). Franck (2012) has classified 4 different types of interventions: a) Cognitive remediation that involves cognitive training with strategies to reorganize, facilitate cognitive processes and

techniques to limit production of errors; b) Palliative strategies, environmental and behavioral approaches; c) Cognitive-behavioral therapies (reminiscence and validation therapies, music therapy); d) Psychosocial therapies with sensory and motor stimulations; and Psycho-educational programs for family, caregivers.

The effectiveness of cognitive stimulation programs has been evaluated on the MMSE test. For example, a significant increase in the MMSE scores was observed after interventions in Orell et al. (2005) study. Alongside, in the 1980s in France, different programs to help the elderly with cognitive impairments were designed. They were called PAC as for Cognitive Activity Programs and concerned seniors with normal aging (PAC-SENIOR) and dementia patients (PAC-FNG) (Breuil et al., 1994, de Rotrou 2001). Study results on both PACs confirm that when memory difficulties were marked, mainly in the dementia group, improvement was possible using an association strategy (de Rotrou, 2001). However, Dorenlot (2006) highlighted several methodological problems relative to this type of intervention. It was criticized for lack of consideration of the individual needs, the heterogeneity of cognitive deficits, and a lack of ecology in the proposed activities. Moreover, de Rotrou (2001) herself stated that the PAC-SENIOR mainly was used a “majority of retired people who participate in these types of activities are socially well-adjusted, physically and mentally fit, with minor memory complaints, and a relatively good quality of life” (p. 188)

The question that we raise in this paper concerns the issues regarding assessment and care for elderly from culturally diverse backgrounds. We have described earlier that the elderly migrant population is vulnerable due to their low language proficiency in their host country, their knowledge of the health care system, their social status and culture adding up to the age-related deficits. These variabilities challenge professionals in practice to provide an adequate support

system to this specific population. Nevertheless, instead of focusing on these differences, we think that an approach towards common underlying processes of all individuals can be more effective. According to Lonner (2011), there are common psychological features present in all human beings. He further elaborates that psychological processes are shared and shaped by an individual's interactions with his environment, including culture.

In response to these limitations and considering the psychological universals, we believe that an approach through embodiment, precisely, sensorimotor stimulation programs, can be an appropriate alternative for culturally diverse populations. Firstly, embodiment considers an individual's sensorimotor interactions with his environment (Lindenberger et Baltes, 1994; Vallet, 2015; Versace, Brouillet et Vallet, 2018). As described by the DCP model, the environment plays an important role in assessing how well an individual does in his everyday life. Secondly, according to Vallet (2015), from an embodied perspective, aging is associated with changes in all spheres such that all sensory organs, physical condition, and cognition are affected. A sensorimotor stimulation program considers the sensory-motor declines by stimulating the decreased sensory inputs (Vallet, 2015). To our knowledge, we have not found any studies dealing with the question of a sensorimotor intervention in a cross-cultural context. Hence, in this present study, we have conducted two preliminary experiments based on the concepts of cultural and linguistic immersion and sensorimotor stimulations.

Indeed, we explored the acceptability of a cross-cultural sensorimotor approach in a culturally diverse setting, i.e., with a difference in cultural and linguistic immersion/appropriation. In our study, we could access three populations: Moroccan elderly immigrants in France, Mauritian population, and French population who had little to no years of schooling. The particularity of these populations is that the Moroccan immigrants are culturally immersed in France, but they do

not speak the language (French). The Mauritian elderly population has a French linguistic immersion; as the language is spoken, there is a French-based creole but with a different culture. Finally, the French population naturally spoke French but without a high academic background. Therefore, we were interested in exploring the extent to which a sensorimotor stimulation program could be applied cross-culturally. In order to work on this problem, we designed a sensorimotor stimulation program (PSSM). We performed a broad cognitive assessment using the RUDAS. The latter scale has tested cultures such as Turkish, Brazilian, Portuguese, Danish populations for a non-exhaustive list (Nielsen et al., 2012, 2018). However, data on Moroccan immigrants in France as well as the Mauritian population is not yet available. Therefore, one of our objectives was to apply this scale and collect data on its validity in these two populations. Secondly, these scores were used to compare participants' performances after the PSSM intervention based on their frequency of participation. By doing this, we wanted to observe their degree of adherence to the program. Therefore, we hypothesized that a higher rate of participation would be correlated to higher scores on RUDAS, irrespective of the two groups.

MATERIAL AND METHODS

2.1 Participants

The study sample consisted of three different populations: *Moroccan Immigrant Sample in France* 13 participants initially. Two participants were excluded due to low scorings at RUDAS (cutoff ≤ 23), inconsistency in participation during the workshops. The final sample number for the Moroccan immigrants was 11. Moroccan participants were members of a migrant association (Tin Hinan) based in Montpellier, France. The association acts as a prevention health center for equality for migrant women by offering administrative help, learning classes, and different

workshops. The Moroccan immigrant sample age ranged from 56 to 70 years old (mean = 64,6; sd = 5,9). All of the participants included in this study were females who did not attend school due to their immigration background and socio-economic reasons. They could write their names in Arabic and French but were unable to recognize other French alphabet letters. Some knew the numbers and how to write them. Others could count up to 10 but were unable to recognize written numbers. None of the subjects reported neurological or psychiatric impairment.

Concerning the *Mauritian sample in Mauritius*, initially, 17 participants agreed to be evaluated after written informed consent was given. 4 participants did not show up for the evaluations post-intervention; therefore, they were excluded from the study. All participants were female and attended classes organized in their local social welfare center in Roche Bois, Mauritius. Sample age ranged from 55 to 83 years old (mean = 72,3, sd = 8,7). Most of the participants did not attend school or had a very low level of schooling. They spoke a French-based creole, which is the native language in Mauritius. They knew numbers, the alphabet, how to write and recognize them. None of the participants reported any neurological or psychiatric impairment. Table 1 shows the Demographics of the sample.

Concerning *The French sample*, initially, 6 participants agreed to be evaluated after written informed consent was given. 1 participant could not continue due to medical reasons; therefore, they were excluded from the study. All of the participants were female and were members of the Clos de la Fontaine, an association for aging people in Montpellier, France. Sample age ranged from 67 to 77 years old (m=71,6, sd = 6,35). Most of the participants did not attend school or had a very low level of schooling. They spoke French, being their native language. They knew numbers, the alphabet, how to write and recognize them. None of the participants reported any

neurological or psychiatric impairment. *Table 1* shows the Demographics of the sample. The ethics committee approved the study of the University of Montpellier.

2.2 Procedure

In this study, we assessed the acceptability of a cross-cultural sensorimotor stimulation program. The research design was an A-B type experimental design. All participants underwent a demographic interview and a 10 minutes assessment of the RUDAS prior to and post the sensorimotor stimulation program intervention. The RUDAS (Storey et al., 2004) has an excellent reliability both inter-rater (ICC = 0.99) and test-retest (ICC = 0.98) reliabilities. It includes multiple cognitive domains on a score of 30 points maximum, in particular, memory (4-item grocery recall), praxis (fist-palm alternation task), language (animal generation), judgment (crossing the road questions), cube copying, and body orientation tests in diverse response formats (verbal, non-verbal, written and praxis). According to the authors, RUDAS can be directly translated to over 30 languages without de-structuring or de-formatting any of the items. Two trained examiners assessed the Moroccan immigrant participants, and there was one examiner for the Mauritian population. In each setting, we have guaranteed the presence of a natural speaker to facilitate comprehension of the question whenever needed.

Participants were assessed at two intervals (T1 before intervention; T2 after intervention) (see table 1 for RUDAS results at T1/T2). After assessments were performed, we used a group-oriented approach, and participants were assigned in two smaller groups of not more than 8 participants for the PSSM intervention. The PSSM was designed in collaboration with administration members of the migrant association (TinHinan) and experimented with psychologists.

The PSSM is an eight-week workshop of approximately 1hour session per week and performed by a trained animator. The program included sensorimotor stimulations of different aspects of memory, i.e., haptic, gesture, auditory, visuospatial, sensory, verbal, and mental flexibility workshops. The exercises included in each had a different difficulty level that would increase as the sessions went along. For example, in the first session, for gestural memory, participants were shown two movements that they would reproduce on the moment. Every other week we would increase the movements, and they were always asked to recall the ones they were shown previously (see anex1 for further details on the PSSM).

2.3 Data analysis

There were two assessment sessions of RUDAS each lasting 10-15mins. The variables used for assessing the effectiveness of the PSSM were RUDAS scores before and after the interventions. All statistical analyses were performed using Statistica 8.0 and all statistical significance levels were set at 0.5.

RESULTS

The purpose of this preliminary study, firstly, was to investigate whether the RUDAS was applicable in a Moroccan and Mauritian population given that the scale is considered as a multicultural cognitive assessment scale. Secondly, it was to explore the acceptability of sensorimotor stimulation program (PSSM) in a cross-cultural context.

		Age	NSC	<i>Rudas</i>	
				before	After
<i>Marocains (n=13)</i>	<i>Moyenne</i>	64,6	5,8	26,2	26,5
	<i>Ecart type</i>	6	0	2,89	1,9
<i>Mauritian (n=13)</i>	<i>Moyenne</i>	72,7	5,46	27,4	27,8
	<i>Ecart type</i>	5,4	0,8	1,5	1,5
<i>France (control), N=5</i>	<i>Moyenne</i>	71,6	5,5	26,5	29
	<i>Ecart type</i>	6,35	0,7	2,12	1,41

Table 1 : Demographic characteristics and Rudas scores pre and post intervention of the Moroccan, Mauritian and French samples

Analysis concerning RUDAS applicability: The cut-off of RUDAS scale was determined at a score of 23 out of 30 (maximum scoring). We analyzed the performances on RUDAS scores for the whole sample; the mean scores pre-intervention was 27 (sd= 2.25) and post-intervention was 27.3 (sd=1.78). We carried out a student T-test on independent variables to test the cross-cultural applicability of the RUDAS in our three samples. Our results showed no statistical significance on the performance scores at pre and post-intervention for the whole sample, $t(46) = -0.43$, $p = ns$. We compared the means of each sample to the normative means of RUDAS ($M=26$, $sd= 3.6$). The results showed that the Moroccan sample do not differ significantly from the norm $t(12) = 0.25$, $p=0.81$. Concerning the Mauritian sample, the result also showed that there is no statistically significant difference from the norm $t(12) = 1.75$, $p = 0.11$. Concerning the French sample, the mean scores pre-intervention was 26.5 (sd= 2.12) and post-intervention was 29 (sd=1.41). Despite having culturally different populations, our results that RUDAS was suitable and applicable in all the cultures reaffirming its multicultural character

Analysis of adherence to the intervention: In order to evaluate the acceptability and the efficiency of the intervention, we recorded the number of sessions attended by participants for the total duration of the intervention. We hypothesized that there will be a positive correlation between number of sessions attended and RUDAS scores after the intervention. A Pearson Correlation was carried out to examine this relationship. Based on the results of the study for the group (Moroccan and Mauritian), as participants attended more sessions ($M=7.5$, $sd = 1.02$), they tended to have higher scores of RUDAS after the intervention ($M=27.4$, $sd = 1.56$), $r_s = 0.55$, $p < .05$. Regarding results of the groups independently, for the Moroccan group, the Pearson Correlation conducted between the number of sessions attended ($M=6.9$, $sd = 1.3$) and RUDAS scores after the intervention ($M=27$, $sd = 1.544$) was positive, $r_s = 0.74$, $p < .05$. For the Mauritian group, since

all participants attended all sessions, we did not perform the Pearson Correlation. Same for the French group.

DISCUSSION

The main aim of this preliminary study was to explore the acceptability of a sensorimotor program in a cross-cultural setting. Similar to multicultural assessment scales such as the RUDAS, we questioned whether there could also be a multicultural cognitive intervention for cognitive deficits that are concomitant to aging. We proposed a sensorimotor stimulation program (PSSM) that could be easily administered in culturally diverse populations to address this issue. Schafer et al. (2006) suggested that sensorimotor interventions are efficient as they are less attention consuming and counteract the cognitive-load hypothesis (Baltes & Lindenberger, 1997), which is typically known to reduce performance in older adults.

According to Sekhon et al. (2017), following a health care intervention, acceptability reflects the cognitive and emotional responses of people benefiting from it. Our results concerning their adherence to the program, thus acceptability of the intervention was statistically significant. This means that, in general, participants had positive cognitive responses (i.e., better scores on RUDAS) when they attended more sessions. Moreover, qualitative feedback from animators and participants showed that they were all willing to attend the workshops and were generally in a positive emotional state afterward. The animators also reported that the PSSM intervention was comprehensible in both groups; however, for the Moroccan group, more than half of the participants had difficulties understanding the instructions, and these instructions had to be given several times. While this could have led to a higher cognitive load on participants, our results show that the intervention was beneficial.

Usually, while evaluating a new intervention, cognitive assessments are carried out pre and post-intervention to account for changes in cognitive behaviors. In the present study, we used a multicultural cognitive scale (RUDAS). Although RUDAS was applied in different cultures, data concerning Moroccan immigrants in France and the Mauritian population in Mauritius were not available. Our study shows that RUDAS is adapted even in the three populations, although the cultural immersion is different. RUDAS is a dementia screening test, and while we were assessing participants, we had two participants whose scores were below the cut-off (<23) and were hence excluded from the study. Our results suggest that the application of RUDAS was successful, therefore revalidating its cognitive screening qualities in elderly adults from different cultural backgrounds.

Finally, we intended to propose a cross-cultural cognitive intervention that could palliate for age-related deficiencies. As reported in the literature, aging is a change characterized by a decline in cognitive and sensorimotor functions (Vallet, 2015; Hoffstaedter et al., 2015; Brouillet & Syssau, 2005; Kalisch, 2008). As a result, sensorimotor stimulations in the elderly can attenuate these declines, as Kattenstroth et al. (2010, 2013) reported. Many cross-sectional studies have mainly focused on aerobic fitness (physical activity) as a sensorimotor intervention for improving cognitive functions (Schafer, 2006). For example, Kattenstroth et al. (2013) showed that 1 hour per week dance classes improved postural, cognitive, reaction times, tactile and sensorimotor performances in healthy elderly individuals. In our PSSM interventions, we also included physical exercises at the beginning of the sessions and several ludic sensorimotor simulation exercises.

We believe that this first exploratory study and the preliminary results open up future avenues for interventions based on sensorimotor stimulation. Care was taken throughout the experimental protocol to standardize approaches in all groups. Nevertheless, certain limitations of

this study should be acknowledged. Firstly, the experiment should be carried out in larger group of participants, especially as far as it concerns our control (French group), we had only 5 participants. Another limit, concerns long-term effects that could not be measured. Since our intervention workshop was designed as closest to an everyday life setup, the follow-up might have given additional data on a potential transfer of knowledge and skills in everyday life. It could also be interesting to correlate language proficiency with cognitive scores or include a control group as further investigations..

CONCLUSION

To our knowledge, this study is the first one to explore the acceptability and efficiency of a sensorimotor stimulation program cross-culturally. Our results suggest that the intervention was feasible and acceptable in all three groups despite cultural and linguistic differences. We can conclude that a sensorimotor stimulation program is acceptable as an alternative approach in a culturally diverse population. Moreover, it can be an alternative approach to cognitive interventions for the minority elderly population facing age-related changes. More research should focus on designing universal cognitive intervention programs to reach a broader population and palliate for cultural barriers that still prevail around the world in health care programs.

REFERENCES

- Ardila, A. (1996). Towards a cross-cultural neuropsychology. *Journal of Social and Evolutionary Systems*, 19(3), 237–248.
- Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. In P. B. Baltes & M. M. Baltes (Eds.), *Successful aging: Perspectives from the behavioral sciences* (pp. 1-34). New York, NY: Cambridge University Press.
- Boroditsky, L. (2011). How language shapes thought. *Scientific American*, 304(2), 62-65.

- Breuil V, De Rotrou J, Forette F, et al. 1994. Cognitive stimulation of patients with dementia: preliminary results. *Int J Geriatr Psychiatry* 9: 211–217
- Brouillet, D. & Syssau, A. (2005). *La maladie d'Alzheimer : mémoire et vieillissement*. Paris cedex 14, France: Presses Universitaires de France.
- Casasanto, D. (2008). Who's afraid of the big bad Whorf? Crosslinguistic differences in temporal language and thought. *Lang. Learn.* 58, 63–79. doi: 10.1111/j.1467-9922.2008.00462.x
- Clare L, Woods B. Editorial: a role for cognitive rehabilitation in dementia care. *Neuropsychol Rehabil* 2001; 11: 193-6.
- Clare, L., Wilson, B. A., Carter, G., & Hodges, J. R. (2003). Cognitive rehabilitation as a component of early intervention in Alzheimer's disease: a single case study. *Aging & Mental Health*, 7(1), 15-21. <http://doi.org/10.1080/1360786021000045854>
- Mazzocco, C., Brouillet, D., & Martin, S. (2015). Validation française de la version brève du French Memory Compensation Questionnaire chez une population âgée. *Revue de neuropsychologie*, 7(2), 135-152. doi:10.1684/nrp.2015.0340
- Craik F. I. M. et Salthouse T. A, (1992), *The Handbook of Aging and Cognition*, Hillsdale, Erlbaum.
- De Araujo, N. B., Nielsen, T. R., Engedal, K., Barca, M. L., Coutinho, E. S., & Laks, J. (2018). Diagnosing dementia in lower educated older persons: validation of a Brazilian Portuguese version of the Rowland Universal Dementia Assessment Scale (RUDAS). *Revista brasileira de psiquiatria (Sao Paulo, Brazil : 1999)*, 40(3), 264–269. <https://doi.org/10.1590/1516-4446-2017-2284>
- De Rotrou, J. (2001). Stimulation et Education cognitive. Le vieillissement cérébral. *Gérontologie et Société*, 97, 175-192.
- de Vet HC, Terwee CB, Knol DL, Bouter LM (2006). When to use agreement versus reliability measures. *J Clin Epidemiol*;59:1033e9.
- Dinse, H. R., Kalisch, T., Ragert, P., Pleger, B., Schwenkreis, P., and Tegenthoff, M. (2005). Improving human haptic performance in normal and impaired human populations through unattended activation-based learning. *ACM Trans. Appl. Percept.* 2, 71–88.
- Dinse, H. R., Kleibel, N., Kalisch, T., Ragert, P., Wilimzig, C., and Tegenthoff, M. (2006). Tactile coactivation resets age-related decline of human tactile discrimination. *Ann. Neurol.* 60, 88–94
- Dorenlot, P. (2006). Démence et interventions non médicamenteuses : revue critique, bilan et perspectives. Non pharmacological interventions in dementia : a review and prospect. *Psychologie et NeuroPsychiatrie du Vieillissement*, 4, 135-144.

- Edwards, Geoffrey, et al. 2014. Disability, rehabilitation research and post-Cartesian embodied ontologies has the research paradigm changed? In: *Environmental Contexts and Disability*, 73–102. Emerald Group Publishing Limited. <https://doi.org/10.1108/S1479354720140000008005>
- Escobar, J. I., Burnam, A., Karno, M., Forsythe, A., Landsverk, J., et al. (1986). Use of the Mini-Mental State Examination (MMSE) in a community population of mixed ethnicity. *Cultural and linguistic artefacts. Journal of Nervous and Mental Disease*, 174, 607– 614.
- Folstein, M., Folstein, S., and McHugh, P. (1975). Mini-mental state: A practical method for grading the mental state of patients for the clinician. *Journal of Psychiatry Research*, 12, 189–198.
- Fougeyrollas, P., Boucher, N., Edwards, G., Grenier, Y., & Noreau, L. (2019). The Disability Creation Process Model: A Comprehensive Explanation of Disabling Situations as a Guide to Developing Policy and Service Programs. *Scandinavian Journal of Disability Research*, 21(1), 25–37. <http://doi.org/10.16993/sjdr.62>
- Fougeyrollas, P., Noreau, L., Bergeron, H., Cloutier, R., Dion, S. A., & St-Michel, G. (1998). Social consequences of long term impairments and disabilities: Conceptual approach and assessment of handicap. *International Journal of Rehabilitation Research*, 21, 127-141.
- Franck, N. *Remédiation cognitive*. Issy-les-Moulineaux : Elsevier Masson ; 2012.
- H.J. Li, X.H. Hou, H.H. Liu, C.L. Yue, G.M. Lu, X.N. Zuo. Putting age-related task activation into large-scale brain networks: a meta-analysis of 114 fMRI studies on healthy aging. *Neurosci. Biobehav. Rev.*, 57 (2015), pp. 156-174
- Hoffstaedter F, Grefkes C, Roski C, Caspers S, Zilles K, Eickhoff SB. Age-related decrease of functional connectivity additional to gray matter atrophy in a network for movement initiation. *Brain Struct Funct*. 2015;220(2):999-1012. doi:10.1007/s00429-013-0696-2
- Jacobs, D. M., Sano, M., Albert, S., Schofield, P., Dooneief, G., & Stern, Y. (1997). Cross-cultural neuropsychological assessment: a comparison of randomly selected, demographically matched cohorts of English- and Spanish-speaking older adults. *Journal of Clinical and Experimental Neuropsychology*, 19(3), 331–339. <http://doi.org/10.1080/01688639708403862>
- Kalisch, T., Tegenthoff, M., & Dinse, H. R. (2008). Improvement of sensorimotor functions in old age by passive sensory stimulation. *Clinical Interventions in Aging*, 3(4), 673–690. <http://doi.org/10.2147/cia.s3174>
- Kattenstroth, J. C., Kalisch, T., Holt, S., Tegenthoff, M., & Dinse, H. R. (2013). Six months of dance intervention enhances postural, sensorimotor, and cognitive performance in elderly without affecting cardio-respiratory functions. *Frontiers in aging neuroscience*, 5, 5

- Kirby, S., Christiansen, M. H., and Chater, N. (2009). "Syntax as an adaptation to the learner," in *Biological Foundations and the Evolution of Syntax*, eds D. Bickerton and E. Szathmáry (Cambridge, MA: MIT Press), 325–343.
- Levasseur, M., Desrosiers, J., & St-Cyr, T. D. (2007). Comparing the Disability Creation Process and International Classification of Functioning, Disability and Health models. *Canadian Journal of Occupational Therapy. Revue Canadienne D'ergotherapie*, 74 Spec No.(5_suppl), 233–242. <http://doi.org/10.1177/000841740707405S02>
- Lindenberger, U., and Baltes, P. B. (1994). Sensory functioning and intelligence in old age: a strong connection. *Psychol. Aging* 9, 339–355. doi: 10.1037/0882-7974.9.3.339
- Lonner, W (2011). The continuing challenge of discovering psychological 'order' across cultures. In F. Van de Vijer, A. Chasiostis, & S. Breugelmans (Eds.), *Fundamental Questions in Cross-Cultural Psychology* (pp. 64-94). Cambridge: Cambridge University Press. doi:10.1017/CB09780511974090.004
- Martineau, A., & Plard, M. (2019). Are elderly immigrants meeting the challenges of successful aging? Review of literature on the aging of elderly migrants in France. *Cybergeo*, 1–27. <http://doi.org/10.4000/cybergeo.33224>
- Maury, P., & Martin, S. (2010). Comment les personnes âgées parviennent-elles à maintenir des capacités de compréhension préservées? Mise en œuvre du support environnemental dans la compréhension de texte. In: D., Brouillet (Ed.). *Le vieillissement cognitif normal : Maintenir l'autonomie de la personne âgée*. De Boeck Université. (parution novembre 2010).
- Naqvi, R. M., Haider, S., Tomlinson, G., & Alibhai, S. (2015). Cognitive assessments in multicultural populations using the Rowland Universal Dementia Assessment Scale: a systematic review and meta-analysis. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne*, 187(5), E169–E175. <https://doi.org/10.1503/cmaj.140802>
- Nielsen, T. R., Segers, K., Vanderaspoilden, V., Beinhoff, U., Minthon, L., Pissioti, A., et al. (2018). Validation of a European Cross-Cultural Neuropsychological Test Battery (CNTB) for evaluation of dementia. *International Journal of Geriatric Psychiatry*, 34(1), 144–152. <http://doi.org/10.1002/gps.5002>
- NIELSEN, T. R., VOGEL, A., GADE, A., & WALDEMAR, G. (2012). Cognitive testing in non-demented Turkish immigrants - comparison of the RUDAS and the MMSE. *Scandinavian Journal of Psychology*, 53(6), 455–460. <http://doi.org/10.1111/sjop.12018>
- Orrell, M., Spector, A., Thorgrimsen, L., & Woods, B. (2005). A pilot study examining the effectiveness of maintenance Cognitive Stimulation Therapy (MCST) for people with dementia. *International Journal of Geriatric Psychiatry*, 20(5), 446–451. <http://doi.org/10.1002/gps.1304>

- Park, D. C., Lautenschlager, G., Hedden, T., Davidson, N. S., Smith, A. D., & Smith, P. K. (2002). Models of visuospatial and verbal memory across the adult life span. *Psychology and aging, 17*(2), 299.
- Park DC, Gutchess AH. Cognitive aging and everyday life. In: Park DC, Schwarz N, editors. *Cognitive aging: a primer*. Philadelphia: Psychology Press; 2000. p. 217 – 32.
- Rhode, A. K., Voyer, B. G., & Gleibs, I. H. (2016). Does Language Matter? Exploring Chinese-Korean Differences in Holistic Perception. *Frontiers in Psychology, 7*, 1508. <http://doi.org/10.3389/fpsyg.2016.01508>
- Salthouse, T. A. (1996). The processing speed theory of adult age differences in cognition. *Psychological Review, 103*, 403–428. doi:10.1037/0033-295X.103.3.403
- Sam, D.L. and Berry, J.W. (Eds) (2015), *Cambridge Handbook of Acculturation Psychology*, 2nd ed., Cambridge University Press, Cambridge.
- Sapir, E. (1921). *Language*. New York : Harcourt Brace
- Sekhoni, M., Cartwright, M., & Francis, J. J. (2017). Acceptability of healthcare interventions: an overview of reviews and development of a theoretical framework. *BMC health services research, 17*(1), 1-13.
- Shakespeare, T., and Nicholas Watson. (2002). The social model of disability: An outdated ideology? In: *Research in Social Science and Disability*. Emerald (MCB UP).
- Storey, J. E., Rowland, J. T., Conforti, D. A., & Dickson, H. G. (2004). The Rowland universal dementia assessment scale (RUDAS): a multicultural cognitive assessment scale. *International Psychogeriatrics, 16*(1), 13-31.
- Tiwari SC, Tripathi RK, Kumar A. Applicability of the Mini-mental State Examination (MMSE) and the Hindi Mental State Examination (HMSE) to the urban elderly in India: a pilot study. *Int Psychogeriatr 2009;21*(1):123e8
- Tomasello, M. (2008). *Origins of Human Communication*. Cambridge, MA: MIT Press.
- Uysal-Bozkir, Ö., Parlevliet, J. L., & de Rooij, S. E. (2013). Insufficient cross-cultural adaptations and psychometric properties for many translated health assessment scales: A systematic review. *Journal of Clinical Epidemiology, 66*(6), 608–618. <http://doi.org/10.1016/j.jclinepi.2012.12.004>
- Vallet, G. T. (2015). Embodied cognition of aging. *Frontiers in Psychology, 6*, 463. <http://doi.org/10.3389/fpsyg.2015.00463>
- Versace, R., Brouillet, D., Vallet, G. (2018). *Cognition incarnée: Une cognition située et projetée*. Wavre, Belgique: Mardaga.

Whorf, B (1956). *Language, Thought and Reality*. Cambridge, MA : MIT Press

Wilson, M. (2002). Six views of embodied cognition. *Psychonomic Bulletin & Review*, 9(4), 625–636.

Winocur, G., Craik, F. I., Levine, B., Robertson, I. H., Binns, M. A., Alexander, M., ... & Stuss, D. T. (2007). Cognitive rehabilitation in the elderly: Overview and future directions. *Journal of the International Neuropsychological Society*, 13(1), 166-171

Wong, T. M., Strickland, T. L., Fletcher-Janzen, E., Ardila, A., & Reynolds, C. R. (2000). Theoretical and practical issues in the neuropsychological assessment and treatment of culturally dissimilar patients. In E. Fletcher-Janzen, T. L. Strickland, & C. R. Reynolds (Eds.), *Critical issues in neuropsychology. Handbook of cross-cultural neuropsychology* (p. 3–18). Kluwer Academic Publishers. https://doi.org/10.1007/978-1-4615-4219-3_1

ANNEX 1 : Course of the PSSM sessions (english)

<p><u>Session 1 :</u> Gestural Memory: 2 series of 2 movements Haptic Memory : 1st exercice Auditory Memory: 1st module Gestural Memory: Redo the two series of 2 movements</p>	<p><u>Session 2 :</u> Gestural Memory : 3 series of 2 movements (Revision of the first two) Haptic memory: 2nd exercice Auditory memory: 2nd module Gestural memory: 3 series of 2 movements</p>
<p><u>Session 3 :</u> Visuo-spatial Memory : Walk around the neighborhood (pictures taken)</p>	<p><u>Session 4 :</u> Gestural Memory : 5 series of 2 movements Visuo-spatial Memory : Feedbacks of the walk (picture recalls) Verbal Memory : 2nd part</p>
<p><u>Session 5:</u> Verbal Memory : 1st part story Haptic Memory : 3rd exercice Auditory Memory : 2nd or 3rd module</p>	<p><u>Session 6 :</u> Gestural Memory : 4 series of 2 movements Visual Memory : Memory (game) first level Olfactory memory Gestural Memory : 4 series of 2 movements</p>
<p><u>Session 7 :</u> Verbal Memory : 3rd part – recall of 1st and 2nd Visual Memory : Memory Game Second level Mental flexibility : Game 1st level</p>	<p><u>Session 8 :</u> Olfactory Memory Verbal Memory Mental Flexibility : 2nd level Gestural Memory : Recall of all movements</p>

IV
GENERAL
DISCUSSION

4.1 Origin of this thesis

First and foremost, we claim this work to be an applied thesis for on-field problematics encountered by practitioners, particularly for those who work with a culturally diverse population. This work originated from an on-field observation and a collaboration with health care professionals committed to offering adapted and ecological services to aging individuals. Indeed, our concern rose from the difficulties practitioners were facing while applying current cognitive interventions with participants from a different cultural background and who did not master the French language, or in general, language difficulties.

Indeed, worldwide today, societies are becoming increasingly diverse with many cultures and social groups, and this new socio-cultural dynamic calls for specific and specialized methods of care services. Health is a fundamental human right and should be accessible to anyone regardless of origin or living environment. Yet, way too often, minority groups are faced with various constraints that do not allow them to benefit the essential health care services justifiably. Amongst the large array of conditions, one of the significant hindrances we highlight presently is the lack of appropriate cognitive assessments and intervention tools. The problem is not only felt on one side but professionals also are often faced with similar challenges in their practice.

On the one hand, psychological assessments allow the identification and description of behaviors and individual characteristics of a person about a psychological construct. The problem is that despite the solid psychometric qualities of these assessments, their use in cultural contexts raises epistemological and ethical issues (Bellaj, 2011). Often, practitioners use translated versions of tests. Therefore, the interpretation of the results requires great caution as diagnostic decisions

based on translated tests, and thus, their norms imply more significant risks of errors. On the other hand, cognitive interventions for culturally diverse populations pose plenty of challenges also. Indeed, the question of interpretation of results is less salient in this case; however, cognitive interventions for the elderly, in most cases, aim at working on cognitive processes that are declining due to age-related difficulties. Therefore, it is essential to ensure that while designing tasks, the latter are pertinent and comprehensible for the population they are destined to.

4.2 Theoretical background

To begin our expose, we first questioned the ethical foundations of practical psychology. Indeed, as psychologists, we have at the heart of our practice to provide proper and equal care to every individual, independent of their socio-cultural belonging. This is not just a subjective desire but also part of the ethical principles of psychologists and the code of conduct that affirms the basis of our practice. Ethics are even more critical when choosing the proper means to communicate with and assess patients from different backgrounds. It is unlikely common that a psychologist and patient share the same cultural experience. Still, a psychologist must understand the uniqueness of each individual such that they can provide better treatment.

As it stands, each individual is unique, but as humans, we all have common psychological mechanisms. Culture colors an individual's experience, values, and belief systems, but these experiences have traces in the universal psychological processes. Norenzayan & Heine (2005, p763) described psychological universals are core mental attributes shared at some conceptual level by all or nearly all non-brain-damaged adult human beings across cultures. To understand these psychological universals, it is essential to carry out cross-cultural studies through thorough strategies. Several researchers have thus, carried out cross-cultural comparative studies, such as in

East Asians and Westerners, and their findings revealed a cultural bias on attentional processes (Park, 2000 ; Park & Gutchess, 2002 ; Park et al., 1999 ; Heine et al., 2002 ; Fung et al.,2013).

Precisely, they found out that East Asians had a more holistically information processing style than an analytical one for Western cultures. While differences were observed by these authors, Hedden and colleagues (2002) found cultural-invariants on tasks involving spatial orientations on the same populations. Findings demonstrate that some functional measures can be similar among cultures, but further investigation is needed to support this information. Hedden et al. (2002) explored these cross-cultural differences in older adults. In line with Park et al. (1999) theories of cognitive resource demands, their findings corroborate that cultural effects on cognition are generalized in aging. In other words, what matters most is how much resources an individual has to perform a specific task in aging. If the tasks are highly demanding, often the case for fluid skills (e.g., working memory or speed processing), cognitive flexibility is reduced in aging. Therefore, older adults perform less well across cultures. However, if tasks call for crystallized skills, i.e., tasks demanding lesser resources, culture is observed as individuals tend to prioritize personal goals that are culturally meaningful to them. Baltes and Baltes (1990) psychosocial approach to aging also confirms these findings. The authors suggest that older adults select, optimize, and compensate for tasks they prioritize as their cognitive resources become limited with age.

The theory of limited resources in aging has been further explained through embodied cognition framework. Embodied cognition asserts that cognition emerges from bodily interactions with the outside world (Foglia & Wilson, 2013; Costello & Bloesch, 2017). Therefore, physical changes that occur during aging may account for cognitive changes also (Schaie et al., 1964; Vallet, 2015; Valentijn et al., 2005; Li & Lindenberger, 2002; Baltes & Lindenberger, 1997;

Lindenberger et al., 2001). Notably, in aging, sensory and motor capacities are known to diminish. So, several theories have been proposed by different authors, such as the cognitive load theory (Baltes & Lindenberger, 1997), sensory deprivation theory (Valentijn et al., 2005), and the common cause theory (Lindenberger & Baltes, 1997). All these theories demonstrate how perception via the senses, action through motricity, and cognition are intertwined. When there is an alteration in one of these domains, it automatically also impacts the others.

One of the essential, if not the only ultimate cognitive process that appears to be necessary for normal cognitive functioning is executive functioning. As per our view, executive functioning (EFg) is a dynamic and integrative consequence of internalized sensorimotor actions of an individual within its environment. Considering EFg through embodied perspectives provides new insights to understand neural (N) mechanisms, functional(F), and daily life(L) consequences of age-related problems. The NFL model described by Kuehn et al. (2018) summarizes the links and potential outcomes of age-related cognitive changes and those relative to bodily perception and action. These new concepts are essential since they are insightful for developing cognitive assessments and interventions for older adults through an embodied perspective.

Cognitive interventions have been applied for years now as a technique to palliate for age-related cognitive decline. The premise behind cognitive intervention is the ability of the brain to modify itself, i.e., brain plasticity. Studies have shown that brain plasticity is still present in older adults (Cajal, 1894, 1933; Azmitia, 2007; Mahncke et al., 2006; Nemeth & Janaseck, 2011), contrary to old beliefs that new neural connections are not possible during aging. Based on these premises, cognitive intervention programs are now indicated as preventive and curative measures for older adults facing cognitive impairments. These approaches are cognition-based (e.g., cognitive rehabilitation for memory) or sensorimotor-based (e.g., physical exercises, sensory

integration). While the number of evidences for applying different interventions in aging is increasing in literature, there is still a gap regarding the potential characteristics that might determine their effectiveness. In most cases, studies have shown efficacy in the quality of life of individuals and engagement during the intervention sessions, yet the potential cognitive benefits do not appear to last over the long term (Sanchez et al., 2015; Vance & Porter., 2001; Baker et al., 2001). Observing the effects of cognitive interventions is very challenging because a successful intervention is usually one which is ecological and specifically designed for an individual.

In the particular situation of minority elderly, applying cognitive interventions can become even more challenging. There are two significant issues with cognitive interventions. Firstly, cognition-based approaches are often language-dependent, challenging to use in an aging population with language issues. Secondly, sensorimotor-based approaches often lack empirical validation. Thus, our main aim in this work was to propose the validation of a sensorimotor-based intervention program that would overcome language barriers for older adults from diverse socio-cultural backgrounds facing age-related effects. The theoretical foundation of our work lies within the embodied perspective, given its relevance for a universal consideration of human cognition that is essentially based on the latter's sensorimotor interactions with the environment.

Subsequently, the research work carried out in this thesis has followed three main axes: The first one (*Study 1*) was intended to demonstrate the embodied framework was a perfect fit for studying age-related cognitive issues and how physical changes linked to aging can affect cognition in aging. In *study 2*, based on our concern to provide an assessment tool that would limit language barriers, we designed a sensorimotor evaluation of the executive functioning (SEE) battery and tested it in healthy older adults. Finally, we developed a sensorimotor cognitive

intervention program (PSSM) in the same line of concern. We tested it across three different cultures to measure its potential of having universal applicability (*Study 3*).

4.3 Main results

4.3.1 Embodiment as a better predictor of cognitive aging issues

Regarding *Study 1*, our first objective was to understand how aging changes time perception through an embodied perspective. Indeed, this study was an extension of Kranjec and McDonough's study carried out in 2011. The authors studied the perception of abstract concepts in young adults. Different authors have described that abstract concepts such as time were embodied according to deictic spatial references compared to a non-deictic spatial reference (Kranjec, 2006, 2011; Boroditsky, 2011). These spatial frames were mainly dependent on one's bodily axes. Hence, any past event is considered as "behind," a future event is situated "in front," and the present is situated as "co-locational" to our body (Clark, 1973; Evans, 2003; Lakoff and Johnson, 1980, 1999, Kranjec, 2006). Therefore, to explore how far temporal concepts are grounded in sensorimotor representations, the authors carried out a 'pointing task' where participants were asked to point the direction of an event (in front for future events; behind for past events). Their findings demonstrated that, indeed, young adults based their reasoning according to their bodily axes when presented with an unknown event.

Consequently, given the sensorimotor alterations experienced by older adults, we were interested in exploring how these bodily alterations would impact the perception of time as an individual age. We replicated the same experimental task using French word stimuli that

represented either past or future events in three groups: Young, middle-, and Older adults. Our study showed a gradual decline in the categorization events and that the grounding of these events appeared to disappear with age. These results validate the idea that sensorimotor decline in aging has an effect on cognitive processes. This task was particularly interesting as participants were given no clue on the items presented, they were not even shown images. We still observed that, in cases where an abstract concept such as time is presented, people usually will conceive the latter based on their own bodily axes. These results corroborate with Lakoff and Johnson's conceptual metaphor theory (1980) that abstract concepts are better understood through concrete domains. In this case, the body acts as the concrete domain that allows the perception and representation of time.

Secondly, according to the action compatibility effect (ACE, Glenberg & Kaschak, 2002), when words are action-related, the motor execution of the corresponding action is facilitated. Hence, based on this conception, we explored whether, in our task, if an abstract concept presented was compatible with the direction that it may depict, for example, executing a forward movement for future actions; would that event be better stored and recalled? Our results indeed validate this theory, that is, we found that when motor actions were compatible with an event, it provided a better recall. However, these effects disappeared in aging.

Generally, the findings of our this study reveal that firstly, time is embodied, i.e., grounded in sensorimotor representations. And that, sensorimotor alterations experienced by older adults makes this conception of time even more difficult. In fact, it is well admitted that aging people perceive the future as limited, the explanation may then lie in these findings. Secondly, these physical changes also impact memory tasks, therefore, they may account for poor performances on memory tasks. As such, this study, allows us to conclude that embodiment is indeed be a better

predictor of cognitive aging and we also believe that these findings may have a more clinical implication. Particularly, for cognitive assessment or interventions in aging.

4.3.2 An embodied evaluation of executive functioning in aging

In *Study 2*, our objective was to design a sensorimotor evaluation for executive functioning (SEE). As we demonstrated that embodiment could explain age-related cognitive changes, based essentially on sensorimotoricity, it appeared plausible to have an assessment tool to evaluate these cognitive changes, which would work without language implication. Indeed, another important concern we had was about evaluating older adults in a cross-cultural context. Instead of going through translated versions that alternatively should be used with great precaution, our idea was to provide a universal evaluation tool.

The SEE battery was based on Miyake's model of executive functions, i.e., inhibition, flexibility, and updating (working memory). We proposed two tasks per function that were compared to existing executive function tests, particularly the TAP (test of attentional performance, Zimmerman and Fimm, 2002). We carried out this experiment in 20 healthy older adults at two different times for test-retest reliability. We found positive correlations for most SEE tests regarding the Test-Retest reliability measures, whether for inhibition, updating, or flexibility measures. Similar results were also found for the TAP. In other words, our results signify that both tests have internal validity in measuring executive functions. Therefore, we can conclude that the measures accurately represent the participant's performance and that there were no irrelevant artefacts such as environmental, methodological, or psychological processes implied.

The second set of analyses compared the SEE and TAP tests on these three constructs, respectively. Our results showed positive correlations for tasks measuring inhibition and updating; however, none were found for flexibility. These results could be interpreted as the fact that

flexibility tasks in the SEE battery were experienced as complex, thus needing higher cognitive resources that are known to be less available in aging. Alternatively, these results could also suggest more than one construct at play in the flexibility tasks of the SEE battery. Therefore, it could be interesting to carry out transverse measures among all the tests. In conclusion, even though the SEE battery must be applied in a larger population, our results suggest that executive functioning can be assessed through sensorimotor tests. Therefore, the SEE can be used by audiences with little education and/or lack of language proficiency.

4.3.3 An embodied sensorimotor intervention in aging

Study 3 was an on-field application of embodied theory to a problematic encountered by practitioners. Indeed, it was observed by health care professionals that cognitive interventions they were using were not adapted to a culturally diverse population, mainly due to language issues. Hence, in this third study, we proposed an intervention that could be relevant and efficient to these populations. Therefore, we designed a sensorimotor stimulation program based on different sensorimotor domains such as auditory, visual, haptics, gestural memory, and executive functioning. The PSSM was an 8-week session that lasted 1h to 1h30 per session (*see table 3 for a summary of tasks*). To measure the effectiveness and applicability of the program, we used a type ABA experimental protocol, and to measure the participants' performances, we used a cross-cultural neuropsychological battery (CNTB, Nielsen, et al., 2019). Moreover, to evaluate the acceptability of the intervention, we recorded the number of sessions attended by the participants and measured their scores on the RUDAS tests (which is part of the CNTB).

This study was carried out in three elderly groups across cultures: Moroccan immigrants, Mauritians, and French with low-level schooling. The first analysis was carried out on the CNTB

to investigate which cognitive processes were more impacted by the intervention. Our results show statistically significant results on memory tests, visuospatial orientation, executive functions for the Moroccan and Mauritian groups, and only on memory and executive functions for the French group. These findings suggest that, firstly, CNTB was applicable across cultures. Secondly, the PSSM intervention did improve the cognitive performances of participants. These results are interesting to note, especially on the visuospatial tasks, confirming the findings of Hedden et al. (2002), who showed that visuospatial domains are culturally invariant. The lack of results in French groups may be due to the few numbers of participants. Compared to the two other groups (13 and 17 participants respectively), we had only 5 participants.

Our second set of analyses concerning adherence to the PSSM intervention was measured according to the rate of participation and scores obtained on RUDAS. Our results showed a positive correlation for the Moroccan group. All participants of the Mauritian and French groups attended all sessions. Hence, the results show that, in general, participants had good adherence to the PSSM. These were even confirmed verbally by participants, as they reported personal satisfaction after each session and globally had positive feedback about the PSSM after the 8-week sessions. Moreover, qualitatively, participants also mentioned that they started meeting with other participants for casual outings outside of the sessions. While we did not particularly measure the impact of the improvement in participants' quality of life, this qualitative feedback suggests that the PSSM had a positive effect. Most studies on cognitive interventions also suggest that what really works in these contexts, is the social dynamic of the group. A finding that is not surprising, as aging people are often socially isolated and the minimum connections that they have impacts their moods and motivations.

Finally, we carried out a qualitative analysis of the feedback of the animators for all sessions combined to measure how the participants represented the sessions. We were concerned whether the exercises proposed were understood in the same way by all participants since we have three cultural groups with different proficiency levels in language, and their spoken languages also differed. We aimed to propose an intervention that could be applied universally, without these language barriers. The qualitative analysis, indeed, confirms that all the participants represented each session according to the proposed theme. This is an interesting result as it shows that a sensorimotor intervention, such as the PSSM, can be effectively applied across cultures without language barriers.

4.4 General conclusion

The foundation of this present work lies in our ethics as practitioners to be rightful towards all individuals since the gap observed between theory and practice appears even greater for aging individuals with culturally diverse backgrounds. Bridging this gap through the consideration of the possibility of a global practice of psychology stemmed out as an essential question. Particularly, when there is clearly a shift of paradigms in cognitive psychology for the study of human cognition and behavior with respect to the embodiment theory.

Embodied cognition suggests that not only the mind is connected to the body, but they both influence each other and are constantly in interaction with the environment. Therefore, contrary to the dualism theory, that the mind and body are separated, studying human cognition without the inclusion of its experiences in a physical world stands more ground. Especially, since, socio-cultural values shape our thoughts, beliefs, and value system and that these experiences have

sensorimotor traces. This fact is real for all individuals across cultures and supposes then, that there are shared processes amongst human beings.

Another fact that is universal is the process of aging. Indeed, during aging, there are sensory, motor and, cognitive changes that affect all individuals irrespective of their cultural background. While for a long time, cognitive changes in aging were studied separately, embodied theories view bodily changes as an explanation. Indeed, several theories have been put forward, such as sensory deprivation theory (Valentijn et al., 2005) or the common cause theory (Lindenberger & Baltes, 1997). These theories suggest that sensory declines in aging, demands higher cognitive resources for individuals to process surrounding information, as such, their performances on cognitive tasks will also be reduced.

As a result, it is interesting to evaluate the extent to which sensorimotor decline impacts cognitive processes through sensorimotor evaluations. Indeed, such type of evaluations is very limited in the literature currently. Through our work, we have explored this question by designing a sensorimotor evaluation for executive functioning (SEE battery) and our findings suggest that it can be applied in populations having language difficulties. While evaluating is a critical step in understanding cognitive behaviors, it is as well important to provide solutions to address cognitive deficits. Since sensorimotor experiences are internalized, it is likely that sensorimotor stimulation can improve the sensorimotor abilities of older adults, thus improving their ability to interact with their environment. The sensorimotor stimulation program (PSSM) designed and studied in this thesis, therefore seemed to confirm these notions. Moreover, the PSSM showed to be applicable across cultures suggesting that sensorimotor interventions can have a universal aspect.

Finally, in this work, while we explored how language and culture are intertwined in aging, our goal was not to suppress these core concepts from an individual's experience. We value as

they define individual experiences and, hence are essential to be acknowledged in practice. Instead of thinking about adaptations, we aimed at providing a universal tool or at least, the consideration that there can be a universal practice of psychology. And this is possible by adopting an Embodied framework.

4.5 Limits and future Perspectives

While the results of our study are promising, certain limitations should be addressed as an extension of this work. First and foremost, it is essential to highlight that this work answers to on-field problematics, and the reality of fieldwork is not always linear. Theoretical research work has often been considered ‘inhuman’ in the sense that capturing human behaviors in a controlled setting limits the expression of natural behaviors. This is in fact paradoxical, since, at the core of psychological research, we aim to capture human behaviors. Yet, it should also be recognized that new theories call for new avenues for the practice. Therefore, bridging the gap between theory and practice can only lead to increased research and new knowledge on how to provide better health services.

Since bringing theory into practice is complex, one should be aware of the methodological, statistical, or even practical challenges. From a methodological point of view, we ensured to have equivalent groups participants in all our studies and ensure that the methodological settings were also respected. However, during this research and practical work, we were faced with a sanitary crisis, making the possibility of working with elderly participants harder. We had difficulties in recruiting participants both for the validation of the SEE battery and the PSSM control group. Therefore, we believe that the inclusion of a larger population could have yielded more statistically significant results. Moreover, concerning the SEE battery, we carried out analysis only on correct

responses of participants. It would be interesting to analyze the errors since studies suggest that older adults are more likely to commit errors on tasks such as executive functions or memory, which can impact their performances (Mathalon et al., 2003; Hoffmann & Falkenstein, 2011).

Concerning theoretical perspectives, our work suggests that embodied framework provides a broader understanding of age-related cognitive changes. Cognition contrary to Cartesian Dualism is embodied through our sensorimotor experiences. A lack of sensorimotor experiences, in turn, alters the cognition, and several studies have given solid evidence (Lindenberger & Baltes, 1994; Baltes & Lindenberger, 1997; Vallet, 2015; Valentijn et al., 2005). Embodied research still needs to uncover further theories and models for explaining the link between cognitive processes and aging. In this study, we have proposed a conception of executive functioning within the embodied framework as a product of the body and environmental interactions. Thus, further theoretical emphasis should be put on balance and behavioral flexibility that older adults use to cope with their environment, rather than assuming that there are given processes (e.g., inhibition) that limit individual behaviors.

Humans embody their experiences, and this embodiment is expressed through the observation of symptoms and behaviors. In clinical practice, the evaluation of these symptoms and behaviors have given rise to the a number of tools and interventions. Yet, somehow the focus shifted on having ‘finer’ tools instead of ‘efficient’ ones. One of our early concerns emerged from the observation of the lack of assessment tools for evaluating cognitive issues in the Mauritian aging population. In a desire to address this issue, we have submitted a research project (*annex 6*) in collaboration with the University of Mauritius to carry test the CNTB battery on a larger scale firstly and the SEE battery to test its applicability.

Final thoughts ...

As humans, our brains are often very binary in how we look at people around us: We either see people as us or others. Whatever the criteria we use to make this distinction, it only keeps digging the gaps in terms of care. As a global community and ultimately global professionals, if we could see that we are all on the same side, maybe then, we can more efficiently solve some of the problems we are currently facing in our practice. Still, maybe these are just the hopes of a disillusioned optimist. In the meantime, I hope this work serves as a reminder and plant a seed for a more inclusive perspective of the health care system and services that should be offered to the elderly globally.

REFERENCES

- Abrams D., Lima L., & Coudin G. (2007). *Experiences and expressions of ageism* (European Social Survey Module template with background information, survey questions).
- Akdag B, Aslan Telci E, Cavlak U. Factors affecting cognitive function in older adults: a Turkish sample. *Int J Gerontol.* 2013;7:137–141. doi: 10.1016/j.ijge.2013.01.002
- Allain, P., Roy, A., Kefi, Z., Pinon, K., Etcharry-Bouyx, F., & Le Gall, D. (2004). Fonctions exécutives et traumatisme crânien sévère: évaluation à l'aide de la *Revue de neuropsychologie*, 14(3), 285-324.
- Ardila, A. (2008). On the evolutionary origins of executive functions. *Brain and cognition*, 68(1), 92-99. <https://doi.org/10.1016/j.bandc.2008.03.003>
- Ayres, A. J. (1960). Occupational therapy for motor disorders resulting from impairment of the central nervous system. *Rehabilitation Literature*, 21, 302-310.
- Azmitia EC. Cajal and brain plasticity: insights relevant to emerging concepts of mind. *Brain Res Rev.* 2007 Oct;55(2):395-405. doi: 10.1016/j.brainresrev.2007.01.010. PMID: 18030688.
- Baddeley, A. (1996). Exploring the Central Executive. *The Quarterly Journal of Experimental Psychology Section A*, 49(1), 5–28. <https://doi.org/10.1080/713755608>
- Baker, R., Bell, S., Baker, E., Holloway, J., Pearce, R., Dowling, Z., ... & Wareing, L. A. (2001). A randomized controlled trial of the effects of multi-sensory stimulation (MSS) for people with dementia. *British Journal of Clinical Psychology*, 40(1), 81-96. <https://doi.org/10.1348/014466501163508>
- Baker, R., Holloway, J., Holtkamp, C. C., Larsson, A., Hartman, L. C., Pearce, R., ... & Owens, M. (2003). Effects of multi-sensory stimulation for people with dementia. *Journal of advanced nursing*, 43(5), 465-477.
- Baker, J., Meisner, B. A., Logan, A. J., Kungl, A. M., & Weir, P. (2009). Physical activity and successful aging in Canadian older adults. *Journal of aging and physical activity*, 17(2), 223–235. <https://doi.org/10.1123/japa.17.2.223>
- Ball, K., Berch, D. B., Helmers, K. F., Jobe, J. B., Leveck, M. D., Marsiske, M., ... & ACTIVE Study Group. (2002). Effects of cognitive training interventions with older adults: a randomized controlled trial. *Jama*, 288(18), 2271-2281.
- Baltes, P. B., & Baltes, M. M. (1990). Psychological perspectives on successful aging: The model of selective optimization with compensation. In P. B. Baltes & M. M. Baltes (Eds.), *Successful aging: Perspectives from the behavioral sciences* (pp. 1–34). Cambridge University Press. <https://doi.org/10.1017/CBO9780511665684.003>
- Baltes P. B. (1997). On the incomplete architecture of human ontogeny. Selection, optimization, and compensation as foundation of developmental theory. *The American psychologist*, 52(4), 366–380. <https://doi.org/10.1037//0003-066x.52.4.366>

- Baltes, P. B., & Mayer, K. U. (Eds.). (2001). *The Berlin aging study: Aging from 70 to 100*. Cambridge University Press.
- Baltes, P. B., & Lindenberger, U. (1997). Emergence of a powerful connection between sensory and cognitive functions across the adult life span: a new window to the study of cognitive aging?. *Psychology and aging*, 12(1), 12. doi: 10.1037/0882-7974.12.1.12
- Baltes, P. B., Staudinger, U. M., & Lindenberger, U. (1999). Lifespan psychology: theory and application to intellectual functioning. *Annual review of psychology*, 50, 471–507. <https://doi.org/10.1146/annurev.psych.50.1.471>
- Baltes PB, & Danish SJ (1980). Intervention in life-span development and aging In Turner RR and Reese HW (Eds.), *Lifespan developmental psychology* (pp. 49–78). New York: Academic Press
- Band, G. P., & Kok, A. (2000). Age effects on response monitoring in a mental-rotation task. *Biological psychology*, 51(2-3), 201–221. [https://doi.org/10.1016/s0301-0511\(99\)00038-1](https://doi.org/10.1016/s0301-0511(99)00038-1)
- Barkow, J. H., Cosmides, L., & Tooby, J. (Eds.). (1992). *The adapted mind: Evolutionary psychology and the generation of culture*. Oxford University Press, USA.
- Barsalou L. W. (2008). Grounded cognition. *Annual review of psychology*, 59, 617–645. <https://doi.org/10.1146/annurev.psych.59.103006.093639>
- Basak, C., Boot, W. R., Voss, M. W., & Kramer, A. F. (2008). Can training in a real-time strategy video game attenuate cognitive decline in older adults?. *Psychology and aging*, 23(4), 765–777. <https://doi.org/10.1037/a0013494>
- Behr, D. (2016): Assessing the use of back translation: the shortcomings of back translation as a quality testing method, *International Journal of Social Research Methodology*, DOI: 10.1080/13645579.2016.1252188
- Bellaj, T. (2011). Evaluation psychologique et culture: aspects conceptuels et méthodologiques. *B. Troadec & T. Bellaj, Psychologies et cultures*, 209-236.
- Benjamin, L.T. (1988). *A history of psychology: Original sources and contemporary research*. New York: McGraw-Hill
- Naveh-Benjamin, M. Recognition memory of spatial location information: Another failure to support automaticity. *Memory & Cognition* 16, 437–445 (1988). <https://doi.org/10.3758/BF03214224>
- Bennett, I. J., & Madden, D. J. (2014). Disconnected aging: cerebral white matter integrity and age-related differences in cognition. *Neuroscience*, 276, 187–205. <https://doi.org/10.1016/j.neuroscience.2013.11.026>
- Berchtold, N. C., & Cotman, C. W. (2009). Normal and pathological aging: from animals to humans. In *Animal models of human cognitive aging* (pp. 1-28). Humana Press.
- Berry, J. W. (2015). Global psychology: Implications for cross-cultural research and management. *Cross Cultural Management*. <https://doi.org/10.1108/CCM-03-2015-0031>
- Berry, J. W., Berry, J. W., Poortinga, Y. H., Segall, M. H., & Dasen, P. R. (2002). *Cross-cultural psychology: Research and applications*. Cambridge University Press.

- Block, N. (1995). On a confusion about a function of consciousness. *Behavioral and Brain Sciences*, 18, 227–287. <http://dx.doi.org/10.1017/S0140525X00038188>
- Blondell, S. J., Hammersley-Mather, R., & Veerman, J. L. (2014). Does physical activity prevent cognitive decline and dementia?: A systematic review and meta-analysis of longitudinal studies. *BMC public health*, 14(1), 1-12.
- Borek, A.J. and Abraham, C. (2018), How do Small Groups Promote Behaviour Change? An Integrative Conceptual Review of Explanatory Mechanisms. *Appl Psychol Health Well-Being*, 10: 30-61. <https://doi.org/10.1111/aphw.12120>
- Borghia, A. M., & Pecher, D. (2011). Introduction to the special topic embodied and grounded cognition. *Frontiers in Psychology*, 2, 187. <https://doi.org/10.3389/fpsyg.2011.00187>
- Boroditsky, Lera, 2000. Metaphoric structuring: understanding time through spatial metaphors. *Cognition* 75 (1), 1–28.
- Boroditsky, L. (2001). Does language shape thought? Mandarin and English speakers' conceptions of time. *Cognitive Psychology*, 43(1), 1–22. <https://doi.org/10.1006/cogp.2001.0748>
- Boroditsky, L. (2009). How Does Our Language Shape The Way We Think? In M. Brockman (Ed.), *What's Next?: Dispatches on the Future of Science* (pp. 117–129). New York: Vintage Books
- Boroditsky, L. (2011). How Language Shapes Thought. *Scientific American*, 304, 62-65. <https://doi.org/10.1038/scientificamerican0211-62>
- Bourgeois, M. S. (1993). Effects of memory aids on the dyadic conversations of individuals with dementia. *Journal of Applied Behavior Analysis*, 26(1), 77-87. <https://doi.org/10.1901/jaba.1993.26-77>
- Bratt, C., Abrams, D., Swift, H. J., Vauclair, C. M., & Marques, S. (2018). Perceived age discrimination across age in Europe: From an ageing society to a society for all ages. *Developmental psychology*, 54(1), 167–180. <https://doi.org/10.1037/dev0000398>
- Brehmer Y, Rieckmann A, Bellander M, Westerberg H, Fischer H, Bäckman L. Neural correlates of training-related working-memory gains in old age. *Neuroimage*. 2011 Oct 15; 58(4):1110-20.
- Brehmer, Y., Westerberg, H., & Bäckman, L. (2012). Working-memory training in younger and older adults: training gains, transfer, and maintenance. *Frontiers in human neuroscience*, 6, 63. <https://doi.org/10.3389/fnhum.2012.00063>
- Brennan, M., Su, Y. P., & Horowitz, A. (2006). Longitudinal associations between dual sensory impairment and everyday competence among older adults. *Journal of rehabilitation research and development*, 43(6), 777–792. <https://doi.org/10.1682/jrrd.2005.06.0109>
- Brown, R. W., & Lenneberg, E. H. (1954). A study in language and cognition. *The Journal of Abnormal and Social Psychology*, 49(3), 454–462. <https://doi.org/10.1037/h0057814>
- Bundy, A. C., Lane, S., & Murray, E. A. (Eds.). (2002). *Sensory integration: Theory and practice* (2nd ed.). Philadelphia: F. A. Davis.

- Cajal S. R. Y. (1894). La fine structure des centres nerveux. *Proc. R. Soc. Lond.* 55, 444–468. 10.1098/rspl.1894.0063 <https://doi.org/10.1098/rspl.1894.0063>
- y Cajal, S. R. (1954). *Neuron theory or reticular theory?*. Editorial CSIC-CSIC Press.
- Camarata, S., Miller, L. J., & Wallace, M. T. (2020). Evaluating Sensory Integration/Sensory Processing Treatment: Issues and Analysis. *Frontiers in integrative neuroscience*, 14, 55. <https://doi.org/10.3389/fnint.2020.556660>
- Camp, C. J., Judge, K. S., Bye, C. A., Fox, K. M., Bowden, J., Bell, M., ... & Mattern, J. M. (1997). An intergenerational program for persons with dementia using Montessori methods. *The Gerontologist*, 37(5), 688-692. <https://doi.org/10.1093/geront/37.5.688>
- Camp, C., Bird, M., & Cherry, C. (2000). Retrieval strategies as a rehabilitation aid for cognitive loss in pathological ageing. In *Cognitive rehabilitation in old age*. Oxford University Press.
- Camp, C. J. (2010). Origins of Montessori programming for dementia. *Non-pharmacological therapies in dementia*, 1(2), 163.
- Cardona, J. F. (2017). Embodied cognition: a challenging road for clinical neuropsychology. *Frontiers in aging neuroscience*, 9, 388. <http://dx.doi.org/10.3389/fnagi.2017.00388>
- Carstensen, L. L. (2006). The influence of a sense of time on human development. *Science*, 312(5782), 1913-1915. <https://doi.org/10.1126/science.1127488>
- Casasanto, D., & Boroditsky, L. (2008). Time in the Mind: Using Space to Think about Time. *Cognition*, 106, 579-593. https://doi.org/10.1007/978-3-642-14749-4_15
- Castel, A. D. (2007). Aging and memory for numerical information: The role of specificity and expertise in associative memory. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 62(3), P194-P196. <https://doi.org/10.1093/geronb/62.3.P194>
- Cattell, R. B. (1963). Theory of fluid and crystallized intelligence: A critical experiment. *Journal of educational psychology*, 54(1), 1.
- Cerella, J. (1990). Aging and information-processing rate. *Handbook of the psychology of aging*, 3, 201-221.
- Chan, H. Y. L., Yau, Y. M., Li, S. F., Kwong, K. S., Chong, Y. Y., Lee, I. F. K., & Yu, D. S. F. (2021). Effects of a culturally adapted group based Montessori based activities on engagement and affect in Chinese older people with dementia: a randomized controlled trial. *BMC geriatrics*, 21(1), 1-8. <https://doi.org/10.1186/s12877-020-01967-0>
- Cheval, B., Orsholits, D., Sieber, S., Courvoisier, D., Cullati, S., & Boisgontier, M. P. (2020). Relationship between decline in cognitive resources and physical activity. *Health Psychology*, 39(6), 519–528. <https://doi.org/10.1037/hea0000857>
- Chuderski, A., Taraday, M., Nęcka, E., & Smoleń, T. (2012). Storage capacity explains fluid intelligence but executive control does not. *Intelligence*, 40(3), 278-295. <https://doi.org/10.1016/j.intell.2012.02.010>
- Cicerone, K. D., Dahlberg, C., Malec, J. F., Langenbahn, D. M., Felicetti, T., Kneipp, S., Ellmo, W., Kalmar, K., Giacino, J. T., Harley, J. P., Laatsch, L., Morse, P. A., & Catanese, J. (2005). Evidence-based cognitive rehabilitation: updated review of the literature from 1998 through

2002. *Archives of physical medicine and rehabilitation*, 86(8), 1681–1692.
<https://doi.org/10.1016/j.apmr.2005.03.024>

- Cicerone, K., Levin, H., Malec, J., Stuss, D., & Whyte, J. (2006). Cognitive rehabilitation interventions for executive function: moving from bench to bedside in patients with traumatic brain injury. *Journal of Cognitive Neuroscience*, 18(7), 1212-22. DOI: 10.1162/jocn.2006.18.7.1212
- Clare, L. (2003). Cognitive training and cognitive rehabilitation for people with early-stage dementia. *Reviews in Clinical Gerontology*, 13(1), 75-83. doi:10.1017/S0959259803013170
- Clare, L., Wilson, B. A., Breen, K., & Hodges, J. R. (1999). Errorless learning of face-name associations in early Alzheimer's disease. *Neurocase*, 5(1), 37-46.
<https://doi.org/10.1080/13554799908404063>
- Clare, L., Wilson, B. A., Carter, G., Hodges, J. R., & Adams, M. (2001). Long-term maintenance of treatment gains following a cognitive rehabilitation intervention in early dementia of Alzheimer type: A single case study. *Neuropsychological rehabilitation*, 11(3-4), 477-494.
- Clare, L., & Woods, B. (2001). A role for cognitive rehabilitation in dementia care. *Neuropsychological Rehabilitation*, 11(3-4), 193-196.
- Clare, L., Van Paasschen, J., Evans, S. J., Parkinson, C., Woods, R. T., & Linden, D. E. (2009). Goal-oriented cognitive rehabilitation for an individual with Mild Cognitive Impairment: behavioural and neuroimaging outcomes. *Neurocase*, 15(4), 318-331.
<https://doi.org/10.1080/13554790902783116>
- Clark, B. H., & Montgomery, D. B. (1998). Deterrence, reputations, and competitive cognition. *Management Science*, 44(1), 62-82. <https://doi.org/10.1287/mnsc.44.1.62>
- Clark, H. H. (1973). Space, Time, Semantics, and the Child. *Cognitive Development and the Acquisition of Language*, 27, 63. <https://doi.org/10.1016/B978-0-12-505850-6.50008-6>
- Cohen, P. (2016). 30 ans après le titre : le code et la profession. *Le Journal des psychologues*, 337, 18-25. <https://doi.org/10.3917/jdp.337.0018>
- Colcombe, S., & Kramer, A. F. (2003). Fitness effects on the cognitive function of older adults: a meta-analytic study. *Psychological science*, 14(2), 125-130
- Costello, M. C., & Bloesch, E.K. (2017). Are older adults less embodied? A review of age effects through the lens of embodied cognition. *Frontiers in Psychology*, 8, Article 267.
<https://doi.org/10.3389/fpsyg.2017.00267>
- Craik, F. I. M. (1983). On the transfer of information from temporary to permanent memory. *Philosophical Transactions of the Royal Society of London. B, Biological Sciences*, 302(1110), 341-359.
- Craik, F. I. (1986). A functional account of age differences in memory. *Human memory and cognitive capabilities: Mechanisms and performances*, 5, 409-422.
- Craik, F. I. M., & Jennings, J. M. (1992). Human memory. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 51–110). Lawrence Erlbaum Associates, Inc.

- Craik, F. I., Winocur, G., Palmer, H., Binns, M. A., Edwards, M., Bridges, K., ... & Stuss, D. T. (2007). Cognitive rehabilitation in the elderly: Effects on memory. *Journal of the International Neuropsychological Society*, 13(1), 132-142.
- Cromwell, H. C., & Panksepp, J. (2011). Rethinking the cognitive revolution from a neural perspective: how overuse/misuse of the term ‘cognition’ and the neglect of affective controls in behavioral neuroscience could be delaying progress in understanding the BrainMind. *Neuroscience & Biobehavioral Reviews*, 35(9), 2026-2035. <https://doi.org/10.1016/j.neubiorev.2011.02.008>
- De Bruin, L. C., & Kästner, L. (2012). Dynamic embodied cognition. *Phenomenology and the Cognitive Sciences*, 11(4), 541-563. <https://doi.org/10.1007/s11097-011-9223-1>
- DE Rotrou, J., Adjemian A., Ouanhnon, P., Kurz, H., Moulin, F. & Forette, F. (1996). Le PACEUREKA. Partenariat recherche et protection sociale (162-182). In : B. Michel, J. De Rotrou, F. Verdureau (Eds), La stimulation cognitive, monographies du groupe de recherche sur la maladie d’Alzheimer, Marseille : Solal
- Derouesné C, Poitreneau J, Hugonot L, Kalafat M, Dubois B, Laurent B. Au nom du groupe de recherche sur l’évaluation cognitive (GRECO). Le Mental-State Examination (MMSE): un outil pratique pour l’évaluation de l’état cognitif des patients par le clinicien. Version française consensuelle. *Presse Méd.* 1999;28:1141-8.
- D’Esposito, M., & Gazzaley, A. (2006). Neurorehabilitation of executive function. *Neural rehabilitation and repair*, 475-487.
- Diversity Vision Statement and Purpose (n.d.) In City University New York (CUNY). Retrieved from : <http://www2.cuny.edu/about/administration/offices/hr/diversity-and-recruitment>
- Duker, H (1963). Uber reaktive Anspannungssteigerung (On challenge-induced reactive increments in cognitive and motivational effort). *Zeitschrift fu r Experimentelle und Angewandte Psychologie*, 10, 46-72
- Ermini-Fünfschilling, D., & Meier, D. (1995). Memory training: an important constituent of milieu therapy in senile dementia. *Zeitschrift fur Gerontologie und Geriatrie*, 28(3), 190-194.
- Engeroff, T., Ingmann, T., & Banzer, W. (2018). Physical activity throughout the adult life span and domain-specific cognitive function in old age: a systematic review of cross-sectional and longitudinal data. *Sports medicine*, 48(6), 1405-1436.
- Evans, J.J. (2012). Goal Setting during rehabilitation early and late after acquired brain injury. *Current Opinion in Neurology*, 25, 651-655 <https://doi.org/10.1097/wco.0b013e3283598f75>
- Evans, W. J. (1995). What is sarcopenia?. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, 50(Special_Issue), 5-8. https://doi.org/10.1093/gerona/50A.Special_Issue.5
- Evans, Vyvyan, 2003. *The Structure of Time*. John Benjamins, Amsterdam and Philadelphia. <https://doi.org/10.1075/hcp.12>
- Feldman MW, Laland KN. Gene-culture coevolutionary theory. *Trends Ecol Evol.* 1996 Nov;11(11):453-7. doi: 10.1016/0169-5347(96)10052-5. PMID: 21237920.

- Fernandes, J., Arida, R. M., & Gomez-Pinilla, F. (2017). Physical exercise as an epigenetic modulator of brain plasticity and cognition. *Neuroscience & Biobehavioral Reviews*, *80*, 443-456. <https://doi.org/10.1016/j.neubiorev.2017.06.012>
- Ferrier, D. (1886). *The functions of the brain*. Smith, Elder.
- Foglia, L., and Wilson, R.A. (2013). Embodied cognition. *Wiley Interdiscip. Rev. Cogn. Sci.* *4*, 319-325. Doi: 10.1002/wcs.122
- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of psychiatric research*, *12*(3), 189–198. [https://doi.org/10.1016/0022-3956\(75\)90026-6](https://doi.org/10.1016/0022-3956(75)90026-6)
- Flament, C., Rouquette, M.L. (2003). Anatomie des idées ordinaires: comment étudier les représentations sociales. Paris : Armand Colin
- Franck, N. (2012). *Remédiation cognitive*. Elsevier Masson
- Freiherr, J., Lundström, J. N., Habel, U., & Reetz, K. (2013). Multisensory integration mechanisms during aging. *Frontiers in human neuroscience*, *7*, 863. <https://doi.org/10.3389/fnhum.2013.00863>
- Friedman, N. P., & Miyake, A. (2004). The Relations Among Inhibition and Interference Control Functions: A Latent-Variable Analysis. *Journal of Experimental Psychology: General*, *133*(1), 101–135. <https://doi.org/10.1037/0096-3445.133.1.101>
- Fung, H. H. (2013). Aging in culture. *The Gerontologist*, *53* 3, 369-77. <https://doi.org/10.1093/geront/gnt024>
- Gallagher, S. (2005). *How the body shapes the mind*. Clarendon Press, Oxford. <http://dx.doi.org/10.1093/0199271941.001.0001>
- Gao, X. (2016). Cultural differences between East Asian and North American in temporal orientation. *Review of General Psychology*, *20*(1), 118-127. <https://doi.org/10.1037%2Fgpr0000070>
- Gates, N. J., Sachdev, P. S., Singh, M. A. F., & Valenzuela, M. (2011). Cognitive and memory training in adults at risk of dementia: a systematic review. *BMC geriatrics*, *11*(1), 1-14. <https://doi.org/10.1186/1471-2318-11-55>
- Geisinger, K. F. (2003). Testing and assessment in cross-cultural psychology. V JR Graham, J. A. Naglieri, & IB Weiner (Eds.), *Handbook of psychology, assessment psychology* (Vol. 10; pp. 95–119). Hoboken.
- Gentner, D. (2001). Spatial metaphors in temporal reasoning. In M.Gattis (Ed.), *Spatial schemas in abstract thought* (pp. 203-222). Cambridge, MA: MIT Press.
- Gibson, J.J. (1966). *The senses considered as perceptual systems*. Houghton Mifflin
- Gibson, E. J. (1994). Has psychology a future?. *Psychological Science*, *5*(2), 69-76. <https://doi.org/10.1111%2Fj.1467-9280.1994.tb00633.x>

- Giroux, D., Robichaud, L., & Paradis, M. (2010). Using the Montessori approach for a clientele with cognitive impairments: A quasi-experimental study design. *The International Journal of Aging and Human Development*, 71(1), 23-41. <https://doi.org/10.2190%2FAG.71.1.b>
- Glenberg, A. M., & Kaschak, M. P. (2002). Grounding language in action. *Psychonomic Bulletin & Review*, 9, 558–565. <https://doi.org/10.3758/BF03196313>
- Glisky, E. L. (1997). Rehabilitation of memory dysfunction. *Behavioral neurology and neuropsychology*, 491-495.
- Goldstone, R. L., & Barsalou, L. W. (1998). Reuniting perception and conception. *Cognition*, 65(2-3), 231–262. [https://doi.org/10.1016/s0010-0277\(97\)00047-4](https://doi.org/10.1016/s0010-0277(97)00047-4)
- Gounden, Y., Hainselin, M., Cerrotti, F., & Quaglino, V. (2017). Dynamic and functional approach to human memory in the brain: A clinical neuropsychological perspective. *Frontiers in psychology*, 8, 688.
- Grayston, F. (2018). Normal changes of aging. *InnovAiT*, 11(11), 627-633. <https://doi.org/10.1177/1755738018793446>
- Haber, S. N., & Rauch, S. L. (2010). Neurocircuitry: a window into the networks underlying neuropsychiatric disease. *Neuropsychopharmacology*, 35(1), 1-3. <https://doi.org/10.1038/npp.2009.146>
- Hamer, M., & Chida, Y. (2009). Physical activity and risk of neurodegenerative disease: a systematic review of prospective evidence. *Psychological medicine*, 39(1), 3-11. <https://doi.org/10.1017/s0033291708003681>
- Wahl, H. W., Iwarsson, S., & Oswald, F. (2012). Aging well and the environment: Toward an integrative model and research agenda for the future. *The Gerontologist*, 52(3), 306-316. <https://doi.org/10.1093/geront/gnr154>
- Harada, C. N., Natelson Love, M. C., & Triebel, K. L. (2013). Normal cognitive aging. *Clinics in geriatric medicine*, 29(4), 737–752. <https://doi.org/10.1016/j.cger.2013.07.002>
- Harnad, S. (1990). The symbol grounding problem. *Physica D: Nonlinear Phenomena*, 42(1-3), 335-346. [http://dx.doi.org/10.1016/0167-2789\(90\)90087-6](http://dx.doi.org/10.1016/0167-2789(90)90087-6)
- Hasher, L., & Zacks, R. T. (1988). Working memory, comprehension, and aging: A review and a new view. *Psychology of learning and motivation*, 22, 193-225. [https://doi.org/10.1016/S0079-7421\(08\)60041-9](https://doi.org/10.1016/S0079-7421(08)60041-9)
- Hedden, T., Park, D. C., Nisbett, R., Ji, L. J., Jing, Q., & Jiao, S. (2002). Cultural variation in verbal versus spatial neuropsychological function across the life span. *Neuropsychology*, 16(1), 65. <https://psycnet.apa.org/doi/10.1037/0894-4105.16.1.65>
- Heine, S. J., Lehman, D. R., Peng, K., & Greenholtz, J. (2002). What's wrong with cross-cultural comparisons of subjective Likert scales?: The reference-group effect. *Journal of personality and social psychology*, 82(6), 903
- Hoffmann, S., & Falkenstein, M. (2011). Aging and error processing: age-related increase in the variability of the error-negativity is not accompanied by an increase in response variability. *PloS one*, 6(2), e17482. <https://doi.org/10.1371/journal.pone.0017482>

- Horn, J. L., & Cattell, R. B. (1967). Age differences in fluid and crystallized intelligence. *Acta Psychologica*, 26(2), 107–129. [https://doi.org/10.1016/0001-6918\(67\)90011-X](https://doi.org/10.1016/0001-6918(67)90011-X)
- Hulsege, J., & Verheul, A. (1987). *Snoezelen: another world*. Rompa.
- Huizinga, M., Dolan, C. V., & Van der Molen, M. W. (2006). Age-related change in executive function: Developmental trends and a latent variable analysis. *Neuropsychologia*, 44(11), 2017-2036. <https://doi.org/10.1016/j.neuropsychologia.2006.01.010>
- Imamizu, H., & Kawato, M. (2009). Brain mechanisms for predictive control by switching internal models: implications for higher-order cognitive functions. *Psychological research*, 73(4), 527–544. <https://doi.org/10.1007/s00426-009-0235-1>
- Ionescu, T. (2012). Exploring the nature of cognitive flexibility. *New Ideas in Psychology*, 30(2), 190–200. <https://doi.org/10.1016/j.newideapsych.2011.11.001>
- Kiely K.M., Anstey K.J. (2015) Common Cause Theory in Aging. In: Pachana N. (eds) Encyclopedia of Geropsychology. Springer, Singapore. https://doi.org/10.1007/978-981-287-080-3_118-1
- Kirby S. Culture and biology in the origins of linguistic structure. *Psychon Bull Rev.* 2017 Feb;24(1):118-137. doi: 10.3758/s13423-016-1166-7. PMID: 28120320; PMCID: PMC5325872.
- Koziol, L. F., Budding, D. E., & Chidekel, D. (2012). From movement to thought: executive function, embodied cognition, and the cerebellum. *Cerebellum (London, England)*, 11(2), 505–525. <https://doi.org/10.1007/s12311-011-0321-y>
- Kramer, A. F., Larish, J. F., & Strayer, D. L. (1995). Training for attentional control in dual task settings: A comparison of young and old adults. *Journal of Experimental Psychology: Applied*, 1(1), 50–76. <https://doi.org/10.1037/1076-898X.1.1.50>
- Kramer, A. F., & Colcombe, S. (2018). Fitness effects on the cognitive function of older adults: a meta-analytic study—revisited. *Perspectives on Psychological Science*, 13(2), 213-217. <https://doi.org/10.1177%2F1745691617707316>
- Kranjec, A. (2006). Extending spatial frames of reference to temporal concepts. In *Proceedings of the Annual Meeting of the Cognitive Science Society* (Vol. 28, No. 28).
- Kranjec, A., & McDonough, L. (2011). The implicit and explicit embodiment of time. *Journal of Pragmatics*, 43(3), 735-748. <https://doi.org/10.1016/j.pragma.2010.07.004>
- Kudlicka, A., Martyr, A., Bahar-Fuchs, A., Woods, B., & Clare, L. (2019). Cognitive rehabilitation for people with mild to moderate dementia. *The Cochrane Database of Systematic Reviews*, 2019(8). doi: [10.1002/14651858.CD013388](https://doi.org/10.1002/14651858.CD013388)
- Kuehn, E., Perez-Lopez, M. B., Diersch, N., Döhler, J., Wolbers, T., & Riemer, M. (2018). Embodiment in the aging mind. *Neuroscience & Biobehavioral Reviews*, 86, 207-225. <https://doi.org/10.1016/j.neubiorev.2017.11.016>
- Kurlychek, R. T. (1983). Use of a digital alarm chronograph as a memory aid in early dementia. *Clin Gerontol*, 1, 93-94.
- Lakoff, G., & Johnson, M. (1980). *Metaphors We Live By*. University of Chicago Press, Chicago, IL.

- Lakoff, G., & Johnson, M. (1999). *Philosophy in the flesh: The embodied mind and its challenge to western thought* (Vol. 640). New York: Basic books. DOI:10.5860/choice.37-0239
- Lancioni, G. E., Cuvo, A. J., & O'Reilly, M. F. (2002). Snoezelen: an overview of research with people with developmental disabilities and dementia. *Disability and rehabilitation*, 24(4), 175–184. <https://doi.org/10.1080/09638280110074911>
- Lai, V. T., & Boroditsky, L. (2013). The immediate and chronic influence of spatio-temporal metaphors on the mental representations of time in English, Mandarin, and Mandarin-English speakers. *Frontiers in Psychology*, 4, Article 142. <https://doi.org/10.3389/fpsyg.2013.00142>
- Lemaire, P., & Bherer, L. (2005). Psychologie du vieillissement: une perspective cognitive. De Boeck Supérieur.
- Lezak, M. D., Howieson, D. B., Bigler, E. D., & Tranel, D. (2012). *Neuropsychological assessment* (5th ed.). Oxford University Press.
- Li, K. Z. H., & Lindenberger, U. (2002). Relations between aging sensory/sensorimotor and cognitive functions. *Neuroscience and Biobehavioral Reviews*, 26(7), 777–783. [https://doi.org/10.1016/S0149-7634\(02\)00073-8](https://doi.org/10.1016/S0149-7634(02)00073-8)
- Light, L. L. (1991). Memory and aging: Four hypotheses in search of data. *Annual Review of Psychology*, 42, 333–376. <https://doi.org/10.1146/annurev.ps.42.020191.002001>
- Lindenberger, U., & Baltes, P. B. (1994). Sensory functioning and intelligence in old age: a strong connection. *Psychology and aging*, 9(3), 339. <https://psycnet.apa.org/doi/10.1037/0882-7974.9.3.339>
- Lindenberger, U., Mayr, U., & Kliegl, R. (1993). Speed and intelligence in old age. *Psychology and Aging*, 8(2), 207–220. <https://doi.org/10.1037/0882-7974.8.2.207>
- Lindenberger, U., & Mayr, U. (2014). Cognitive aging: is there a dark side to environmental support?. *Trends in cognitive sciences*, 18(1), 7-15. <https://doi.org/10.1016/j.tics.2013.10.006> Science, 18, 7-15
- Lindenberger, U., Scherer, H., & Baltes, P. B. (2001). The strong connection between sensory and cognitive performance in old age: not due to sensory acuity reductions operating during cognitive assessment. *Psychology and aging*, 16(2), 196. doi: 10.1037/0882-7974.16.2.196
- Lista, I., & Sorrentino, G. (2010). Biological mechanisms of physical activity in preventing cognitive decline. *Cellular and molecular neurobiology*, 30(4), 493-503. <https://doi.org/10.1007/s10571-009-9488-x>
- Loftus, E. F., & Palmer, J. C. (1974). Reconstruction of automobile destruction: An example of the interaction between language and memory. *Journal of Verbal Learning & Verbal Behavior*, 13(5), 585–589. [https://doi.org/10.1016/S0022-5371\(74\)8001](https://doi.org/10.1016/S0022-5371(74)8001)
- Loftus, E. F. (1977). Shifting human color memory. *Memory & Cognition*, 5(6), 696–699. <https://doi.org/10.3758/BF03197418>
- Logan, G. D. (1994). On the ability to inhibit thought and action: A users' guide to the stop signal paradigm. In D. Dagenbach & T. H. Carr (Eds.), *Inhibitory processes in attention, memory, and language* (pp. 189–239). Academic Press.

- Lonner, W. J. (2011). The continuing challenge of discovering psychological order across cultures. <https://psycnet.apa.org/doi/10.1017/CBO9780511974090.004>
- Lucy, J. A. (1997). Linguistic relativity. *Annual review of anthropology*, 26(1), 291-312. <https://doi.org/10.1146/annurev.anthro.26.1.291>
- MacDonald C. (2002) Back to the real sensory world our ‘care’ has taken away. *Journal of Dementia Care* 10, 33–36.
- Mahncke, H. W., Bronstone, A., & Merzenich, M. M. (2006). Brain plasticity and functional losses in the aged: scientific bases for a novel intervention. *Progress in brain research*, 157, 81-109. [https://doi.org/10.1016/S0079-6123\(06\)57006-2](https://doi.org/10.1016/S0079-6123(06)57006-2)
- Malone, M. L., & Camp, C. J. (2007). Montessori-based dementia programming®: Providing tools for engagement. *Dementia*, 6(1), 150-157. <https://doi.org/10.1177%2F1471301207079099>
- Mahendra, N., Hopper, T., Bayles, K. A., Azuma, T., Cleary, S., & Kim, E. (2006). Evidence-based practice recommendations for working with individuals with dementia: Montessori-based interventions. In *Database of Abstracts of Reviews of Effects(DARE): Quality-assessed Reviews [Internet]*. Centre for Reviews and Dissemination (UK).
- Maury, P., & Martin, S. Comment les personnes âgées parviennent-elles à maintenir des capacités de compréhension préservées? Mise en œuvre du support environnemental dans la compréhension de texte. In: D., Brouillet (Ed.). *Le vieillissement cognitif normal : Maintenir l'autonomie de la personne âgée*. De Boeck Université. (parution novembre 2010).
- Mathalon, D. H., Bennett, A., Askari, N., Gray, E. M., Rosenbloom, M. J., & Ford, J. M. (2003). Response-monitoring dysfunction in aging and Alzheimer’s disease: an event-related potential study. *Neurobiology of aging*, 24(5), 675-685.
- Mayr U. (2001). Age differences in the selection of mental sets: the role of inhibition, stimulus ambiguity, and response-set overlap. *Psychology and aging*, 16(1), 96–109. <https://doi.org/10.1037/0882-7974.16.1.96>
- McDougall G. J., Jr (1999). Cognitive interventions among older adults. *Annual review of nursing research*, 17, 219–240. DOI: 10.1891/0739-6686.17.1.219
- Meier, D., Ermini-Fünfschilling, D., & Zwick, V. (2000). Gedächtnistraining für Patienten mit beginnender Demenz. *Geriatr Prax*, 3, 4851.
- Milner, B. (1971). Interhemispheric differences in the localization of psychological processes in man. *British medical bulletin*.
- Miyake, A., Friedman, N. P., Rettinger, D. A., Shah, P., & Hegarty, M. (2001). How are visuospatial working memory, executive functioning, and spatial abilities related? A latent-variable analysis. *Journal of experimental psychology: General*, 130(4), 621.
- Miyake, A., & Friedman, N. P. (2012). The nature and organization of individual differences in executive functions: Four general conclusions. *Current directions in psychological science*, 21(1), 8-14. <https://doi.org/10.1177/0963721411429458>
- Moghaddam, F. M., Taylor, D. M., & Wright, S. C. (1993). *Social psychology in cross-cultural perspective*. W H Freeman/Times Books/ Henry Holt & Co.

- Montessori, M. (1958). *The discovery of the child*, translated by MA Johnstone.
- Montgomery, S., & Åsberg, M. (1979). A New Depression Scale Designed to be Sensitive to Change. *British Journal of Psychiatry*, 134(4), 382-389. doi:10.1192/bjp.134.4.382
- Murphy, D. R., Craik, F., Li, K., & Schneider, B. A. (2000). Comparing the effects of aging and background noise on short-term memory performance. *Psychology and aging*, 15(2), 323–334. <https://doi.org/10.1037/0882-7974.15.2.323>
- Myerson, J., Hale, S., Wagstaff, D., Poon, L. W., & Smith, G. A. (1990). The information-loss model: A mathematical theory of age-related cognitive slowing. *Psychological Review*, 97(4), 475–487. <https://doi.org/10.1037/0033-295X.97.4.475>
- Navon, D. (1977). Forest before trees: The precedence of global features in visual perception. *Cognitive Psychology*, 9, 353- 383. doi:10.1016/0010-0285(77)90012-3
- Nairn H. (1995) Discover the difference activities can make. *Journal of Dementia Care* 3, 16–18.
- Nejati, V., Shahidi, S., & Helmi, S. (2016). Enhancement of executive functions with cognitive rehabilitation in older adults. *Journal of Modern Rehabilitation*, 10(3), 120-127.
- Nemeth, D., & Janacek, K. (2011). The dynamics of implicit skill consolidation in young and elderly adults. *Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 66(1), 15-22. <https://doi.org/10.1093/geronb/gbq063>
- Netz, Y., Wu, M. J., Becker, B. J., & Tenenbaum, G. (2005). Physical activity and psychological well-being in advanced age: a meta-analysis of intervention studies. *Psychology and aging*, 20(2), 272–284. <https://doi.org/10.1037/0882-7974.20.2.272>
- Newman, B. M., & Newman, P. R. (2020). *Theories of adolescent development*. Academic Press.
- Nicassio, P. M., Meyerowitz, B. E., & Kerns, R. D. (2004). The Future of Health Psychology Interventions. *Health Psychology*, 23(2), 132–137. <https://doi.org/10.1037/0278-6133.23.2.132>
- Nielsen, T. R., Segers, K., Vanderaspoilden, V., Beinhoff, U., Minthon, L., Pissioti, A., ... & Waldemar, G. (2019). Validation of a European Cross-Cultural Neuropsychological Test Battery (cntb) for evaluation of dementia. *International journal of geriatric psychiatry*, 34(1), 144-152.
- Nielsen, T. R. (2019). Effects of illiteracy on the European cross-cultural neuropsychological test battery (CNTB). *Archives of Clinical Neuropsychology*, 34(5), 713-720.
- Nisbett, R. E., & Norenzayan, A. (2002). Culture and cognition. In H. Pashler & D. Medin (Eds.), *Steven's handbook of experimental psychology: Memory and cognitive processes* (pp. 561–597). John Wiley & Sons Inc. <https://doi.org/10.1002/0471214426.pas0213>
- Noack, H., Lövdén, M., Schmiedek, F., & Lindenberger, U. (2009). Cognitive plasticity in adulthood and old age: gauging the generality of cognitive intervention effects. *Restorative neurology and neuroscience*, 27(5), 435-453. doi: 10.3233/RNN-2009-0496
- Norenzayan, A., & Heine, S. J. (2005). Psychological universals: What are they and how can we know? *Psychological Bulletin*, 131(5), 763–784. doi:10.1037/0033-2909.131.

- Norman, D., Shallice, T.: Attention to action: Willed and automatic control of behavior. In Davidson, R.J., Schwartz, G.E., Shapiro, D., eds.: *Consciousness and Self-Regulation*. Plenum Press, New York (1980)
- Nusbaum, N. J. (1999). Aging and sensory senescence. *Southern medical journal*, 92(3), 267-275. DOI: 10.1097/00007611-199903000-00002. PMID: 10094265.
- Olesen, P. J., Westerberg, H., & Klingberg, T. (2004). Increased prefrontal and parietal activity after training of working memory. *Nature Neuroscience*, 7(1), 75-9. <https://doi.org/10.1038/nm1165>
- Orain, S. (2008). Le snoezelen. *Gérontologie et société*, 31(126), 157-164. <https://doi.org/10.3917/g.s.126.0157>
- O'Regan, J. K., & Noë, A. (2001). A sensorimotor account of vision and visual consciousness. *The Behavioral and brain sciences*, 24(5), 939–1031. <https://doi.org/10.1017/s0140525x01000115>
- Orsulic-Jeras, S., Schneider, N. M., Camp, C. J., Nicholson, P., & Helbig, M. (2001). Montessori-based dementia activities in long-term care: Training and implementation. *Activities, Adaptation & Aging*, 25(3-4), 107-120. https://doi.org/10.1300/J016v25n03_08
- Park, D. C., & Bischof, G. N. (2013). The aging mind: neuroplasticity in response to cognitive training. *Dialogues in clinical neuroscience*, 15(1), 109–119. <https://doi.org/10.31887/DCNS.2013.15.1/dpark>
- Park, D. C., Nisbett, R., & Hedden, T. (1999). Aging, culture, and cognition. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, 54(2), P75-P84. <https://doi.org/10.1093/geronb/54B.2.P75>
- Park, D. C. (2000). The basic mechanisms accounting for age-related decline in cognitive function. In D. C. Park & N. Schwarz (Eds.), *Cognitive aging: A primer* (pp. 3–21). Psychology Press.
- Park, D. C., & Gutchess, A. H. (2002). Aging, cognition, and culture: a neuroscientific perspective. *Neuroscience and biobehavioral reviews*, 26(7), 859–867. [https://doi.org/10.1016/s0149-7634\(02\)00072-6](https://doi.org/10.1016/s0149-7634(02)00072-6)
- Peng T-C, Chen W-L, Wu L-W, Chang Y-W, Kao T-W, Sarcopenia, and cognitive impairment: A systematic review and meta-analysis, *Clinical Nutrition*, <https://doi.org/10.1016/j.clnu.2019.12.014>.
- Pérez-Álvarez, M. (2018a). Para pensar la psicología más allá de la mente y el cerebro: un enfoque transteórico. *Papeles del Psicólogo*, 39(3), 161-173. doi.org/10.23923/pap.psicol2018.2875
- Pérez-Álvarez, M. The Structure of Behavior as Unity of Psychology According to Mariano Yela. *Psicothema*. 2021 Aug;33(3): 372-377. Doi:10.7334/psicothema2021.29.PMID: 34297666
- Perez-Arce, P. The Influence of Culture on Cognition, *Archives of Clinical Neuropsychology*, Volume 14, Issue 7, October 1999, Pages 581–592, <https://doi.org/10.1093/arclin/14.7.581>
- Pettigrew, C., & Martin, R. C. (2014). Cognitive declines in healthy aging: Evidence from multiple aspects of interference resolution. *Psychology and Aging*, 29(2), 187–204. <https://doi.org/10.1037/a0036085>

- Pezzulo, G. (2011). Grounding procedural and declarative knowledge in sensorimotor anticipation. *Mind & Language*, 26(1), 78-114. <https://doi.org/10.1111/j.1468-0017.2010.01411.x>
- Pfeifer, R., & Bongard, J. (2007). *How the body shapes the way we think: A new view of intelligence*. MIT Press. Cambridge (MA). <http://dx.doi.org/10.7551/mitpress/3585.001.0001>
- Physical Changes With Aging By Richard W. Besdine, By, Besdine, R. W., & Last full review/revision Apr 2019| Content last modified Apr 2019. (n.d.). Physical changes with aging - geriatrics. MSD Manual Professional Edition. Retrieved September 16, 2021, from <https://www.msmanuals.com/professional/geriatrics/approach-to-the-geriatric-patient/physical-changes-with-aging#v43035806>
- Pinker, S. (1997). *How the mind works*. New York: Norton.
- Pinker, S., & Bloom, P. (1990). Natural language and natural selection. *Behavioral and Brain Sciences*, 13(4), 707–784. <https://doi.org/10.1017/S0140525X00081061>
- Pinker, S. (2003). Language as an adaptation to the cognitive niche. *Studies in the Evolution of Language*, 3, 16-37. DOI:10.1093/acprof:oso/9780199244843.003.0002
- Pieramico, V., Esposito, R., Cesinaro, S., Frazzini, V., & Sensi, S. L. (2014). Effects of non-pharmacological or pharmacological interventions on cognition and brain plasticity of aging individuals. *Frontiers in systems neuroscience*, 8, 153.
- Prakash, R. S., Voss, M. W., Erickson, K. I., & Kramer, A. F. (2015). Physical activity and cognitive vitality. *Annual review of psychology*, 66, 769-797. <https://doi.org/10.1146/annurev-psych-010814-015249>
- Prasad, L., Fredrick, J., & Aruna, R. (2021). The relationship between physical performance and quality of life and the level of physical activity among the elderly. *Journal of education and health promotion*, 10, 68. https://doi.org/10.4103/jehp.jehp_421_20
- Prescott, S., Fleming, J., & Doig, E. (2015). Goal setting approaches and principles used in rehabilitation for people with acquired brain injury: a systematic scoping review. *Brain Injury*, 29(13-14), 1515-1529. DOI:10.3109/02699052.2015.1075152
- Rey-Mermet, A., & Gade, M. (2018). Inhibition in aging: What is preserved? What declines? A meta-analysis. *Psychonomic bulletin & review*, 25(5), 1695-1716. <https://doi.org/10.3758/s13423-017-1384-7>
- Rhode, A. K., Voyer, B. G., & Gleibs, I. H. (2016). Does language matter? Exploring Chinese–Korean differences in holistic perception. *Frontiers in psychology*, 7, 1508. doi: 10.3389/fpsyg.2016.01508
- Roberts, K. L., & Allen, H. A. (2016). Perception and Cognition in the Ageing Brain: A Brief Review of the Short- and Long-Term Links between Perceptual and Cognitive Decline. *Frontiers in Aging Neuroscience*, 8, 289–7. <http://doi.org/10.3389/fnagi.2016.00039>
- Rogers, R. D., & Monsell, S. (1995). Costs of a predictable switch between simple cognitive tasks. *Journal of Experimental Psychology: General*, 124(2), 207–231. <https://doi.org/10.1037/0096-3445.124.2.207>

- Roussel, C., Giraud-Baro, É., & Gabayet, F. (2011). Place de la remédiation cognitive dans le processus de réhabilitation des personnes souffrant de schizophrénie. *Emc - Psychiatrie*, 8, 1-9. <https://doi.org/10.1016/S0246-1072%2811%2958373-7>
- Saling, L. L., & Phillips, J. G. (2007). Automatic behaviour: efficient not mindless. *Brain research bulletin*, 73(1-3), 1-20. <https://doi.org/10.1016/j.brainresbull.2007.02.009>
- Salthouse, T. A. (1991). *Theoretical perspectives on cognitive aging*. Lawrence Erlbaum Associates, Inc.
- Salthouse T. A. (1996). The processing-speed theory of adult age differences in cognition. *Psychological review*, 103(3), 403–428. <https://doi.org/10.1037/0033-295x.103.3.403>
- Salthouse, T. (2010). Selective review of cognitive aging. *Journal of the International Neuropsychological Society*, 16(5), 754-760. doi:10.1017/S1355617710000706
- Sánchez, A., Maseda, A., Marante-Moar, M. P., De Labra, C., Lorenzo-López, L., & Millán-Calenti, J. C. (2016). Comparing the effects of multisensory stimulation and individualized music sessions on elderly people with severe dementia: a randomized controlled trial. *Journal of Alzheimer's Disease*, 52(1), 303-315.
- Sapir, E. (1929). The status of linguistics as a science. *Language*, 207-214. <https://doi.org/10.2307/409588>
- Schäfer, S., Huxhold, O., & Lindenberger, U. (2006). Healthy mind in healthy body? A review of sensorimotor–cognitive interdependencies in old age. *European Review of Aging and Physical Activity*, 3(2), 45-54. <https://doi.org/10.1007/s11556-006-0007-5>
- Schaie, K. W., Baltes, P., & Strother, C. R. (1964). A study of auditory sensitivity in advanced age. *Journal of Gerontology*, 19(4), 453-457. doi: 10.1093/geronj/19.4.453
- Schaaf, R., & Miller, L. (2005). Occupational therapy using a sensory integrative approach for children with developmental disabilities. *Mental Retardation and Developmental Disabilities Research Review*, 11, 143-148. <https://doi.org/10.1002/mrdd.20067>
- Semin, G. R. (2009). Language and social cognition. In F. Strack & J. Förster (Eds.), *Social cognition: The basis of human interaction* (pp. 269–289). Psychology Press.
- Seron, X., & Van der Linden, M. (2016). Chapitre 1 Objectifs et stratégies de la revalidation neuropsychologique. *Traité de neuropsychologie clinique de l'adulte: Tome 2-Rééducation*, 3.
- Shallice, T. (1988). *From neuropsychology to mental structure*. Cambridge University Press. <https://doi.org/10.1017/CBO9780511526817>
- Shapiro, L. (Ed.). (2014). *The Routledge handbook of embodied cognition*. Routledge.
- Sheppard, C. L., McArthur, C., & Hitzig, S. L. (2016). A Systematic Review of Montessori-Based Activities for Persons With Dementia. *Journal of the American Medical Directors Association*, 17(2), 117–122. <https://doi.org/10.1016/j.jamda.2015.10.006>

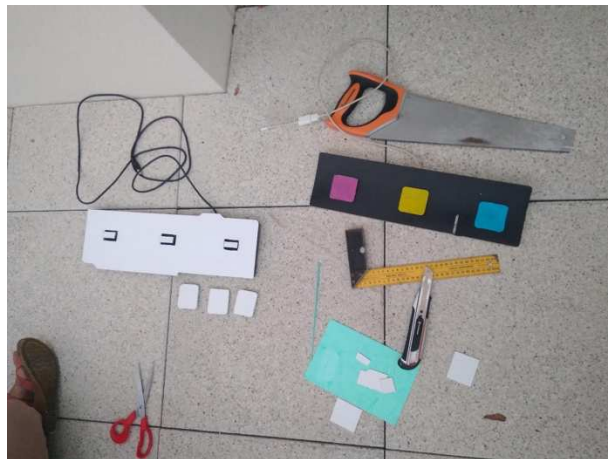
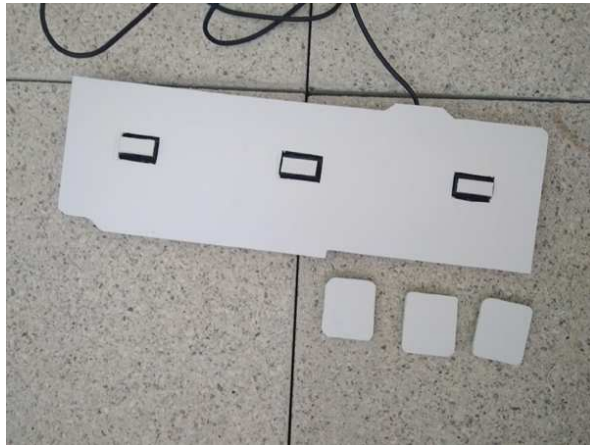
- Smith, S., Press, B., & Koenig K. (2005). Effects of sensory integration intervention on self-stimulating and self-injurious behaviors. *American Journal of Occupational Therapy*, 59, 418-425. <https://doi.org/10.5014/ajot.59.4.418>
- Sofi, F., Valecchi, D., Bacci, D., Abbate, R., Gensini, G. F., Casini, A., & Macchi, C. (2011). Physical activity and risk of cognitive decline: a meta-analysis of prospective studies. *Journal of internal medicine*, 269(1), 107-117. <https://doi.org/10.1111/j.1365-2796.2010.02281.x>
- Sohlberg, M. M., & Mateer, C. A. (1989). *Introduction to cognitive rehabilitation: Theory and practice*. Guilford Press.
- Solomon, P., Kubzansky, P. E., Leiderman, P. H., Mendelson, J. H., Trumbull, R., & Wexler, D. (1961). *Sensory deprivation*. Harvard University Press.
- Span, M.M., Ridderinkhof, K.R., & van der Molen, M.W. (2004). Age-related changes in the efficiency of cognitive processing across the life span. *Acta psychologica*, 117 2, 155-83. <https://doi.org/10.1016/j.actpsy.2004.05.005>
- Spielberger, C. D. (1983). State-Trait Anxiety Inventory for Adults (STAI-AD) [Database record]. APA PsycTests. <https://doi.org/10.1037/t06496-000>
- Squire, L. R., Knowlton, B., & Musen, G. (1993). The structure and organization of memory. *Annual review of psychology*, 44(1), 453-495. <https://doi.org/10.1146/annurev.ps.44.020193.002321>
- Stahl, C., Voss, A., Schmitz, F., Nuszbaum, M., Tüscher, O., Lieb, K., & Klauer, K. C. (2014). Behavioral components of impulsivity. *Journal of Experimental Psychology: General*, 143(2), 850–886. <https://doi.org/10.1037/a0033981>
- Stenling, A., Sörman, D. E., Lindwall, M., Hansson, P., Körning Ljungberg, J., & Machado, L. (2021). Physical activity and cognitive function: between-person and within-person associations and moderators. *Aging, Neuropsychology, and Cognition*, 28(3), 392-417. DOI: 10.1080/13825585.2020.1779646
- Talassi, E., Guerreschi, M., Feriani, M., Fedi, V., Bianchetti, A., & Trabucchi, M. (2007). Effectiveness of a cognitive rehabilitation program in mild dementia (MD) and mild cognitive impairment (MCI): a case control study. *Archives of gerontology and geriatrics*, 44, 391-399. <https://doi.org/10.1016/j.archger.2007.01.055>
- TATE, R. L. (1997). Subject Review: Beyond one-bun, two-shoe: Recent advances in the psychological rehabilitation of memory disorders after acquired brain injury. *Brain Injury*, 11(12), 907-918.
- Thibodeau, P. H., & Boroditsky, L. (2011). Metaphors we think with: The role of metaphor in reasoning. *PloS one*, 6(2), e16782. <https://doi.org/10.1371/journal.pone.0016782>
- Tomasello, M. (2008). *Origins of human communication*. MIT Press.
- Tonetta, M. (1998). Riabilitazione neuropsicologica e TNP (training neuropsicologico). Aspetti teorici e pragmatici.
- Troyer, A. K., Graves, R. E., & Cullum, C. M. (1994). Executive functioning as a mediator of the relationship between age and episodic memory in healthy aging. *Aging and Cognition*, 1(1), 45-53.
- Tulving, E. (1972). 12. Episodic and Semantic Memory. *Organization of memory*/Eds E. Tulving, W. Donaldson, NY: Academic Press, 381-403.

- Tulving, E. (1985). Memory and consciousness. *Canadian Psychology/Psychologie canadienne*, 26(1), 1–12. <https://doi.org/10.1037/h0080017>
- Tulving, E. (1995). Organization of memory: Quo vadis? In M. S. Gazzaniga (Ed.), *The cognitive neurosciences* (pp. 839–853). The MIT Press.
- Tyupa, S. (2011). A theoreticcal framework for back-translation as a quality assessment tool. *New Voices in Translation Studies*, 7, 35–46.
- Uysal-Bozkir, Ö., Parlevliet, J. L., & de Rooij, S. E. (2013). Insufficient cross-cultural adaptations and psychometric properties for many translated health assessment scales: A systematic review. *Journal of Clinical Epidemiology*, 66(6), 608-618.
- Valentijn, S. A., Van Boxtel, M. P., Van Hooren, S. A., Bosma, H., Beckers, H. J., Ponds, R. W., & Jolles, J. (2005). Change in sensory functioning predicts change in cognitive functioning: Results from a 6-year follow-up in the Maastricht Aging Study. *Journal of the American Geriatrics Society*, 53(3), 374-380.
- Vallet G, Simard M, Versace R. Sensory-dependent knowledge in young and elderly adults: arguments from the cross-modal priming effect. *Curr Aging Sci*. 2011 Jul;4(2):137-49. doi: 10.2174/1874609811104020137. PMID: 21235495.
- Vallet, G. T. (2015). Embodied cognition of aging. *Frontiers in psychology*, 6, 463. <https://doi.org/10.3389/fpsyg.2015.00463>
- Vance, D. E., & Porter Jr, R. J. (2001). Montessori methods yield cognitive gains in Alzheimer's day cares. *Activities, Adaptation & Aging*, 24(3), 1-22. https://doi.org/10.1300/J016v24n03_01
- Van Beek, J. H., Kirkwood, T. B., & Basingthwaighte, J. B. (2016). Understanding the physiology of the ageing individual: computational modelling of changes in metabolism and endurance. *Interface Focus*, 6(2), 20150079. <http://dx.doi.org/10.1098/rsfs.2015.0079>
- VAN DER LINDEN, M., and Van der Kaa, M. (1989). “Reorganization therapy for memory impairments,” in *Cognitive Approaches in Neuropsychological Rehabilitation*, eds X. Seron and G. Deloche (New York: Lawrence Erlbaum Associates), 105–158.
- Van der Linden, M., & Hupet, M. (1994). *Le vieillissement cognitif*. Paris : PUF
- Van der Linden, M., & Juillerat, A. C. (2004). La revalidation neuropsychologique dans la maladie d’Alzheimer à un stade précoce: principes, méthodes et perspectives. *Revue neurologique*, 160(4), 64-70. [https://doi.org/10.1016/S0035-3787\(04\)70945-5](https://doi.org/10.1016/S0035-3787(04)70945-5)
- Van der Ven, S. H., Kroesbergen, E. H., Boom, J., & Leseman, P. P. (2012). The development of executive functions and early mathematics: A dynamic relationship. *British Journal of Educational Psychology*, 82(1), 100-119.
- Velligan, D. I., & Bow-Thomas, C. C. (2000). Rehab rounds: two case studies of cognitive adaptation training for outpatients with schizophrenia. *Psychiatric Services*, 51(1), 25-29. <https://doi.org/10.1176/ps.51.1.25>
- Verhaeghen, P. and Cerella, J. (2002) Aging, Executive Control, and Attention: A Review of Meta-Analyses. *Neuroscience & Biobehavioral Reviews*, 26, 849-857. [https://doi.org/10.1016/S0149-7634\(02\)00071-4](https://doi.org/10.1016/S0149-7634(02)00071-4)

- Versace, R., Vallet, G. T., Brunel, L., Riou, B., Lesourd, M., and Labeye, E. (2014). ACT-IN: an integrated view of memory mechanisms. *J. Cogn. Psychol.* 26, 280–306. doi: 10.1080/20445911.2014.892113
- Versace, R., Brouillet, D., Vallet, G. (2018). *Cognition incarnée: Une cognition située et projetée*. Wavre, Belgique: Mardaga. <https://doi.org/10.3917/mard.valle.2018.01>
- Wechsler, D. (1997) Wechsler Adult Intelligence Scale. 3rd Edition, The Psychological Corporation, San Antonio
- Whorf, B. L. (1956). “The relation of habitual thought and behavior to language,” in *Language, Thought and Reality: Selected Writings of Benjamin Lee Whorf*, ed J. B. Carroll (Cambridge, MA: MIT Press), 134–159.
- Wilson, B.A., Evans, J.J., & Gracey, F. (2009). Goal setting as a way of planning and evaluating neuropsychological rehabilitation. *Neuropsychological rehabilitation: Theory, models, therapy and outcome*, 37-46. Cambridge: Cambridge University Press
- Winocur, G., Craik, F. I., Levine, B., Robertson, I. H., Binns, M. A., Alexander, M., Black, S., Dawson, D., Palmer, H., McHugh, T., & Stuss, D. T. (2007). Cognitive rehabilitation in the elderly: overview and future directions. *Journal of the International Neuropsychological Society : JINS*, 13(1), 166–171. <https://doi.org/10.1017/S1355617707070191>
- Woods, B., Spector, A., Prendergast, L., & Orrell, M. (2009). Cognitive stimulation to improve cognitive functioning in people with dementia (protocol). *The Cochrane Database of Systematic Reviews*. Chichester, England: Wiley.
- Wykes, T. (2004). Thérapie de Remédiation Cognitive (TRC) pour la psychose grave. *Manuel de réadaptation psychiatrique (2004) Lecomte et Leclerc*.
- Zimmer, C., McDonough, M. H., Hewson, J., Toohey, A., Din, C., Crocker, P. R., & Bennett, E. V. (2021). Experiences With Social Participation in Group Physical Activity Programs for Older Adults. *Journal of Sport and Exercise Psychology*, 1(aop), 1-10.
- Zimmermann, P., & Fimm, B. (1994). Test of attentional performance. *Vera Fimm, Psychologische Testsystem*.
- Zimmermann, P., & Fimm, B. (2002). A test battery for attentional performance. *Applied neuropsychology of attention. Theory, diagnosis and rehabilitation*, 110, 151.
- Zilliox, L. A., Chadrasekaran, K., Kwan, J. Y., & Russell, J. W. (2016). Diabetes and Cognitive Impairment. *Current diabetes reports*, 16(9), 87. <https://doi.org/10.1007/s11892-016-0775-x>
- Zacks, R. T., & Hasher, L. (2006). Aging and Long-Term Memory: Deficits Are Not Inevitable. In E. Bialystok & F. I. M. Craik (Eds.), *Lifespan cognition: Mechanisms of change* (pp. 162–177). Oxford University Press.

ANNEXES

ANNEX 1: Keyboard design idea by Frederic Collin – Adapted by Draushika Mooruth



ANNEX 2: Feedbacks of the pretesting of SEE

	<u>Local/gl</u>	<u>Dots/Trian</u>	<u>Soun</u>	<u>Stop</u>	<u>Smilin</u>	<u>TicTacT</u>
	<u>obal</u>	<u>gles</u>	<u>d span</u>	<u>signal</u>	<u>g faces</u>	<u>oe</u>
<u>J1</u>	<p>Compréhension de l'exercice à travers des associations et essai erreurs</p> <p>Feedback important</p> <p>Whitescreen avant de passer à un autre bloc</p> <p>TR plus long</p>	<p>Mettre des images exemple 2</p> <p>Augmenter les nombres d'essais</p> <p>Passer d'un bloc à un autre utiliser keyboard touche du milieu</p>	<p>Pas évident de comprendre ce qu'il faut faire</p> <p>Rajouter démo ?</p> <p>Titre essai 2 et revoir consignes (version consignes)</p>	<p>Comprends pas ce qu'il faut faire</p> <p>Revoir les consignes</p>	<p>Enlever les images des réponses et garder que ceux ciblés</p>	<p>Augmenter essai bloc 2</p>
<u>J2</u>	<p>Entre essai et test rajouter des whitescreen</p> <p>Enlever feedback bloc global</p> <p>Amorcer les blocs local ou global par les couleurs correspondante</p> <p>Compréhension facile à travers le feedback</p>	<p>Plus d'essais et apprentissages (problème niveau nombre des boucles)</p> <p>Si la personne ne répond pas est-ce que c'est compté comme une non-réponse ?</p> <p>Corriger erreurs grammairales</p>	<p>Faire une démo et rajouter plus d'essais</p> <p>Revoir l'exemple de l'ordre inverse</p>	<p>Augmenter le temps entre présentation de son et réponse</p> <p>Bloc mix : remettre les deux sons – rappeler les consignes</p>	<p>Bloc 3 : changer nom</p> <p>Corriger erreurs grammairales</p> <p>Les nombres d'essais pas identiques</p>	<p>Erreur consécutive, problème code (réglé)</p>
<u>J3</u>	<p>Apprentissage réussi par essai-erreur</p> <p>Whitescreen</p> <p>Comment faire comprendre bleu = local / Orange = global</p>	<p>dire le plus rapidement possibles</p>	<p>Décaler le son et l'affichage</p> <p>Discrimination des sons ok</p>	<p>Décaler le son grave</p> <p>Dire attendre la fin de la séquence</p> <p>Dire la séquence augmente au fur et à mesure</p> <p>Consigne ordre inverse pas très clair</p>	<p>Pas de problème de compréhension</p>	<p>Mettre consigne avant présentation item</p>
<u>J4</u>	<p>Passer d'un bloc à autre : Utiliser touche du milieu</p> <p>Association de couleurs</p> <p>Phase d'essai – enlever feedback global pour la partie test</p>	<p>Augmenter le nombre d'essai</p>	<p>Démom nécessaire</p>	<p>Apprentissage ok</p>	<p>Apprentissage ok</p>	<p>Bloc 2 revoir les consignes</p>

<u>J5</u>	Enlever feedback global	Augmenter le nombre d'essai	Compréhension ok mais besoin de temps	Ok Enlever whitescreen avant bloc arrow Toucher le milieu pour changer de bloc Remettre les sons dans le troisième bloc pour rappeler la tâche	ok	Maintien en mémoire, temps de présentation augmenter
Modifications 1						
<u>A6</u>	TR plus long Pas évident de comprendre ce qu'il faut faire d'emblée mais avec les essais ça va surtout partie local Nécessiter un minimum de langage pour comprendre ce qu'il faut faire Effet du genre ?	Mettre les bonnes réponses en vert au lieu de mettre la bande jaune	Augmenter le temps de présentation des sons (fait)	Augmenter le temps de présentation des sons (fait)	Bloc expression à revoir niveau essais	Images défilent trop vite Faire attention à la fatigabilité
<u>A7</u>	Facile à comprendre Si l'image est bleu, donnez la plus petite forme Si l'image est orange donnez la grande forme	Bloc 2 – Corriger triangle verts – nombre et taille Rajouter des essais « ou y'a-t-il le plus de points rouge ? ou triangles verts »	Consignes ?			
<u>A8</u>	Compréhension ok	Rajouter whitescreen entre les blocs	Bien insisté qu'il faut laisser entendre la séquence complète avant de répondre et écouter la démo	Demande de la concentration On se perd, ça va trop vite	Compréhension ok mais long	Enlever l'image de la présentation, car ça perturbe Laisser le temps de répondre Donner le nombre d'essai Les images passent trop vite

<p><u>A9</u></p>	<p>Bloc local – TR+</p>	<p>Laisser plus de temps de présentation pour les exemples</p> <p>Whitescreen après bloc mix</p> <p>Analyse des données : Élimination des premiers réponses dû aux hasard ?</p>	<p>Enlever les touches de réponses le temps de la démo</p> <p>Différencier les 2 blocs</p> <p>Mettre des sons plus discriminants ?</p> <p>Exercice compréhensible</p>	<p>Temps de présentation et apprentissage ok</p> <p>Spécifier lorsque le son apparaît, il ne faut pas répondre à l’item suivent uniquement</p>	<p>3 images confus</p> <p>Bloc 3 marche pas</p>	<p>Bloc HML compliqué</p> <p>Annoncer le nombre de bloc pour la troisième phase</p> <p>Laisser la présentation des grilles plus longtemps</p> <p>Bloc 3 difficile – car faut compter le nombre de grilles et retenir les deux dernières</p>
<p><u>A10</u></p>	<p>Compréhension de consignes ok</p> <p>A quelle point peut-on donner des consignes spécifiques ?</p> <p>Revoir les touches du milieu !!</p>	<p>Passage d’un exemple à l’autre, trop rapide</p> <p>Bloc 3 corriger triangles</p> <p>Exercice simple !</p>	<p>Difficile à comprendre ce qu’il faut faire au premier abord</p>	<p>Mettre plus d’exemples/essais avant de passer à la vraie tâche</p>	<p>Epreuve simple à comprendre</p>	<p>Exemples passent trop vite (clavier trop sensible)</p> <p>Ne pas annoncer le nombre d’items</p> <p>Augmenter au fur et à mesure l’item ? Non, car attentes donc facilitation des réponses.</p>
<p><u>A11</u></p>	<p>Régler taille des formes (triangle)</p> <p>Compréhension ok</p>	<p>Changer image des consignes – augmenter 1-2-3..</p> <p>Avoir trois fois les mêmes images ne permet pas de comprendre qu’il faut retenir le plus grand nombre</p> <p>Bloc 3 rajouter whitescreen</p>	<p>Rajouter des essais, car si participant ne réussit pas, l’exercice s’arrête et on passe au bloc inverse sans comprendre ce qu’il faut faire.</p>	<p>Partie Arrow ok</p> <p>Préciser à l’annonce du son, faut pas répondre juste à l’item suivant.</p> <p>Bloc 2 : Comprendre le lien entre son et inhibition de la réponse pas évidente</p> <p>Bloc 3 : Nécessaire de donner un minimum de consignes pour comprendre</p>	<p>Apprentissage par essai-erreur</p> <p>Image Homme triste/content pas facile à différencier</p>	<p>Corriger temps de présentation des consignes</p> <p>Bloc 5-9 trop d’items ?</p> <p>Nécessité de se concentrer plus longtemps afin de se rappeler de l’avant dernière configuration</p>
<p><u>A12</u></p>	<p>Mettre pousse feedback pour la réponse correcte</p> <p>Mettre que des formes pleines pour local et creuses. Pour global</p>	<p>Changer les items consignes : augmenter au fur et à mesure</p> <p>Bloc 3 : whitescreen</p>	<p>Essai ++</p>	<p>Difficulté à distinguer les sons, peut être rajouter des sons des instruments mais problème, car autres sons peuvent activer de l’affectif</p>	<p>Ok</p>	<p>Revoir les blocs</p> <p>Augmenter les tests nback ?</p>

A13	Bloc 1 : Compréhensible mais après plusieurs essais	Des difficultés à maintenir les consignes dans la durée	Rajo uter des essais	Compr éhensible	Pas tout compris	Compréh ensible
	Compliq ué de comprendre le passage d'un bloc à un autre Comme nt faire pour enregistrer les BR	Langage ? Haut et bas, Droite et gauche = Concepts non acquis / Solution : Coller les mains sur les touches pour inciter/ faciliter les réponses		Discri mination des sons ok Moye n de revenir en arrière ?	Monsi eur – appui côté monsieur : pensait que les possibilités de réponses ne changeront pas. Mais dans l'ensemble, compris l'épreuve Image homme triste pas très discriminant	Dernier bloc plus compliqué – retenir l'avant dernier

Changes made after taking into account the feedbacks :

- Inclusion of feedback in the learning section
- Improvement of the 'instructions' sections with more detailed images
- Addition 'white screens' between blocks within the same trial to make it easier to move between the trial and test phase
- Equalisation of trial and test items for each block and trial
- Integration of the middle key of the keyboard
- Smiling faces task: Deleted the display of the 4 answers in blocks 1 and 2, as there is too much information
- Sound shift task: Adding a demonstration phase
- Local/global task: Addition of color primers/ solid-local and hollow-global figures, but problematic when the local and global image is identical (e.g. large star made up of small stars) /abandon
- TicTacToe task: Modification of the test, no more low memory load, and high memory load blocks but only two blocks: block 1 - Nback and block 2 - Nback-1 with 3-6 random presentation grids

ANNEX 3: PSSM exercises

TITRE: Sport Adapté -Enchaînement Mouvements

OBJECTIFS: Pouvoir enchaîner 1 série de 10 mouvements consécutifs.

Développer la concentration
Développer les attitudes de cohésion

MATERIEL:
Des ballons et/ou des cerceaux

Durée	Activité	Consignes
30 mns	L'éducateur sportif nous montre 1 série de 2 mouvements. Les participants observent la série. Au signal de l'encadrant ils doivent exécuter les mouvements. A chaque fois, l'animateur ajoute 1 série de mouvements jusqu'à arriver à 10.	<ol style="list-style-type: none"> Observer les enchaînements Au signal reproduire les mêmes gestes. Arriver à tout reproduire dans l'ordre
EVALUATION: L'animateur doit être attentif à ce que les participants effectuent les bons gestes, dans le même ordre que lors de la présentation.		

TITRE: Mémoire auditive
Plusieurs modules ou méthodes possibles, par exemple : Un vieux chef de tribu qui va prendre, retraite cherche son successeur en proposant l'activité musicale décrite ci-dessous, (variantes possibles dans le scénario et dans le choix des instruments).

OBJECTIFS:
Développer la mémoire auditive
Développer la concentration
Développer les attitudes de cohésion avec les autres

MATERIEL:
Un tambourin et la baguette
Des claves

Durée	Activité	Consignes
	Chaque participant possède une paire de claves. Le chef possède le tambourin. Il frappe un rythme et laisse le groupe s'imprégner de celui-ci. Au signal vocal „HOP” le groupe joue le même rythme. Puis le chef s'arrête et le groupe continue de jouer sans lui. Puis, le chef désigne d'un signe de la main la personne qui va s'arrêter de jouer (arrêter en priorité les personnes qui sont en difficulté). Le chef fait taire tous les participants un à un. Répéter l'exercice avec des rythmes de plus en plus complexes.	<ol style="list-style-type: none"> Prendre deux claves. Les manipuler librement. S'asseoir en cercle Ecouter le chef Au signal vocal „HOP” reproduire le rythme du chef Continuer de jouer quand le chef s'arrête Au signal manuel du chef, s'arrêter de jouer (un à un)
Evaluation Evaluation par le chef (l'animateur) sur : <ul style="list-style-type: none"> - La mémoire auditive : la capacité à reproduire le rythme - La concentration - L'écoute des autres, l'attention portée au groupe 		

TITRE: Mémoire auditive (1er module)
Plusieurs modules ou méthodes possibles, par exemple : Un vieux chef de tribu qui va prendre, retraite cherche son successeur en proposant l'activité musicale décrite ci-dessous, (variantes possibles dans le scénario et dans le choix des instruments).

OBJECTIFS:
Développer la mémoire auditive
Développer la concentration
Développer les attitudes de cohésion avec les autres

MATERIEL:
Un tambourin et la baguette
Des claves

Durée	Activité	Consignes
	Chaque participant possède une paire de claves. Le chef possède le tambourin. Il frappe un rythme et laisse le groupe s'imprégner de celui-ci. Au signal vocal „HOP” le groupe joue le même rythme. Puis le chef s'arrête et le groupe continue de jouer sans lui. Puis, le chef désigne d'un signe de la main la personne qui va s'arrêter de jouer (arrêter en priorité les personnes qui sont en difficulté). Le chef fait taire tous les participants un à un. Répéter l'exercice avec des rythmes de plus en plus complexes.	<ol style="list-style-type: none"> Prendre deux claves. Les manipuler librement. S'asseoir en cercle Ecouter le chef Au signal vocal „HOP” reproduire le rythme du chef Continuer de jouer quand le chef s'arrête Au signal manuel du chef, s'arrêter de jouer (un à un)
Evaluation Evaluation par le chef (l'animateur) sur : <ul style="list-style-type: none"> - La mémoire auditive : la capacité à reproduire le rythme - La concentration - L'écoute des autres, l'attention portée au groupe 		

TITRE: Mémoire auditive „Jeux des Bougies” (2ème module)

OBJECTIFS: Idem Fiche 1 mais objectifs plus poussés
Développer la mémoire auditive
Développer la concentration
Développer les attitudes de cohésion avec les autres

MATERIEL:
Un tambourin et la baguette
Instruments divers: claves, maracas, tambourins, xylophones...

Durée	Activité	Consignes
	Chaque participant choisi et essaye son instrument. Le chef garde le tambourin. Il frappe un rythme et laisse le groupe s'imprégner de celui-ci. Par un appel visuel (regard insistant) le chef invite un participant à jouer avec lui (il allume une bougie de manière symbolique). Ce participant invite à son tour une autre personne à jouer et ainsi de suite jusqu'à ce que tout le groupe joue avec le chef. Puis le chef s'arrête et le groupe continue de jouer sans lui. Ensuite, le chef arrête un à un les participants d'un signe de la main.	<ol style="list-style-type: none"> Choisir un instrument et l'essayer S'asseoir en cercle Ecouter le rythme joué par le chef et le regarder Lorsque vous recevez un appel visuel vous jouez. Quelques instants après c'est à votre tour d'inviter une autre personne à jouer. Continuer de jouer quand le chef s'arrête Au signal manuel du chef s'arrêter de jouer (un à un)
Evaluation Evaluation par le chef (l'animateur) sur : <ul style="list-style-type: none"> - Le respect des consignes - La mémoire auditive : la capacité à reproduire le rythme - La concentration - L'écoute des autres, l'attention portée au groupe 		

TITRE: Mémoire auditive (3ème module)

OBJECTIFS:

Développer la mémoire auditive
 Développer l'écoute
 Développer la concentration
 Développer l'imagination : laisser libre cours à son imagination à partir des sensations ressenties, les yeux fermés, que rêve-t-on ?

MATERIEL: baton de pluie, gaine électrique, sifflets, claves, clochettes, castagnettes, maracas, tambourins, baguettes chinoises avec 3 supports (verre, terre, fer), crécelle, vache qui se retourne

Durée	Activité	Consignes
20 mns par séance	<p><u>En 2 temps :</u></p> <p>1) Les participants écoutent les différents sons joués par l'animateur en cherchant à se souvenir de l'ordre.</p> <p>2) Après le choix par chacun d'un instrument, le groupe joue en respectant l'ordre d'apparition des instruments tel qu'il a été joué par l'animateur dans la première partie de l'exercice. Ce dernier harmonise les interventions par des signes pour guider.</p> <p>Dans les séances suivantes, le jeu se complexifie:</p> <p>3) L'animateur introduit plus de sons (6 à 7)</p> <p>4) Les participants inventent une histoire intégrant les différents sons.</p> <p>5) Le groupe joue alors des différents instruments en respectant leur apparition en fonction de l'histoire narrée par l'animateur.</p>	<p>1) L'animateur demande aux participants assis en cercle de fermer les yeux et d'écouter en se concentrant sur les sons qu'ils vont entendre et leur ordre d'apparition (4 à 5 sons max)</p> <p>2) Chaque participant choisit un instrument.</p> <p>L'animateur, chef d'orchestre invite alors chacun par un geste à jouer puis stopper (plusieurs personnes peuvent jouer en même temps).</p> <p>3) Idem 1er exercice avec plus de sons.</p> <p>4) L'animateur propose aux participants d'inventer une histoire avec les différents sons.</p> <p>5) L'animateur invite les participants à jouer à nouveau, à partir de l'histoire inventée ensemble qu'il va raconter.</p> <p>6) Variante plus difficile: L'animateur laisse le groupe jouer sans chef d'orchestre.</p>
Evaluation		

TITRE: Mémoire Haptique (le toucher)

OBJECTIFS: Stimuler la mémoire haptique à partir d'objets cachés

MATERIEL: 2 sacs opaques / Fruits secs: amande, noix, noisette, châtaigne, marron d'inde pistache et un intrus ...

Ou bien fruits frais: pomme, poire, orange, pamplemousse, citron, mandarine, kiwi et un intrus

Durée	Activité	Consignes
30 min	<p><u>1. Présentation des 2 sacs :</u></p> <p>- sac n°1 contenant 1 fruit. - sac n°2 contenant tous les fruits.</p>	<p>Toucher le fruit du sac n°1 Le retrouver (par le toucher) dans le sac n°2</p>
30 min	<p><u>2. Présentation des 2 sacs :</u></p> <p>- sac n°1 contenant 3 ou 4 fruits - sac n°2 contenant ces mêmes fruits et un intrus.</p>	<p>Retrouver l'intrus par le toucher.</p>
20 min	<p><u>Evaluation :</u> La semaine suivante, présenter une série de photos correspondant aux fruits qui étaient dans le sac (les fruits utilisés précédemment) Présenter le sac contenant l'ensemble des fruits.</p>	<p>Par le toucher, retrouver le fruit correspondant à la photo montrée.</p>

TITRE: Mémoire visuo-spatiale

OBJECTIFS:

Stimuler la mémoire visuo-spatiale à partir d'une randonnée
 Développer l'activité physique

MATERIEL:

Appareil photo
 Sacs pour la cueillette (suivant le lieu)
 papier, crayon, plan

Durée	Activité	Consignes
1h30	<p><u>1 Marche</u></p> <p>Je dessine ou je prends des notes</p> <p>Je photographie</p> <p><u>2 Exploitation en salle</u></p> <p>Avoir développé les photos et y ajouter 3 intrus.</p>	<p>Expliquer le but de l'activité: mémoriser un trajet afin d'être capable de l'expliquer à quelqu'un. Prendre des repères : appareil photo ou/et papier - crayon. Oralement, préciser les lieux par lesquels on passe.</p>
10min	<p>Reformuler le trajet.</p>	<p>Reformuler le trajet de différentes façons.</p>
20min	<p>A l'aide des photos retrouver les lieux et supprimer les intrus. Mettre les photos dans l'ordre.</p>	<p>Id</p>
10min	<p>Sur le plan tracer le trajet.</p>	<p>Id</p>
20min	<p>Dessiner le trajet et y positionner les photos.</p>	<p>Id</p>
Evaluation		
<p>Faire une randonnée avec un 1/2 groupe. Leur demander d'accompagner l'autre 1/2 groupe pour refaire la ballade.</p>		

TITRE: RANDONNÉE

OBJECTIFS: Stimuler la mémoire visuo-spatiale
 Développer l'activité physique

MATERIEL: Appareil photo / Sacs pour la cueillette (suivant le lieu) / Papier crayon
 Plan

Durée	Activité	Consigne
1h30	<p><u>1 Marche</u></p> <p>Je dessine ou je prends des notes</p> <p>Je photographie</p> <p><u>2 Exploitation en salle</u></p> <p>Avoir développé les photos et y ajouter 3 intrus.</p>	<p>Expliquer le but de l'activité: mémoriser un trajet afin d'être capable de l'expliquer à quelqu'un. Prendre des repères : appareil photo ou/et papier - crayon. Oralement, préciser les lieux par lesquels on passe.</p>
10min	<p>Reformuler le trajet.</p>	<p>Reformuler le trajet de différentes façons.</p>
20min	<p>A l'aide des photos retrouver les lieux et supprimer les intrus. Mettre les photos dans l'ordre.</p>	<p>Id</p>
10min	<p>Sur le plan tracer le trajet.</p>	<p>Id</p>
20min	<p>Dessiner le trajet et y positionner les photos.</p>	<p>Id</p>
Evaluation		
<p>Faire une randonnée avec un 1/2 groupe. Leur demander d'accompagner l'autre 1/2 groupe pour refaire la ballade.</p>		

TITRE: Intégration sensorielle (mémoire émotionnelle)

OBJECTIFS: stimuler la mémoire à partir des émotions suscitées par l'utilisation de nos sens

MATERIEL:

1 boîte opaque sur 3 cotés avec 5 matières . Ex : bois, pierre, cuir, coton, soie
 5 flacons d'odeurs. Ex : vanille, cire, muguet, menthe, citron (+2 intrus pour la variante
 + 5 fruits. Ex: noix, noisette, amande, olive, mandarine (+ 2 intrus pour la variante 5)
 + 5 images abstraites (+ 2 intrus pour la variante 5)
 + 5 sons. Ex: claves, sifflet, eau + 2 golets, brosse, souffle, clochette
 + 1 fiche pour inscrire les choix des participants (ci-jointe)

Durée	Activité	Consignes
30mns par séance en 2 temps	En 2 temps: 1) Chaque participant choisit spontanément 1 son, 1 odeur, 1 fruit, 1 matière et 1 image. 2) L'animateur demande à chaque participant de se remémorer ses choix. Séances suivantes, le jeu se complexifie: 3) 1ère variante : on doit nommer ses choix et non plus les montrer lors de la restitution (Introduction du langage) 4) 2ème variante : chaque participant choisi non plus pour lui mais en pensant à une autre pers. 5) 3ème variante: Lors de la restitution, l'animateur introduit des intrus (autres images, autres sons...)	1) L'animateur étale sur la table les fruits et images. Il fait entendre les sons (sans montrer les instruments), sentir les odeurs et toucher les objets dans la boîte sans les montrer. Chaque participant doit choisir 1 matière, 1 odeur, 1 fruit, 1 image et 1 son, parmi les propositions. L'animateur inscrit les choix des participants sur sa fiche (ci-jointe) 2) Une heure plus tard, chaque participant devra être capable de restituer ses choix en les désignant lors d'une 2ème présentation par l'animateur. 3) 1ère variante : lors de la restitution, chacun devra nommer son choix sans que l'animateur ne rappelle les sons, images... 4) 2ème variante : L'animateur propose de choisir non plus pour soi-même mais „si c'était pour X „(en nommant un autre participant). 5) 3ème variante : Lors de la restitution, l'animateur (sans le préciser aux participants) a rajouté des intrus (images, matières, odeurs...).
Exercice de base		
Activité en 2 temps : - environ 3 mns par participant pour le choix. - 3 mns par participant pour la restitution.		
	Evaluation	

TITRE: Flexibilité mentale

OBJECTIFS: Stimuler la flexibilité mentale

MATERIEL: Jeu Bazar Bizarre

Durée	Activité	Consignes
Difficulté 1	Disposer les objets sur la table et la pioche précédemment formée. Un des joueurs retourne une carte de la pioche. Tous les joueurs jouent en même temps. Le but du jeu est d'attraper le plus vite possible l'objet représenté à l'identique sur la carte. Ex : sur la carte sont représentés un fauteuil bleu et un fantôme blanc. Celui qui s'empare le plus vite possible du fantôme remporte la manche.	Trier les cartes du jeu : faire une pioche avec les cartes où sont représentés sur l'image au moins un des objets à l'identique (forme et couleur identique)
Difficulté 2	Disposer les objets sur la table. Former une pioche avec toutes les cartes du jeu. Un des joueurs retourne une carte de la pioche. Tous les joueurs jouent en même temps. Le but du jeu est, cette fois, d'attraper les objets représentés sur la carte (on joue avec la forme et non la couleur)	Jouer avec l'ensemble des cartes
Difficulté 3	Disposer les objets sur la table. Former une pioche avec toutes les cartes du jeu. Un des joueurs retourne une carte de la pioche. Tous les joueurs jouent en même temps. La consigne change : il faut attraper les objets dont la couleur est représentée sur la carte (on joue avec les couleurs et non plus les formes)	Jouer avec l'ensemble des cartes
Difficulté 4	Disposer les objets sur la table. Former une pioche avec toutes les cartes du jeu. Un des joueurs retourne une carte de la pioche. Tous les joueurs jouent en même temps. Le but du jeu est de prendre l'objet pour lequel ni la forme ni la couleur ne sont représentés. Exemple : la carte représente 1 fauteuil vert et 1 fantôme gris. Je dois donc prendre le livre bleu.	Jouer avec l'ensemble des cartes

ANNEX 4: Feedback of the pretesting of the PSSM

Remarques générales :

Présence aux ateliers : entre 3 et 6 personnes

Durée moyenne : 1h30

Public comprenant relativement bien le français, réalisation rapide des exercices car bonne compréhension des consignes, et nombre de participants peu élevé.

Introduction en début de séance de la revue de presse pour augmenter la durée totale des séances.

<p>Séance 1 : 5 participantes. - Mémoire gestuelle : RAS - Mémoire haptique : Un certain temps a été nécessaire pour comprendre la consigne. Question: Doit-on mettre des fruits secs qui se ressemblent ? Nous avons mis châtaigne et noisette : un peu de difficulté pour les distinguer. NB : si beaucoup de monde : partager le groupe en deux, puisque les participants sont passifs en attendant leur tour. - Mémoire auditive : bonne compréhension de la consigne.</p>	<p>Séance 2 : 3 participantes. - Revue de presse. - Mémoire gestuelle : RAS - Mémoire haptique : exercice réussi, mais difficulté pour expliquer la consigne. Surtout pour trouver l'intrus : terme compliqué : celui qui n'y était pas avant... Déterminer une consigne claire. - Mémoire auditive : RAS, chacune a pris la place de chef. Nous notons l'importance que chacune puisse jouer, essayer les instruments, tester des rythmes. - Flexibilité mentale : Il est indispensable d'expliquer la consigne avec des exemples. Si beaucoup d'erreur : faire jouer un par un en guise d'exemple, et expliquer. Puis jouer à nouveau ensemble.</p>
<p>Séance 3 : 5 participantes. Mauvais temps donc changement de séance. - Mémoire gestuelle. - Revue de presse. - Mémoire olfactive : même remarque que pour la mémoire haptique : difficulté de donner une consigne facilement compréhensible, le concept d'intrus est compliqué. Doit-on plutôt faire trouver les odeurs déjà senties plutôt que l'intrus ? Dans ce cas n'est-ce pas trop facile ? Lors de cette séance nous avons eu la chance d'avoir une stagiaire parlant arabe et berbère qui a pu traduire. - Tangram. - Mauvaise prise (jeu identique à bazar bizarre).</p>	<p>Séance 4 : 5 participantes - Randonnée - Mémoire gestuelle (lors de la promenade)</p>
<p>Séance 5 : 5 participantes - Revue de presse. - Mémoire olfactive : Faut-il prendre des odeurs très différentes ? Ou augmenter la difficultés avec des odeurs similaires. Toujours la même difficulté d'explication de la consigne. - Mémoire visuo-spatiale : Ne pas mettre plus de 10 photos, prises de vue facilement reconnaissables. <u>Remarques</u> : pendant la promenade les dames discutées et n'étaient pas très attentives à l'itinéraire. Pour pallier à cela faut-il capter leur attention à certains endroits ou repères visuels, décrire le trajet oralement ? Faut-il qu'elles prennent elles-mêmes les photos, ou bien l'animatrice le fait sans attirer leur attention ? - Flexibilité mentale - Tamgram</p>	<p>Séance 6 : - Revue de presse. - Mémoire verbale : difficulté à se rappeler des mots : elles retiennent plus facilement des onomatopées. Remarques : comment travailler la mémoire verbale sans langage ? - Mémoire haptique : Mettre le même nombre de chaque fruit. - Mémoire auditive</p>
<p>Séance 7 :</p>	<p>Séance 8 :</p>

<p>3 participantes Revue de presse. - Mémoire verbale : - Mémoire visuelle 1 : faire un tapis de jeu avec des cases pour replacer facilement les images à la bonne place) -Jeu Rondin des Bois : mémoire visuelle.</p>	<p>6 participantes - Revue de presse. - Mémoire gestuelle. - Mémoire olfactive. - Mémoire Visuelle. - Jeux Rondin des Bois</p>
<p>Séance 9 : Présentes : Aïcha, Sarah, Nellie, Nessma, Houria - Mémoire verbale : 10min - Remettre dans l'ordre : ok. Puis explication du chemin « retour » - Memory visuelle : 25min - Memory niveau 2 et 3 - Jeux : 15 min - Mémoire verbale : remettre en sens inverse : ok puis suite et fin du conte.</p>	<p>Séance 10 : 3 participantes. - Mémoire sensorielle - Mémoire verbale : restitution du conte et remise dans l'ordre des images dans le bon ordre. OK, se rappelle du vocabulaire dans sa globalité et des onomatopées. - Mémoire visuelle : memory forme géométrique et magasin : ok - Mémoire sensorielle : restitution des choix de départ - Flexibilité mentale : 3 consignes : 1 couleur ; 2 formes, 3 ce qui n'y est pas - Puzzle</p>
<p>Séance 11 : Sortie en ville</p>	

ANNEX 5 : AAP CARSAT

Projet METIS

EVALUATION ET PRISE EN CHARGE POUR LES PERSONNES VEILLISSANTES FRAGILES DU FAIT DU LANGAGE ET DE LA CULTURE

Porté par Sophie Martin, Laboratoire Epsilon, Université Paul Valéry

Que ce soit pour les personnes vieillissantes de faible niveau socio-culturel ou celles issues de l'immigration, il n'existe pas en France à l'heure actuelle de batterie d'évaluation cognitive qui s'affranchissent complètement de l'impact du niveau de lecture et d'écriture sur les performances évaluées (Ardila, 2001). Cette absence d'outil adapté entraîne des soins à deux vitesses et majorent l'isolement des plus fragiles. Or, nos collègues européens ou encore des Etats-Unis du nord et du Canada ont déjà mis en œuvre, de façon multicentriques, un système d'évaluation transculturel qui s'affranchit du niveau de langage (i.e. Nielsen et col, 2019). En collaboration avec ces laboratoires étrangers, nous proposons de tester l'usage de cette batterie CNTB auprès de personnes fragilisées de la région, et de mettre à l'épreuve sa sensibilité par l'évaluation de l'impact de séances de remédiation de la mémoire qui s'affranchissent elles-mêmes de la culture et du langage.

Origine de la recherche :

Nous avons reçu une demande très forte de la part des intervenants de terrain concernant 1) la constitution d'une batterie d'évaluation de la cognition et de la fragilité à destination personnes vieillissantes de faible niveau socio-culturel et 2) le développement de séances de remédiation cognitive s'affranchissant de tout prérequis culturel. En effet, les retours d'expérience et la recherche pointent notre incapacité actuelle à diagnostiquer et prendre en charge les aînées de faible niveau socio-culturel. Plus que le niveau scolaire, les travaux récents montrent que c'est le niveau d'accès à l'écriture et à la lecture qui constituent une réelle situation de handicap. C'est tout particulièrement vrai pour la population immigrée âgée qui représente un public fragile car un des nombreux obstacles qu'elle rencontre est la barrière de la langue. Ceci concerne plus de 805 000 personnes de plus de 55 ans selon le « rapport d'information sur les immigrés âgés » (rapport N° 1214).

Objectif 1 : Traduire en français la batterie d'évaluation cognitive CNTB dont l'innovation est d'être interculturelle et non sensible au niveau socio-éducatif destinée aux personnes vieillissantes fragiles (bas niveau socioculturel et issue de l'immigration).

Objectif 2 : Tester l'usage de cette batterie en évaluant l'impact d'une remédiation de la cognition (indépendante du langage et du niveau éducatif) sur la confiance cognitive et la qualité de vie des personnes vieillissantes fragiles.

Objectif 3 : Proposer un ensemble de préconisations concernant l'évaluation des interventions auprès des personnes vieillissantes fragiles.

Résultats attendus :

- Bonne adhésion à la batterie d'évaluation par les personnes vieillissantes issues de l'immigration et fragilisées (objectifs visés 90 % de participation avant et après l'intervention, donc projection d'une faible mortalité de l'échantillon au cours de l'étude contrairement à d'autres type d'évaluation)
- Modification des représentations mentales des usagers vieillissants sur le fonctionnement cognitif et le système de santé concernant la prise en charge des troubles de la mémoire (évaluée par l'analyse lexicale par le logiciel IRAMUTEQ des paroles des usagers issus de l'immigration et fragilisés recueillis par des entretiens semi-dirigés)
- Adhésion aux ateliers sensorimoteurs estimée par le nombre de présences à chaque séance tout au long du dispositif (objectif visé 80% de participation complète)
- Augmentation du sentiment d'auto-efficacité cognitive estimé par des questionnaires personnalisés pour chaque participante.

Les indicateurs d'atteinte de nos objectifs (attendus) seront les livrables suivants :

- Traduction française de la batterie d'évaluation cognitive, The Cross cultural neuropsychological battery (CNTB) dont l'innovation est d'être interculturelle et non sensible au niveau socio-éducatif destinée aux personnes vieillissantes fragiles
- Communication orale en colloque scientifique des résultats : Colloque pressenti - International convention of psychological science, ICPS Prague 2020
- Article scientifique : Revue scientifique pressentie - Rehabilitation psychology (American Psychological Association)
- Bilan final du projet comprenant 1) un ensemble de préconisations concernant l'évaluation des interventions auprès des personnes vieillissantes fragiles et issues de l'immigration, 2) une cartographie lexicale heuristique des représentations mentales de ces mêmes personnes sur la cognition et le système de soin et 3) un ensemble de pistes d'amélioration des propositions d'ateliers mémoire fournies par les usagers eux-mêmes

ANNEX 6: AAP MAURITIUS

<p>Appel à projets de recherche France MAURICE/ Call for Research Projects France MAURICE</p> <p>Le Réduit 2020 Dossier de candidature / Application File</p>

Nom du projet / Project Title: Mauritian cross-cultural neuropsychological battery for aging population	
In France	In Mauritius
Responsable scientifique / Project coordinator: Dr Sophie Martin (Maître de conférences)	Responsable scientifique / Project coordinator: Dr Uma Bhowon
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Domaine de recherche/spécialisation / Field of Research / Specialty : Cognitive Psychology, Clinical and Cognitive Neuropsychology	Domaine de recherche/spécialisation / Field of Research / Specialty : Cognitive Psychology/ Work-Family/Family-Work Conflict
Nom du laboratoire / Laboratory name : Epsilon EA 4556	Nom du laboratoire / Laboratory name: none attached
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Project Team

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Institution de recherche/université / Research Institution/University Name: University of Montpellier, Paul Valéry	Institution de recherche/université / Research Institution/University Name: Global Rainbow Foundation (GRF)
Domaine de recherche/spécialisation / Field of Research / Specialty : Cognitive Psychology	Domaine de recherche/spécialisation / Field of Research / Specialty :
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Signature : Le Président Patrick GILLI	Signature : Armand Carpooran

Dossier de candidature Le partenariat Hubert Curien le Reduit. 2020.

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PROJET DE RECHERCHE/RESEARCH PROJECT

Résumé / Summary

Le résumé doit expliquer clairement (a) l'importance de la collaboration internationale et franco-mauricienne, (b) l'excellence scientifique et les objectifs principaux, (c) la méthodologie, (d) les actions principales, (e) les résultats attendus.

The summary is expected to clearly explain: (a) importance of international and France-Mauritius collaboration, (b) scientific excellence and main objectives, (c) methodology, (d) main actions (e) expected results

Project Name

Mauritian cross-cultural neuropsychological battery for the aging population

Résumé / Summary

Life expectancy in Mauritius has significantly grown in recent years due to a high-quality and long-term public health care system. Despite these gains, Mauritius still faces important health challenges led by diabetes (type 2, Diabetes Mellitus, DM) and dementia (Alzheimer's Disease, AD)⁵. Both AD and DM can have an enormous impact on a patient's quality of life, and are associated with substantial health care

⁵ https://arc2018.aarpinternational.org/File%20Library/Countries/2018_Mauritius.pdf

costs. However, both are still underdiagnosed. A meta-analysis on epidemiological studies of cognitive impairment in patients with DM found evidence that these patients have a higher risk of both vascular dementia or AD (Pasquier *et al.*, 2006). Moreover, they have also highlighted that there is a strong link between DM and moderate cognitive impairment, on memory and executive functions (Pasquier *et al.*, 2006). Indeed, diabetes silently damages the brain, leading to early cognitive difficulties. The burden of diabetes in the elderly population is high as it increases the risk of complications, loss of cognitive functions and mobility, and the risk of dependence. It is important to act early because when those cognitive difficulties prevent the acts of everyday life, it becomes a major cause of disability. In that context, it must be noted that the assessment of cognitive disorders is neither satisfactory nor systematic. Actually, cognitive measures are insufficiently adapted due to language and cultural differences in individuals. Mauritius has a multi-ethnic background (Asian Indian Hindus, Asian Indian Muslims, Chinese, and Creoles), and mastering all of the languages spoken in Mauritius (Creole, French, English, Hindi, Arabic) has been mostly a heritage to the new generation rather than the elderly. As a result, part of the Mauritian elderly population has a limited education level or proficiency in a language, which makes them even more vulnerable to the effects of aging. The question that we raise presently is a transnational and global issue: How do we evaluate cognitive deficits in populations with limited educational level or when the language used in assessments are not adapted? We propose in this current project to provide an alternative approach to evaluate cognitive deficits through a cross-cultural neuropsychological battery (CNTB, Nielsen *et al.*, 2018). The aim of this research is to measure the feasibility and acceptability of a clinical tool that has reduced biases relative to culture and language. Finally, we hope to provide Mauritius health care and wellness system, a leap of progress in its support to the elderly population by promoting an intercultural and standardized cognitive assessment.

Mots clés / Key words: Cognitive assessment, aging, diabetes, cognitive deficits

1. Description du projet de recherche incluant le positionnement, les objectifs et hypothèses. Ces objectifs doivent être clairs, mesurables, réalistes et réalisables.

Projects description, including scope, objectives, and hypothesis. The objectives should be clear, measurable, realistic, and achievable within the duration of the project.

The history of a country lies in the memories of the elders. However, the advancing age compromises this memory that holds the vestiges of our past. Mauritius, along with European countries, has an aging population with an increased life expectancy, improved health, and quality of life attributed to remarkable progress in the medical/paramedical field. Nevertheless, the effects of normal or pathological aging remain a major issue. Alzheimer's Disease (AD) and Diabetes Mellitus (DM) are known to be the most popular diseases that affect the aging population. Both of these non-communicable diseases share a lot of common features, let aside the substantial health care costs that they generate on the state. Studies show that type 2 diabetes can be a risk factor for Alzheimer's disease, cerebrovascular disease, and other types of cognitive impairment because cardiovascular problems associated with diabetes are also associated

with cognitive disorders (Chatterjee & Mudher, 2018). A 7-year follow-up Hisayama study on an aging population of 828 residents found out that there was an increased risk of vascular dementia associated with a diagnosis of diabetes (Yoshitake T *et al.*, 1997). DM, as reviewed by the few epidemiological studies that exist to date, show evidence of the latter disease to be associated with cognitive impairments both for memory, executive functions, attention, concentration, and verbal fluency (Craik, 1986, Miyake *et al.*, 2000, Pasquier *et al.*, 2006.). These deficits lead to difficulties in handling and following treatments against diabetes.

The literature highlights different theories related to the impact of aging on cognition. Aging affects not only the cognitive sphere but also senses such as perceptual, auditory and motricity (Brouillet *et al.*, 2018) with varying degrees of vulnerability in individuals. It has been noted that aging participants compared to younger ones seem to have poorer performances. These differences in performances could be explained by the theory of slowing down developed by Salthouse (1996, 2000) or by recent theories of embodied cognition (Lindenberger and Baltes., 1997, Vallet, 2015). Embodied cognition hypothesis holds that our actions and the comprehension of the latter arise from the ongoing interaction of our body and its complex environment (Lakoff and Johnson., 1980). An individual's cognition is closely linked to the way he perceives his environment as well as how he acts in it. As such, concomitant physical and perceptual changes resulting from aging can provide plausible explanations for the cognitive deficits they experience (Glenberg *et al.*, 2013, Vallet *et al.*, 2015).

Cognitive assessment in neuropsychology has been used as a predictive instrument, as a probability measure of a manifestation of a neuropathological condition, or as a measure of the cognitive consequences of a particular brain disorder (Lezak, Howieson *et al.*, 2004). The goal of clinical neuropsychology is to diagnose the presence of brain damage and dysfunction as well as the preserved cognitive and executive functions, emotion, and motivation. Assessment is also often used to facilitate patient care and rehabilitation and is useful as a baseline for cognitive training. However, some researchers have pointed out that cognitive evaluations are very limited when it comes to understanding individual differences (Ardila, 1995; Helm, 1992). Evaluations of ethnic populations in a cross-cultural setting have often proved to be inappropriate or even misleading due to educational, linguistic, and cultural factors (Nielsen *et al.*, 2016). Whether for aging people of low socio-cultural background or those with an immigrant background, there is currently a lack in cognitive evaluation battery that completely eliminates the impact of the level of education, reading and writing on evaluated performances (Ardila, 2003). This lack of suitable tools results in two-tiered care and increases the isolation of the most vulnerable. Hence, cross-cultural evaluations appear as an important approach in understanding the cognitive processes of the elderly ethnic populations.

In France, the "Information Report on Older Immigrants" (Report N ° 1214 of the National Assembly) and several INSEE studies show that a significant number of immigrants suffer from illiteracy or illiteracy, a very low level of education and there is a lack of appropriate tools to evaluate cognitive deficits in this population. In Mauritius, the 2014 Observatory report on aging shows that there are major gaps in the health system concerning specialized care, support, and awareness for the elderly suffering from diabetes and dementia. Hence, the question that we are pointing out is a transnational and global problem. The issue of a cross-cultural evaluation, to our knowledge, has been addressed in only a few studies to our knowledge (see Ardila *et al.*, 2003; Nielsen *et al.*, 2018).

Our European colleagues or the United States of North and Canada have implemented, in a multicentric way, a transcultural evaluation system that frees itself from the level of language (i.e. Nielsen *et al.*, 2019). In collaboration with these foreign laboratories, we propose to measure the feasibility of the CNTB in a vulnerable population. The CNTB (Nielsen *et al.*, 2018) brings together several tools to evaluate the efficiency of different cognitive domains: global cognitive function, memory, executive functions, and visuospatial functions. This battery has been tested through a multicenter cross-sectional study of 330 participants from 22 different countries, including Moroccans, Pakistanis, Poles, Turks, and Western Europe. The statistical results show that the CNTB is clinically significant and is consistent with the construction validity of the test. The main advantage of the CNTB is that this test is simple and relatively short to administer (60minutes) while avoiding the impact of cultural, linguistic, and educational characteristics of the population concerned. Despite the wide range of cultures tested, the CNTB has not yet been tested in France neither in Mauritius. In collaboration and agreement with the authors of the test, we can now include this neuropsychological battery in our study to provide additional data on Europe and Mauritius.

The project that we submit to your interest and expertise is an exploratory work in view to generalize a novel type of standardized cognitive evaluation to distinguish between the different types of cognitive deficits either relative to DM or AD. Therefore, it will be centered on a 1) testing the feasibility of a cultural cross-cultural evaluation battery such as the CNTB. Precisely, we have two objectives:

Objective 1: To test the feasibility of the cognitive neuropsychological evaluation battery (CNTB) whose innovation is to be intercultural and not sensitive at the socio-educational level intended for frail aging people.

Objective 2: To test the acceptance of the CNTB by patients and professionals and propose modifications to the battery if needed.

2. *Description du caractère international et innovant du projet. La nécessité et l'importance d'une mise en œuvre du projet grâce à une collaboration internationale ainsi que la description de la valeur ajoutée attendue de cette collaboration doivent être détaillées.*

The international and innovative aspect of the project. The necessity and importance of implementing the project with international collaboration and description of the added value to be expected from the collaboration should be written in detail.

Firstly, we are concerned about the consequences of Diabetes in the Mauritian population. Despite the availability of free health services, continued efforts from the Ministry of Health and Quality of Life (MOH & QOL) to provide easily accessible diabetes care to all patients, the outcome remains poor. Patients have their own lifestyle and diet, set of beliefs, and values and they are very reluctant to change even when faced with serious health issues. There is indeed a high need to understand the psychological/cognitive processes that they are going through in order for professionals to implement and for patients to sustain appropriate rehabilitation approaches. Secondly, in regard to several internships carried out in Mauritius, Mooruth D, Mauritian and a Cognitive Psychologist in France, has faced a significant challenge while assessing her patients. The tools used during her internships had to be translated, thus, they were not standardized to the Mauritian population and could not be interpreted efficiently. A need to provide proper evaluation tools emerged from her observations. On the other hand, there was also been a very strong demand from practitioners at TinHinan Association, who also observed that the immigrant population they are working with had difficulties adhering to French cognitive programs while they did not understand the language. Indeed, these feedbacks and research point to our current inability to diagnose and care for elders with low socio-cultural backgrounds. More than the education level, recent work shows that it is the level of access to writing and reading that constitutes a real handicap situation. Therefore, the problems observed in France and Mauritius seem to have common roots. Mooruth D's PhD work, is focused on finding alternative approaches to classical neuropsychological evaluations, that is, to provide a robust and valid tool to assess the elderly population by eliminating any language barrier that could hinder the process of providing care and support to any individual in need. The existence of the CNTB can be a very powerful tool if we show evidence that they are easily accepted by a multi-ethnic, cross-cultural population. It is therefore an opportunity for Mauritius to enrich their health care system by promoting this intercultural and standardized cognitive assessment.

3. *La méthodologie employée / Methodology*

The study will be carried out in Mauritius at The Global Rainbow Foundation (GRF) in Petit Raffray. GRF is a non-profit association that works with diabetes and disabled patients by providing

them with a complete medical support. We will also take participants from local districts through population registries, relatives to patients in memory clinics, senior centers, voluntary organizations, social networks of bilingual researchers etc.

Participants and Procedure: 20 participants aged above 65years separated in two groups – Controls group and Diabetes Group. All participants will undergo approximately 90-minute assessment, including a structured demographic and medical interview, screening for depression with the MADRS (Montgomery-Asperg Depression Rate Scale, 1997), and the CNTB. All participants will be assessed by trained examiners in their primary language using multilingual research assistants or interpreters when necessary. Tests will always be administered in the same order. Education will be measured as years of formal education and ethnicity will be classified according to country of origin.

Description of the CNTB: The CNTB consists of 12 tests that cover several cognitive domains and designed to (1) be relevant for assessing of cognitive impairment in AD and other dementia disorders; (2) be applied across ethnic groups and languages without need to change the content; (3) be administered with an interpreter in a straightforward manner; and (4) be performed on people with limited or no education. The individual tests in the CNTB are briefly presented in Table 1 (Nielsen et al., 2018).

TABLE 1 Tests in the CNTB

Test	Description	Range of Scores
Global cognitive function		
Rowland Universal Dementia Assessment Scale (RUDAS) ¹⁰	Brief multicultural cognitive screening test containing six items that assess body orientation, praxis, drawing, judgment, memory, and language	0-30
Memory		
Recall of Pictures Test (RPT) ¹⁹	Learn and remember 10 colored pictures on three learning trials; the first trial consists of incidental recall of the pictures. Free recall and recognition of target pictures after a 10-min interference interval.	0-10
Enhanced Cued Recall (ECR) ²⁰	Sixteen colored pictures have to be recalled shortly after presentation, and a semantic cue is given for those pictures that are not freely recalled; the score is the total score of free and cued recall.	0-16
Recall of semi-complex figure ⁹	Copy of semi-complex figure and without forewarning recall it after a 3-min interference interval.	0-22
Language		
Picture naming ⁹	Naming of the 10 colored pictures in the first learning trial on the RPT.	0-10
Category verbal fluency ²¹	Consists of two components: Animals and supermarket items; 1 min for each.	Words produced
Executive functions		
Color Trails Test (CTT) ²²	Has two components: CTT 1 requires participants to connect numbered circles in ascending order; CTT 2 requires participants to switch between pink and yellow colors while connecting circles in an ascending sequence (ie, pink 1, yellow 2, pink 3, yellow 4, and so on).	Time in seconds
Five Digit Test (FDT) ²³	Has three components: FDT 1 requires participants to name a series of 50 digits; FDT 2 to count a series of 50 asterisks; FDT 3 to count a series of 50 digits in which the numeric value of the digits is incongruent with the number of digits.	Time in seconds
Serial threes ²⁴	Participants are required to count down from 20 by threes.	0-6
Visuospatial functions		
Copying of simple figures ²⁵	Copy of two simple figures; a Greek cross and a four-pointed star.	0-6
Copying of semi-complex figure ⁹	Copy of semi-complex figure; the figure used in recall of semi-complex figure.	0-22
Clock Drawing Test (CDT) ²⁶	Insert numbers and indicate the time 10 after 11 in a predrawn circle.	0-5
Clock Reading Test (CRT) ²⁷	Read the time on a series of 12 different clocks without numbers.	0-12

4. *Les résultats attendus / Expected results*

We are expecting a good adherence to the battery of evaluation by the elderly population of different origins (objectives aimed 90% of participation before and after the intervention, thus projection of a low mortality of the sample during the study unlike other types of evaluation). Otherwise, we hope data analysis will provide sufficient content in order to implement any modifications to the CNTB

5. *Actions envisagées et partage des responsabilités. Le détail des travaux/actions mis en œuvre dans le cadre de la coopération internationale ainsi que les responsabilités de chacun des partenaires doivent être indiqués.*

Planned actions and share of responsibilities. The work(s) to be implemented under international cooperation, responsibilities and work descriptions of both partners should be written in detail.

- Protocol design: The current proposed project is part of a thesis work that has started two years ago. We have designed the protocol in collaboration with researchers in France for the general experimental procedure. European authors of the CNTB test were contacted for the rights to use the CNTB in our procedure. The cognitive remediation program was set up in collaboration with an Association in France (TinHinan) that works with an elderly immigration population and where we are presently doing our study.
- Mooruth D, specialized in the evaluation of cognitive functioning and behavior will be in charge of the project in Mauritius, and will be going through the CNTB evaluations herself
- Martin S will be the project coordinator in France, assuring the procedures are respected and the timeline is respected.
- Statistical analysis of the data recorded in Mauritius will be treated by the researcher.
- A complete report and article will be written concerning the results in association with all the project collaborators.
- Lecturers from the University of Mauritius will accompany the researcher in setting up the experimentation in Mauritius and provide consistent follow-up and advice throughout the implementation and realization of the study.
- This feasibility study aims at the submission of a larger project for Mauritius, that is, to evaluate cognitive and psycho-behavioral disorders in diabetes and normal and pathological aging. Funding applications will be submitted at the national and European levels. The search for patronage is also envisioned.
- Finally, once Mooruth D holds her doctorate degree, she can take specific actions in

6. *Le consortium proposé pour le projet / the proposed consortium for the project*

This project aims to facilitate the exchange and expansion of resources and knowledge based on a scientific expertise in cognitive psychological domain between France and Mauritius. The innovative aspect of this emphasizes on adapting cognitive evaluations to individuals instead of having them to adapt to the administered tests. All of the researchers collaborating in this project are in the field of psychology with a specific specialization in cognitive psychology, neuropsychology, clinical psychology.

Doctor Sophie Martin: Psychologist specialized in neuropsychological evaluation, researcher at university of paul valery, Montpellier 3 and scientific co-head of the Cogithon Platform which is an Interdisciplinary participatory social innovation platform focused on disability and functional limitation (UPVM, School of Mines, Lirmm)

Professor Emeritus Denis Brouillet: Psychologist since 1976, Master of Conferences, University Professor from 1995 to 2018, whose research theme is the active approach to memory in both adults and the elderly

Draushika Mooruth: Cognitive psychologist, specializing in the evaluation of cognitive functioning and behaviors, third-year doctoral student specializing in cognitive psychology.

Association Tin Hinan: Association qui lutte pour le Droit de la femme et de la famille à travers la citoyenneté, l'accès à la culture, la santé et la formation.

Dr Uma Bhuwon: Professor of Social Studies at the Faculty of Social Studies & Humanities,

University of Mauritius. She is specialized in organizational behavior with a research interest in Stress, Work-family Interface, Acculturation, Ethics, Interpersonal conflict, leadership, HIV/AIDS

Bundhoo Harshalini: Lecturer in Psychology; Faculty of Social Studies and Humanities, University of Mauritius; 3rd July 2008-present. She is specialized in clinical psychology with a research interest on mental health issues, Personality and Ethics.

Parsuramen Armoogum: Has been a senior advisor at UNESCO in Paris, Senegal, and India. He is presently the founder and director of the Global Rainbow Foundation. Through this mission, he is rethinking how to be of service by leveling the ground for people with disabilities

Global Rainbow Foundation: Association that aims to empower people with special needs and vulnerable groups through Education & Training, in order to leave a happy and rewarding life with dignity and respect in the local and global community, in particular to diabetic patients.

This panel of collaborators is very rich and working together on this will be a huge opportunity to learn from these different fields, as well as to promote creativity and development of new approaches in the management of the psychological health of the population with a low socio-cultural/educational background.

