Les neurosciences au service de l'entrepreneuriat : ce que nous apprend la littérature sur le multitasking.

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Summary: Research on entrepreneurship has grown over the past decade exploring entrepreneurial cognition and the analysis of the ways of thinking of entrepreneurs. The research community believes that value exists in grounding entrepreneurship in neuroscience (Mitchell et al, 2016). The daily routine of entrepreneurs consists widely in executing simultaneous tasks, process known as Multitasking. A question to be inquired is to know if there is a way of developing multitasking habits in order to improve entrepreneurial skills such as speed of information processing (Dux et al., 2009)**,** creativity and adaptability **(**Dye, Green et Bavelier, 2009a, 2009b; Basak et al., 2008; Marmeleira et al., 2009 ; Anguera et al., 2013). Nevertheless, the direct link between the neuroscientific approach to multitasking and entrepreneurship is yet to be uncovered. That is why we conducted an extensive Literature Review on Multitasking.

Résumé : La dernière décennie a mis en lumière la nécessité de mettre en place une éducation et un accompagnement à l'entrepreneuriat plus efficace. Le champ des neurosciences a permis de comprendre les mécanismes cognitifs qui sous-tendent l'action entrepreneuriale (Mitchell et al., 2016). La vie quotidienne des entrepreneurs est faite d'une multitude de tâches à accomplir simultanément et nous pouvons nous poser la question de savoir en quoi les connaissances en neurosciences peuvent éclairer la performance entrepreneuriale et quels mécanismes précis peuvent être un levier positif pour le développement des compétences des entrepreneurs à travers le Multitasking. Des découvertes récentes en neurosciences ont permis de montrer l'impact positif du multitasking sur les facultés cérébrales, telles que la rapidité du traitement d'information (Dux et al., 2009), la créativité et l'adaptabilité à l'environnement **(**Dye, Green et Bavelier, 2009a, 2009b; Basak et al., 2008 ; Marmeleira et al., 2009 ; Anguera et al., 2013)**.** Cependant le lien direct entre l'approche neuroscientifique du multitasking et les performances entrepreneuriales est encore à développer. Une revue de littérature sur le multitasking est donc justifiée.

Introduction and methodology

The first course on entrepreneurship given at Harvard in 1947 and it has seen a huge rise of the Educational scope since the 70's (Katz, 2003; Kurato, 2005). The development of such teaching programs has accelerated within the past 20 years, especially under the pressure of public policies in many countries around the world (Fayolle, Verzat and Wapshott, 2016). They believe that the educational field in entrepreneurship is a motor of growth and innovation as well as a cause of society change and of employment facilitator (European Comission, 2013). The daily routine of entrepreneurs consists widely in executing simultaneous tasks, a process known as Multitasking. A belief among everyday multitaskers states that multitasking increases their task performance (Ophir et al., 2009; Rideout et al., 2010; Strayer et al., 2003; Watson& Strayer, 2010). Indeed, real world participants have shown to have greater flexibility on task prioritization and in adaptive strategies. It is hence a priority for researchers and professionals to seek levers to improve entrepreneurial education: we decided to focus on the poorly explored theme of multitasking as a tool for entrepreneurial enhancement.

The common modus operandi for entrepreneurs known as multitasking - seen as the ability to process multiple tasks simultaneously - has become a new way of working (Courage et al., 2014). The speed of access to information and communication tools fuels the expectation that our cognitive system would be able to analyze, integrate, organize, and respond simultaneously to multiple sources of information efficiently and effectively (Greenfield et al., 2010). Continuous use of computers, for example, involves the frequent interruption of activities (Crook and Barrowcliff, 2001). The omnipresence of the technological supports pushes the phenomenon to extend to all responsibility levels within companies and throughout a large scale of ages. Multitasking continues to become a reality of new ways of working, consciously or not. Since it is a recognized way of working, its performance can and should be improvable through a specific teaching method. We have conducted a thorough literature review on multitasking to appreciate the findings of the scientific field and to distinguish gaps and opportunities of research.

In order to proceed with our literature review, we referenced articles and publications containing key words such as « multitasking » AND «Entrepreneurial Education » OR « entrepreneurial efficiency » OR « entrepreneurial skills » OR « training and practices in entrepreneurship ». We used several data bases like ISI Web of Knowledge, Google Scholar or Ebsco. On 51 articles, we kept and analyzed 32, which were relevant for our purpose. We excluded ones that were redundant or applicable only in very specific cases like NASA. Multitasking has not been considered much as a lever for entrepreneurs to work better in the past. Our approach is being broad in scope to welcome several conceptual frames as well as a variety of article sources. Most articles were taken from the psychology field (45% of the sources), from the entrepreneurial education field (30%), from neurosciences (15%) and from the management field (10%). Definitions and concepts were then gathered according to the scientific scope and we focused on extracting the results and challenges in order to articulate multitasking and entrepreneurship.

The objective of this paper is to present what the multitasking literature teaches us so far and to explore how these notions can be applied to entrepreneurial education and training in order to better prepare future entrepreneurs. We will present the multiple definitions of multitasking, its contributions to the entrepreneurial education field and the possible future research paths. Our study links entrepreneurial performance and multitasking abilities.

1. What is multitasking: multiple definitions

Multitasking is a prevalent behavior within entrepreneurial practice as shown through IT platforms usage in the workplace, at home or within educational structures. Entrepreneurs often switch tasks to check online sites and social media for instance. Studies report that computer users such as modern entrepreneurs have multiple applications open, and switch between them frequently (Crook and Barrowcliff, 2001; Czerwinski *et al.*, 2004) and even managing one's email involves a lot of multitasking (Bellotti *et al.*, 2005). Literature shows that multitasking can hold different definitions depending on how tasks and times are defined (Benbunan-Fich *et al.*, 2011):

- The performance of several tasks at once (Rubinstein *et al.*, 2001) or activities conducted simultaneously (Meyer and Kieras, 1997)
- Task switching process (Czerwinski *et al.*, 2004).
- An alternative accommodation: Salvucci and Taatgen (2011) defined a multitasking continuum based on the average time spent on one task before switching to another. On one extreme, there are tasks that involve highly frequent and sometimes imperceptible switching, such as talking while driving. And on the other extreme, there are tasks that involve longer spans between switches, writing a paper and reading email for example.

There are two different drivers of multitasking called *external* interruptions and *internal* decisions (Gonzalez and Mark, 2004; Mark *et al.*, 2005; Miyata and Norman, 1986). An internal interruption comes from one's self, i.e. self-initiated, when a user decides to switch tasks at his/her discretion (Miyata and Norman, 1986). An external interruption occurs when an event in the environment forces a user to switch tasks. One and the other occur just as often (Gonzalez and Mark, 2004).

Conceptual and Definitional Issues Multitasking has been studied across many different fields of work, including cognitive psychology, human factors, information science, and communication studies. A definition of multitasking can be the performance of two (or more) tasks within a concurrent timeframe (e.g., Carlson & Sohn, 2000; Monsell, 2003; Salvucci, Kushleyeva, & Lee, 2004) placing ourselves in a workplace like situation. The definition highlights two main components. The first key facet entails understanding the definition of a "task" as "a distinct activity carried out for a distinct purpose" (Cascio, 1978: 133). Past multitasking research has different approaches as far as definitions goes**.** Some include non-task behaviors such as listening to music while working (Lesiuk, 2005, Andrade, 2010). Non-task behaviors that do not have a specific goal or outcomes vary in comparison to task behaviors, which involve distinct goals and objectives and thus remain in a pre-mind area as long as they remain incomplete (Leroy, 2009; Zeigarnik, 1927). Second, focus has been paid on tasks that require primarily mental effort, with few physical aspects children (Kalenkoski & Foster, 2010, Knight & Baer, 2014. Third, some definitions specify that tasks must be conducted within a concurrent time frame, suggesting that multitasking behavior is not binary but rather a position along a continuum (Salvucci, Taatgen, & Borst, 2009). Research has yet to clarify how individuals concurrently work on multiple tasks. Some scholars argue that humans are limited in their capacity to perform concurrent mental operations by a central mechanism (Schweickert & Boggs, 1984) so that when people believe they are performing two tasks simultaneously, they are really switching back and forth between those tasks (Rubinstein, Meyer, & Evans, 2001) demonstrated by the delay in task performance caused by the central bottleneck, i.e the time delay caused by task switching (Pashler, 1994; Welford, 1952). Indeed,

related cognitive research on dual-task performance finds that people struggle with performing two tasks concurrently (Pashler, 1994) and that they do so because they experience a psychological refractory period effect, which refers to the period of time a second stimulus is significantly slowed because a first stimulus is still being processed (e.g., Pashler, 1994; Welford, 1952). On the other hand, research has also found that people can sometimes be trained to perform two tasks simultaneously without any refractory period as though there were no bottleneck (Schumacher, et al., 2001; Hazeltine, Teague, & Ivry, 2002), implying that the content and difficulty of multitasking behavior is a factor in its performance decrement. Regardless of the theoretical differences, research into how humans perform complex shows that performing multiple tasks simultaneously requires complex cognitive modeling (Salvucci, et al., 2004).

We plan to further seek a model or Teaching Model (TM) on "effective multitasking for entrepreneurs" in later research agenda.

Based on the review of the definition of Multitasking in the scientific literature, we conclude that the application of the neuroscientific approach of multitasking is rich in its possibilities for future entrepreneurial training (McCrickard and al., 2003c). Our results show particularly that:

- Tasks context and procedures affects multitasking efficiency. These variations of tasks include cognitive charge (Gilbert et al, 1988), perception impact (Maynard & Hakel, 1997), tasks prioritization (Northcraft et al, 2011), type of interruption (Oulasvirta and Saariluoma, 2004) or complexity (Speier et al, 2003).
- Multitasking training improves the time cost caused by the bottleneck effect, i.e. the time delay between tasks (Schumacher et al., 2001) and hence increases its efficiency.

Multitasking allows mental flexibility through a neuroscientific process known as neuronal plasticity (Sparrow et al., 2011). It is also a motor of creativity (Chaitali Kapadia, 2014) and a enhancer of educational models (Courage et al. 2004, Greenfield; Rosen et al., 2010; Small and Vorgan, 2008).

2. Related Areas of Research

Several disciplinary fields analyze multitasking such as the behavioral approach, the field of cognitive psychology, communication and information empirical studies or the management and education field. Research on multitasking is definitively a multidisciplinary ecosystem. If linkage to computational models (Salvucci & Taatgen, 2011) or with educational opportunities (Salvucci & Taatgen, 2011), the direct impact of multitasking on entrepreneurship improvement is yet to be properly assessed. We will present in a synthetic table below (table 1) the main finings that help discovering the possible positive leverage effects of multitasking on entrepreneurial efficiency. It has been constructed on the basis of our literature review results.

Table 1. Definitions, conceptual Frameworks and applications on entrepreneurship.

Definition	**Conceptual Framework**	**Application on entrepreneurship**
PERFORMING TWO (OR MORE) TASKS WITHIN A CONCURRENT TIMEFRAME (E.G., CARLSON AND SOHN, 2000; MONSELL, 2003; SALVUCCI, KUSHLEYEVA, AND LEE, 2004)	Workplace environment, behavioral	How do exactly (which tasks) entrepreneurs perform multitasking?
NON-TASK VS TASK BEHAVIORS, I.E WITH SPECIFIC GOALS (LEROY, 2009; ZEIGARNIK, 1927) MENTAL EFFORT VS PHYSICAL ASPECTS (KALENKOSKI & FOSTER, 2010, KNIGHT & BAER, 2014) CONCURRENT TIME FRAME: MULTITASKING BEHAVIOR IS NOT BINARY BUT RATHER A POSITION ALONG A CONTINUUM (SALVUCCI, TAATGEN, & BORST, 2009)	Heuristics, Epistemology	Certain tasks are not considered as multitaskable: music while working but not actually paying attention to it. Multitasking can be done when entrepreneurs successively start and stop tasks: you can be doing emails and research at the same time, then stop for a phone call and resume an email. Your brain functions can be trained to do this fragmented work smoothly and efficiently.

DELAY IN TASK PERFORMANCE CAUSED BY THE CENTRAL BOTTLENECK. PSYCHOLOGICAL REFRACTORY PERIOD (PASHLER, 1994; WELFORD, 1952). DISCRETIONARY MULTITASKING VS VOLITIONAL (PAYNE *ET AL.* ,2007)	Psychology, Education	As entrepreneurs, we can learn to bypass the decrease in time efficiency required by switching tasks. There is an important role played by the degree of will of the entrepreneur in engaging in a multitasking work modality.
TIME AND EFFORT SWITCHING ALLOCATION (NORTHCRAFT, SCHMIDT, & ASHFORD, 2011).	Empirical studies	Entrepreneurs can decide and modify the time spent on tasks as well as the effort that they allocate to those tasks: for instance, you can pick easy-to-respond-to emails or a short phone call.
FORM OF GOAL PRIORITIZATION IN TASK SWITCHING	Experimental studies	Within a daily entrepreneur's schedule, prioritization of the tasks to be completed successfully is crucial: your brain will work much better if there is a strategy applied to sorting out tasks beforehand in order of importance.
DISCRETIONARY MULTITASKING THE PSYCHOLOGY LITERATURE. PAYNE *ET AL.* (2007), R.F. ADLER AND R. BENBUNAN-FICH (2013)	Psychology literature	Entrepreneurs can self-initiate interruptions, i.e. in the absence of external triggers such as electronic alerts or email notifications. An important research is to define how to link positive feelings to the decision of interrupting tasks and, as a result, how to increase the efficiency in entrepreneurial multitasking.

Gaps and opportunities for entrepreneurial improvement need to be explored. We can apply the results of this synthetic table on entrepreneurial efficiency and especially on entrepreneurial models of education and training. Three main areas can be researched: the optimization of learning abilities, the creation of new cognitive models on multitasking and the opening to the further analysis of multitasking impact on entrepreneurial creativity.

2.1. Entrepreneurial learning abilities and multitasking

We are now zooming in the entrepreneurial skill and abilities education and training: which levers can educators, professionals and trainers can be triggered to improve learning abilities of entrepreneurs through multitasking mastering?

The increased demand of a constant availability to media source within the daily lives of entrepreneurs has raised concern about the quality and performance of learning abilities. Classic experimental literatures on divided attention in task-switching and dual performances indicates that multitasking is almost always less efficient in time and accuracy and result in a more superficial learning than one occurring during single task performances (M.Courage et al. 2014). Alternatively, when practice is permitted though adequate platforms, multitasking strategies can result in successful enhanced visual and perceptual skills as well as knowledge acquisition (Courage et al. 2004).

Advances in cognitive and computational modeling, training attention and neuroergonomic evaluation of performance are helping the design of learning environment optimized for multitasking. Multitasking is becoming an obligation in our fast-paced world and there is an increasing demand to deliver more results and to process more information faster. Examples in the real life of entrepreneurs are numerous, from driving, to millennials life style to workers, everybody is confronted to this multiple task operation mode.

The high-speed availability of information and communication technology fuels the expectation of our human cognitive system capable of processing, integrating organizing and responding simultaneously to multiple sources of information efficiently and productively (Greenfield; Rosen et al., 2010; Small and Vorgan, 2008).

Researchers have focused their analysis on the impact of multitasking on performance. Certain views imply that multitasking enables -and is even necessary for-high level efficiency and productivity. Our contemporary work and learning environment is indeed constantly emphasizing competition. Multitasking promotes for some authors mental flexibility that actually changes and molds the way we learn and retain information through neural plasticity (Dye, Green and Bavelier, 2009a, 2009b; Green and Bavelier, 2008; Lui and Wong, 2012; Maclin et al. 2011; Small et al., 2009; Small et Vorgan, 2008; Sparrow et al., 2011).

Another school of thought opposes this view to a detrimental influence of multitasking on performance. Especially when task juggling produces distraction, errors, lost time and mental stress (Abate, 2008; Bowman et al.2010; Gupta et al., 2009; Ophir, Nass et Wagner, 2009; Rosen, 2008; Strayer and Drews, 2007). The roots of this argument go back to experimental literatures on divided attention, dual-task performance and task switching from the 1930's when it was commonly assumed that the human information processing system has a limited capacity (Kahneman, 1973; Telford, 1931; Welford, 1952,1967). It was then believed that sharing resources among tasks would come at the cost of performance and productivity, but this was ling before multitasking emerged as a cognitive and socially significant and unavoidable phenomenon. Today this contentious view remains active with the debate on the perceptual and response requirements of the tasks involved (Levy et al.,2006; Pashler and Boer, 2006; Monsell, 2003; Pashler et al., 2001; Strayer et al., 2003, Ophir et al., 2009; Parasuraman, 2011; Watson and Strayer, 2010).

An alternative view is to seek the equilibrium in which attention relocation is effective: William James (1890) believed that "the number of processes of conception that can go simultaneously is not easily more than one unless the processes are very habitual" ("Principles of Psychology, 1890). Pashler (1994), Navon and Gopher (1979) or Kahneman (1973) also share the view of attention seen as a finite mental resource and that the level of attention depends directly on the kind of tasks to be focused on. Many results to experimental studies show that when there are two or more tasks there is a degree of dual-task interference or "switch cost" associated with it, such as slower reaction time, increased error and extended task completion.

Other scientists proposed a more flexible approach through the idea of Adaptive Executive Control (AEC) in which individuals have an adjustable control over the second task processing (Anderson, 1982; Kieras et al., 2000; Meyer & Kiernas, 1999). The performance of multitasking depends in this case on the conversion of declarative knowledge (verbal description of the task requirements) into procedural rules. The result is that the bottleneck effect (immutable, central, systematic delay of the second task performed) isn't unchangeable after all: Some authors searched for a perfect time sharing and attention allocation possible under certain conditions. Borst, Taatgen & van Rjin, 2010, have categorized distinctions such as:

1. Tasks given with equal priority
2. Tasks performed quickly
3. Tasks using different perceptual and motor processes
4. No constrains on temporal relations or serial order among responses
5. Participants received enough practice to compile procedural rules

Further research tried to find out if the bottleneck effect was bypassed or simply latent (Lien, Ruthruff and Jonson, 2006; Pashler et al., 2001; Tombu and Jolicoeur, 2004).

Courage and al., (2015), have described three major phenomena: (a) multitasking while driving and its consequence on attention, (b) multitasking in the academic setting and the link to learning performance, (c) multitasking through new technologies learning.

Examining the three situations brought the following observations:

- Not all distractions are equally disruptive to performance with much depending on the demands of the secondary tasks (Haigley et al., 2000; Horrey et al., 2006),
- Several decades of research indicate that human information processing system is probably not well equipped to attend different tasks simultaneously. Yet, some students say that multitasking helps them concentrate (Roberts & Foehr, 2008). But Brasel and Gips (2011) found that students were poor judges of their multitasking performance.
- In some cases, multitasking can improve performance. The time and duration of interruptions, type and difficulty of the tasks and the engagement with the primary task are variables that directly interfere with multiple task outcome. Mayer & Moreno, 2003, showed that when there is no time limit on task completion, multitasking did not diminish performance.

- Recent studies have also reported that there is an emotional need to interrupt activities, usually to check in with social media. There is less anxiety when students are permitted to do so (Rosen et al. 2013; Wand & Tcherney, 2012).

Rosen et al. (2013) proposed that educators might use findings of recent research to develop adaptive strategies optimizing student learning though multitasking approaches.

There is no consensus on the nature of the limitation of human information processing during multitasking as shown by the advances in cognitive neuroimaging (Dux et al., 2009; Dux& Marois, 2006; Just et al., 2001 ; Marois & Ivanoff, 2005 ; Parasuraman, 2011 ; Tombu et al., 2011). It is unclear whether the performance is based on structural pillars (human cognitive/neural architecture), strategic considerations (executive decision making) and how it is implemented (serially or simultaneously). Increased task switching research looks further into the procedure in which stimuli are presented (Kiesel et al., 2010; Monsell, 2003; Vandierendonck, Liefooghe & Verbruggen, 2010).

Tasks are alternated rather than actioned simultaneously. There are many variables at play:

1- Procedural (task structure; bivalent stimuli, response overlap or incompatibility).

2- Cognitive (working memory, memory retrieval, cue encoding).

Consensus agrees on the need for added research to try and correlate multitasking success with personality characteristics (Buchweitz et al., 2012; Engle, 2002; Ishizaka et al., 2001; Watson & Strayer 2010). This field could be rich as there exists a profound literature on entrepreneur's traits and characters. The training and education on effective entrepreneurship could be based on a customized approach use of multitasking based on personality.

Moreover, Tuzin et al. (2008) showed that primary school children made significant academic and motivational improvements after participating in multitasking learning tools (computerized geography curriculum in a game format). Multimedia learning is hence not always a source of cognitive overload when it is controlled in time and use. A limit on this approach is the lack of well-controlled studies on technology effectiveness as learning platforms because of the variation of cognitive resources required for their use (Bavelier & Dye, 2010; Owen et al., 2010, Subrahmanyam & Greenfield, 2008).

2.2. Cognitive models of multitasking

The past two decades have seen interdisciplinary work finding explanation of the human cognitive functioning to attempts to map and understand the underpinning phenomena explaining human thought processing. Disciplines including psychology (Ochsner and Lieberman, 2001; Van Overwalle, 2009), economics (Camerer, Lowenstein and Prelec, 2005), and sociology (Franks, 2010; Todorov, Fiske and Prentice, 2011) have examined cognitive neuroscience and social neuroscience.

Recent book "Entrepreneurial Cognition "by J. R. Mitchell, R. K. Mitchell and B. Randolph-Seng, (2016), states the importance of cognition approaches on entrepreneurial theories. In the

same way that authors have examined how entrepreneurs's brain function under different experiences and knowledges (D. Baucus et al., 2014), establishing the existence of a grounding entrepreneurship research in neuroscience, extensive analysis of multitasking has been conducted by the neuroscience crowd. In 2009, P. Duc, M. Tombu et al. have elaborated three models of experimental research to observe the impact of training on multitasking performance.

They have found that:

- Training leads to a shift in sensory-motor information away from slow and deliberate processing in prefrontal cortex, to fast and efficient processing in task specific pathways.
- Training results in the functional segregation of neural ensembles, creating independent streams of information processing for each task.
- Improved efficiency of information processing develops efficient multitasking.

This research supports the hypothesis that training greatly reduces multitasking costs (Schumacher et al., 2001; Tombu et Jolicoeur, 2004; Van Selst et al., 1999) by increasing the speed of information processing in certain brain regions.

Behavioral studies suggest indeed that multitask training improves the performance of each task (Ruthruff et al., 2001, 2003) but they provide no explanation on how the changes are neutrally implemented. Neurobiological literature on the same subject (Erickson et al., 2007; Jonides, 2004; Poldrack et al., 2005; Rioult-Pedotti et al., 1998, 2000; Sakai et al., 1998) do not point out specific neural mechanisms that can explain cost-free multitasking or positive impact of training on cognitive task performance. However further research has suggested that functional reorganization can take place affecting the strength of connections between brain regions (Poldrack, 2000). Multitasking efficiency emerges with training because it would bypass the neural locus of multitasking limitations. Hypothesis tests have been conducted by performing connectivity analysis (Büchel et al., 1997) and structural equation modeling (Rogers et al., 2004; Rowe et al., 2002). They have found that brain usage changes with the process chosen for multitasking and that there is hence a way to optimize multitasking efficiency. Observations showed that efficient multitasking results from a decreased reliance on brain regions involved in cognitive control and attention. Regions initially required to deal with unfamiliar, novel task-specific brain regions are progressively replaced by more efficient task-specific networks with training (Chein and Schneider, 2005; Haier et al., 1992, Jansma et al., 2001; Petersen et al., 1998). Yet further research is called in this area.

In sum, the difference between pre-training and post-training data on multitasking performance, with a significant improvement on the latest, permits to engage in a broadening of the educational and learning fields.

Computer science and psychophysiology fields using video games have also monitored the effects of multitasking learning through complex video game practice and have come up with the conclusion of several enhanced attention and resource allocation processes (E.Maclin et al., 2011). The authors of the study call for further research on the interaction of training effects with learning abilities, strategies and skill transfer.

Researchers have tried to develop cognitive models that attempt to qualify task interference (performance cost in speed and accuracy) and to predict performance (Adler & Benbunan-Fich, 2012; Altman & Tarfton, 2007; Horrey et al., 2066; Logan & Gordon, 2001, Tombu & Jolicoeur, 2002; Wickens, 2002). Others have relied on computational models through a computer simulation that could generate a behavior of interest (Salvucci & Taatgen, 2011).

Salvucci and colleagues (2004, 2006, 2008,2011) proposed a model called "Threaded cognition" which holds that streams of thoughts can be represented by as independent threads coordinated without the need for task-specific executive processes. People can then start, execute and stop threads of behaviors to adapt dynamically to any task environment. The limitations of the human information processing system exist only in certain combination of tasks or certain situations.

These models are useful to predict the degree of interference between tasks and to design work and learning environments to optimize multitasking performance (Horrey & Wickens, 2004 Horrey et al., 2006; Salvucci & Taatgen, 2011).

In their need of constant multitasking behavior, entrepreneurs must learn how to master the practice of simultaneous tasks compiling and task switching through a proper training model that we want to develop in our further research agenda.

2.3. Multitasking and Creativity

Chaitali Kapadia (2014) proposes that multitasking behavior has a beneficial influence on subsequent creativity. Parallel to theories of energy, the author states that multitasking behavior induces a higher level of activation, which in turn, positively influences downstream creative performance. The examination of this model provided support for a positive relationship between multitasking and subsequent creative performance and demonstrated that this effect is specific to creative performance and not task performance. There is also support on how multitasking indirectly increases creative performance through higher activation on two of three creativity measures. Results from the field study suggest that multitasking improves creative performance indirectly through activation, and that a person's dispositional preference for multitasking, i.e. polychronicity (M.J. Grawitch, L.K Barber, 2013, D.M. Kirchberg, R.A.Roe, W Van Eerde, 2015), moderates this relationship such that the effect of multitasking on activation is stronger for someone who prefers not to multitask. Together this work yields important theoretical and practical implications about managing creativity in the fast-paced contemporary workplace.

3. Contributions of our findings and Future possible research

While multitasking has been widely examined in some scientific areas such as the human–computer interaction (HCI) literature, there is still ample opportunity to extend research on this topic (McCrickard *et al.*, 2003c). There are at least two areas where additional research might be fruitful. One is the study of voluntary task switching. The work of Payne *et al.* (2007) established that people switch away from tasks that are no longer rewarding. Related research studies by Janssen *et al.* (2011) and Duggan *et al.* (2013) have incorporated explicit

payoff structures (rewards) to investigate in more depth the determinants of voluntary task interleaving. The second area that could benefit from additional research is the study of how multitasking affects performance. The existing literature in this regard is somewhat fragmented. Some studies have examined how users' performance is impacted when receiving external interruptions (Bailey and Konstan, 2006; McFarlane, 2002; Speier *et al.*, 2003). Other studies have focused on the relation between discretionary multitasking and the resulting performance. The findings suggest that although some amount of multitasking may not be detrimental for performance (Davidson, 2011; Palladino, 2007), intensive multitasking, characterized by high frequency switching and a large number of ongoing tasks, tends to degrade performance (Adler and Benbunan-Fich, 2012; Bailey and Konstan, 2006; Hembrooke and Gay, 2003).

This analysis brings us to the following research question: "How to make multitasking training beneficial to entrepreneurial cognitive skills?" and "how to extract the results or findings of our research to improve entrepreneurial capacities?"

Newest findings in neurology and computational science link multitasking abilities to enhanced cognitive skills such as creativity or flexibility (Kapadia, 2017). Improving internal processes of multitasking and creating new learning environments facilitating the practice of multitasking is a need in today's entrepreneurial environments. Works in neurosciences allow to have detailed information about primary constructs underpinning multitasking: retrospective memory, prospective memory and planning. The way in which the subject engages in the selection of tasks and their duration directly influences the outcome of multiple task processing (Burgess et al., 2000). Other experiments such as the effect of music based multitask training on cognition and mood show a significant improvement in cognitive functions and decreased anxiety compared with non-exerting control. This experiment from 2013 calls for further research to delineate weather training engages improvement in cognitive function and if it can contribute to multiple task enhancement (M.Hars et al., 2013). Paul E. Dux et al. have demonstrated in an experimental research of 2009, that training does effectively improve multitasking performance by increasing the speed of information processing in human prefrontal cortex.

These observations lead to further questioning on how to create an innovative teaching model, in order to improve entrepreneurship efficiency through multitasking training. Some of the questions could be:

- How to include multimedia in multitasking education effectively?
- How to train our cognitive faculties to incorporate and improve trough the multitask approach?
- How to incorporate our model within Students, Workers or Childrens' traditional learning corpus?
- What are the levers that can be trained in order to increase entrepreneurial efficiency?
- How to make multitasking training beneficial to entrepreneurial cognitive skills?

- How to extract the results or findings of our research to improve entrepreneurial capacities?

Researchers and professionals in the entrepreneurship field need to work together to find relevant applications supporting entrepreneurial efficiency. Moreover, advances in practice and research need to embrace the changes within the workplace and within the modern world taking in account the multitasking phenomena, which is inevitable nowadays. It is hence a necessity to explore -rather than condemn- this widespread behavior recognized as a particular way of working. Entrepreneurs especially are prone to use simultaneous tasks and task switching behaviors.

As we have discovered through our literature review, empirical findings have been exploring the effects of multitasking on performance and on mental and cognitive workload, bringing to our knowledge several counter-intuitive results such as the improvement of information integration speed, adaptability, or creativity through multitasking training. Yet, there are also numerous negative results sourced in a non-adequate usage of multitasking behavior. It is therefore important to continue researching the modalities of training to make multitasking a tool for entrepreneurial efficiency improvement. Using a multidisciplinary analysis, we could spot important discoveries encouraging us on a future developmental path of Entrepreneurship Education and Training. To this aim our research agenda will focus on creating an innovative and relevant Teaching Model based on the findings of transversal research and specifically on the impact of neurosciences on entrepreneurship development.

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