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Working Memory training in aging: from the nature of the training to the transfer effects in everyday life.

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1. A GENERAL INTRODUCTION AND THESIS AIMS

1.1. General Introduction

Life expectancy has increased and will increase in the future Currently, it is estimated at being about 78 years, but it has been anticipated that it will reach 83 years during the next few decades. As reported in the *World Population Aging report* (United Nations, 2013), population ageing is taking place throughout the world and is the result of a decrease in mortality and the decline in birth rate. It is believed that in 2047, older people might outnumber children. Overall, the number of older people (over 60 years) is expected to more than double in the future, from the current one billion to two billion in 2050. More specifically in relation to older people aged 80 years and over (who are defined as being the oldest-old), they will be multiply by three, together with the number of centenarians who are also rapidly increasing. This phenomenon is present in both more developed and less developed Countries, and it has significant social and economic consequences: the world dependency ratio, for example, (that is the indicator of the relationship between the dependent population - under age 15 and people aged 65 years or over- and working aged- people between 15-64 years), will increase, thus implying that more people will be economically dependent. Therefore, the statutory retirement age will rise and people will need to work longer.

Population aging is also associated with higher health expenditure. The transition from high to low mortality has indeed meant a shift in the cause of disease and death: from infectious and acute diseases to an increased prevalence in disability or chronic and degenerative diseases, including dementia or cognitive problems (World Health Organization, 2011).

In this context, the need for effective methods to promote successful and healthier aging is becoming of international interest, in order to reduce disability and dependence. Older adults autonomy, however, cannot be set aside from cognitive functioning. So, strategies and procedures to maintain a good cognitive functioning or to delay cognitive decline are fundamental. Cognitive functioning in older adults is strictly related to independent living and the need for care (Ball et al., 2002).

Luckily, together with population aging, our knowledge of cognitive aging has accrued: starting from the second half of the XX century, with the emergence of Life Span Psychology (Baltes & Baltes, 1990), researchers have proved that aging is not a unitary process but that different patterns of change are present, according to the specific cognitive abilities considered. In fact, besides abilities which clearly show an age-related decline (e.g., fluid abilities, problem solving), related to biological aspects, there are other ones, related to prior knowledge or experience (defined as "crystallized abilities") that continue to be well preserved in aging or even improved (e.g., vocabulary performance). Life Span Psychology assumes that development can be modified or plastic, implying that there are both "gains" and "losses" during all phases of life. Development is conceptualized as being a multi-dimensional and multi-directional process (Willis & Schaie, 2009). Furthermore, considerable evidence has shown that, cognitive plasticity- the brain's reactive capacity to anatomically change in response to environmental demands (Lovden, Backman, Lindenberger, Schaefer & Schmiedek, 2010). - is also present in later life and that a lifestyle rich in mental, physical and social stimulation, has a beneficial influences on the level of cognitive performance (e.g., Herzog, Kramer, Wilson & Lindenberger, 2009).

Consequently, based on this positive evidence, numerous studies have investigated *if* and *how* it is possible to improve abilities subject to age-related decline, in particular memory abilities. These studies are now not only focused on pathological aging, but also on healthy older adults underlining the importance of these interventions from a preventive point of view.

Efforts to improve cognitive functioning in healthy older adults have been extensively conducted over the last few decades, focusing typically on the use of strategies to facilitate the encoding of information that has to be remembered (for reviews see Verhaeghen, Marcoen & Gossen 1992; Rebok, Carlson & Langbaum, 2007; Lusting, Shah, Seilder & Reuter Lorenz, 2010). Recently, however research' s attention has been focused on "implicit process based training" whose aim is to directly enhance a cognitive function, based on a repetitive practice with a given task. Usually they involve practice with tasks focusing on tasks' switching (Karbach & Krey, 2009), updating (e.g., Dahlin, Nyberg, Backman & Neely, 2008) and Working Memory (WM) (e.g., Olson & Jiang, 2004; Borella, Carretti, Riboldi & De Beni, 2010).

Given the central role of WM in high order cognition (e.g., Miyake & Shah, 1999) and its decline in aging (e.g., Bopp & Verhaeghen, 2005; Park *et al.*, 2002) process based WM training have been considered in this thesis, addressing -as its core aspect- issues about the possible generalization of training benefits to other cognitive abilities and everyday life.

WM training could even have broad effects on the cognitive system, inducing process-based cognitive plasticity (e.g., Dahlin, *et al*., 2008), thus, influencing other WM-related skills that engage similar processes or brain regions (Buschkuehl, Jaeggi, & Jonides, 2012). However, while the beneficial effects have been clearly demonstrated in the tasks used to train WM (the WM criterion tasks), whether there are any transfer effects on other abilities related to this component, but not trained directly, and whether the benefits will be maintained over time is still subject to debate.

Furthermore, recent reviews (e.g., Melby-Lervag & Hulme, 2013) have identified two key problems with training studies 1) the use of a single measure to assess gains in WM-related abilities (different authors have used different tasks, but-usually- never more than one in any given study), and 2) the lack of studies assessing everyday life competences after training. WM training benefits, could -theoretically- generalize everyday life abilities, improving the quality of life for older adults but, until now, this aspect has been largely under-investigated.

Moving on from the aforementioned aspects, this work aims - firstly- to investigate the possible transfer effects of verbal WM training to everyday life and other abilities using different tasks for each assessed ability.

The stimuli's features adopted in WM training activities and the nature of the tasks (verbal or visuo-spatial) used, also has been investigated in more depth: the majority of WM training studies have been conducted using a visuo-spatial training procedure (often with poor results), whereas only a few studies, using verbal ones (e.g., Borella *et al.,* 2010), providing divergent evidence. The lack of studies comparing both training modalities (verbal vs visuo-spatial training) - as well as the different type of tasks' stimuli (more or less meaningful for older adults)- make it difficult to draw conclusions about WM training efficacy and on what might influence its transfer effects. Important food for thought in this direction was derived from the study conducted by Borella and colleagues (2014) from which two of the studies presented in this thesis had their origin.

In 2014, Borella and colleagues tested the efficacy of WM training conducted using a visuo-spatial modality, while maintaining the same procedure used in a previous WM training study that adopted a verbal modality (2010). The results of the former study -although positive- were weaker (in terms of transfer effects) compared with the latter one. The authors speculated that those differences might be attributed eventually to the more relevant age- related decline of the visuo-spatial WM component (e.g., Myerson, Emery, White, & Hale, 2003) on one hand. On the other hand, a possible reason might be the particular abstract stimuli used in the visuo-spatial training (dots in a matrix)- less familiar and meaningful for older adults (e.g., Cornoldi, Bassani, Berti & Mammarella, 2007)- an hypothesis tested in this work.

A related, but - until now-uninvestigated issue in older adults concerns the possible influence of emotional stimuli in WM training. As suggested by a number of authors (see Mather & Carstensen, 2005), aging coincides with changes in people’s emotion-regulating patterns that could also affect cognition through the so-called “positivity effect”, i.e. the tendency of older adults to delete or ignore negative emotional stimuli and focus on positive ones instead (Charles, Mather & Carstensen, 2003). Despite the decline of WM in aging, when positive emotional stimuli are used in WM tasks, older adults seem to perform just as well as younger people (Mikels, Larkin, Reuter-Lorenz & Carstensen, 2005) – giving the impression that the greater appeal of positive stimuli could compensate for older adults' memory difficulties (Dolcos, LaBar & Cabeza, 2004). So it may be that any gains which might be derived from WM training could be enhanced by using positive emotional stimuli in the training, thereby, stimulating greater interest in training activities and improving participants motivation (*this hypothesis has been tested in study 3).*

1.2 Thesis structure and aims

In an attempt to overcome some of the aforesaid drawbacks in previous studies, this thesis aims to examine, in an original way:

i) WM training's transfer effects to older adults' everyday life abilities using performance based measures of functional competences (study 1).

WM gains after training could, at least theoretically, induce benefits in everyday activities related to WM (i.e., text comprehension, problem solving, reasoning), fostering autonomy and quality of life in older adults. As previously mentioned, this aspect has been largely under-investigated despite the strong correlations between WM and everyday cognition, and the thoroughly-studied relationship between a decline in WM and functional difficulties (e.g., Allaire & Marsiske, 1999). Only a few studies have, so far, attempted to assess the effect of WM training on everyday cognitive measures (Richmond, Morrison, Chein & Olson, 2011; Brehmer, Westerberg & Backman, 2012; Carretti, Borella, Zavagnin & De Beni, 2013). Furthermore, self-report measures - which could only reflect participant's expectation about training- are usually used. Diversely, this study adopted objective measures of functional abilities. These objective tasks have been adapted in consideration of the Italian culture. Moreover, parallel versions of each task have been developed in such a way as to avoid test-retest effects.

Again, in order to obtain more convincing evidence, multiple indicators have been used for each assessed ability.

ii*) to investigate if the stimuli features used in WM training tasks might affect transfer benefits or if the nature of task modality* per se *could affect training benefits.*

Stimuli features have been manipulated using the visuo-spatial paradigm adopted by Borella and colleagues (2014). Thus, in study 2, more familiar stimuli (such as images of common objects) were used, assuming that they could sustain more attention and motivation towards the training tasks.

iii) to investigate if the use of positive stimuli could further foster training gains, exploiting the positivity effect in aging (Study 3), an issue that has yet to be undertaken.

Before presenting the three studies, a brief review of training literature has been presented in chapter 2, discussing the different types of memory training and more recent evidence in terms of the transfer training gains. Space has been given on the previous results obtained using the paradigm of Borella and colleagues (2010; 2014), which gave origin to this work.

A specific introduction and discussion of the results obtained, have been provided for each study.

Finally, the main findings derived from the three studies and future perspectives have also been set forth in chapter 6.

CHAPTER 2

WORKING MEMORY TRAINING IN AGING

2.1. Cognitive plasticity in aging

It has been well documented that aging is related to diminished cognitive abilities and that this decline is associated with losses in the capacity of living independently and managing one's own life. These losses represent one of the greatest fears that adults express when considering old age (Lusting, *et al.*, 2009). Consequentially, over the last few decades, efforts have been made in researching effective interventions that might delay cognitive decline or to enhance cognitive performance, despite the changes in brain structure, neural deterioration (e.g., Masliah, Mallory, Hansen, De Teresa & Terry, 1993; Cabeza Anderson, Locantore, & McIntosh, 2002; Span, Ridderinkhof & van der Molen, 2004) and changes in cerebral functioning (Raz et al., 1997; 2005)

The research on cognitive training is based on studies that have shown that the rate of cognitive decline in aging is mediate by substantial individual differences. An individual, might be able to maintain good levels of cognitive functioning according to his degree of "*reserve capacity"*, a pool of resources that could mitigate aging effects. *Reserve capacity* is constituted by internal (i.e., physical condition, cognitive abilities, psychological well-being) and external (i.e., financial status, family, social network) resources, available to the individual at any given time (Baltes & Baltes, 1990) and that permit one to be more or less resilient to damages and losses. This concept has been differentiated in "*baseline reserve capacity"* and "*developmental reserve capacity"* (Baltes, 1987; Kliegl & Baltes, 1987). Researchers denote, with the first term, the level of maximum performance achieved by an individual at a given time, with the resources already available; with the latter ones, instead, the level of performance that it is possible to reach if specific interventions - which are aimed at optimizing an individual's cognitive and motivational potential or reserves- are proposed (Kliegl, Smith & Baltes, 1989). One of the Life Span Theory's columns is the idea that resilient functioning- or rather the ability to maintain and regulate an adequate level of functioning in the face of risk and losses- is possible in old age and could also be potentiated (Staudinger, Marsiske & Baltes, 1995).

This idea suggests that some aspects of life experience might constitute a skills repertoire or contribute to functional changes that allow some people to cope with damages and pathologies - among which progressive and neurodegenerative diseases too - better than others (e.g., Katzman *et al.*, 1989), a concept defined as "*Cognitive Reserve*". (Stern, 2002; Scarmeas & Stern, 2003; Stern, 2009). According to the idea of cognitive reserve, the results of the famous longitudinal "Nun Study" (Snowdon, 1991-2003), have shown that a synchrony between the degree of pathology present in the brain and the clinical expression of the disease could not always be present. Some of the 678 nuns enrolled for the study (from 75 to 107 years old), achieved very high scores on the annual cognitive examination, despite the abundance of Alzheimer disease lesions in the neocortex and evident presence of neurofibrillary tangles, reported from a post-mortem magnetic resonance imaging scan. 8% of the participants with the most severe spread of the Alzheimer disease pathology did not show any symptoms of memory impairments (Snowdon, 2003).

The degree of resistance to the clinical manifestation of neuropathology -and, thus, the extension of the cognitive reserve- probably relates to events and processes that occur during the life span for example educational aspects, social factors and cognitive training interventions (Ball *et al*., 2002).

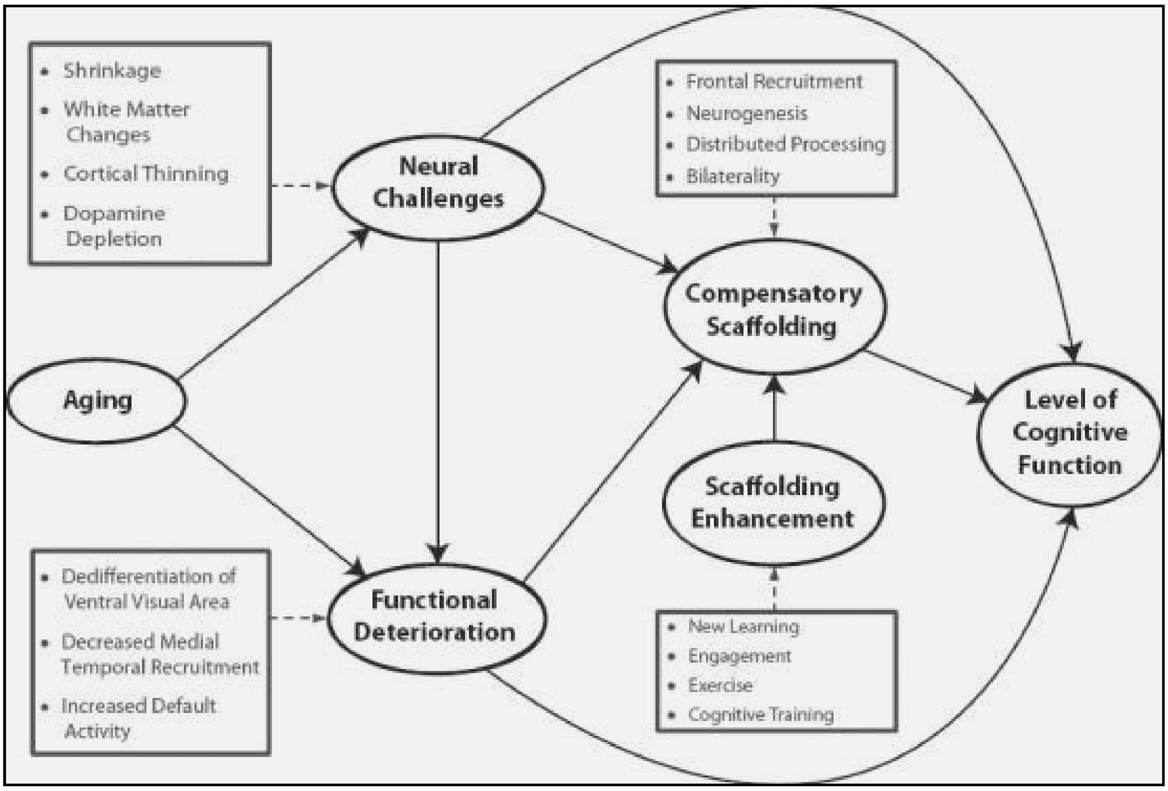
The *cognitive plasticity* concept underpins both the "Reserve capacity" (Baltes & Baltes, 1990) and the "Cognitive Reserve" (Stern, 2002) ideas. This means the capacity of the brain to change structure and/or functions, in a sustained way, in response to some external stimulation (Park & Bischof, 2013). Examples of cognitive plasticity in aging are represented by the *Hemispheric Asymetry reduction in Older Adults* (Cabeza *et al.*, 2002) and *Posterior- Anterior Shift in Aging* (Davis, Dennis, Daselaar, Fleck & Cabeza, 2008) models. These models describe mechanisms of neural compensation in aging, based respectively on i) the less lateralized prefrontal activity in older adults -compared to younger adults- when the performance of complex cognitive tasks is required (such as working memory tasks, see Park & Reuter-Lorenz, 2009), and ii) the use of frontal areas when the participants have to perform perceptual and motor activities that, in the young, require an occipital areas activation. These mechanisms, however, only seem to be present in high-performing but not in low-performing older adults, suggesting that the former counteracted age-related neural decline through a plastic reorganization of neuro-cognitive networks (Cabeza, *et al*., 2002).

The *Scaffolding Theory of Aging and Cognition* (STAC, Park & Reuter-Lorenz, 2009) provides a theoretical model for the causes and consequences of age-related compensatory neural activity. STAC affirms that functional changes in aging are part of a lifespan process and that the compensatory cognitive scaffolding represents the way in which the brain attempts to alleviate the cognitive decline (Goh & Park, 2009). Scaffolding is conceptualized as being the recruitment of additional circuitry during the execution of complex tasks. The STAC model also provides for the possibility that cognitive training (or sustained engagement in a novel task or environment), as well as exercise, can enhance the development of compensatory scaffolding. Therefore, the ability to increase scaffolding could be the result of cognitive training that confers protection on cognitive functioning. Considerable evidence has shown, for example, that after physical or cognitive interventions older adults could increase neural volume in the areas involved in the latter (e.g., Boyke, Driemeyer, Gaser, Buchel, & May, 2009), and that neural activity might be modulated with cognitive training, both in the direction of diminished activation- after intervention- of the areas involved in the exercise (e.g., Brehmer *et al*., 2011), and in the sense of in these areas augmented response (e.g., Nyberg *et al.*, 2003). Changes in cerebral blood flow are also possible after cognitive training (Mozolic, Hayasaka, & Laurienti, 2010).

In summing up, the STAC model affirms that the aging brain has the ability to adapt and change itself, in response to experiences and environmental demands, both through functional changes and neuro-plasticity, implying the possibility to even have neurogenesis in older adults (see figure 2.1).

Although studies in humans are limited, there is, indeed, evidence as to the possibility that ennriched environments might promote neuroplasticity in older adults (e.g., Colcombe *et al*., 2006).

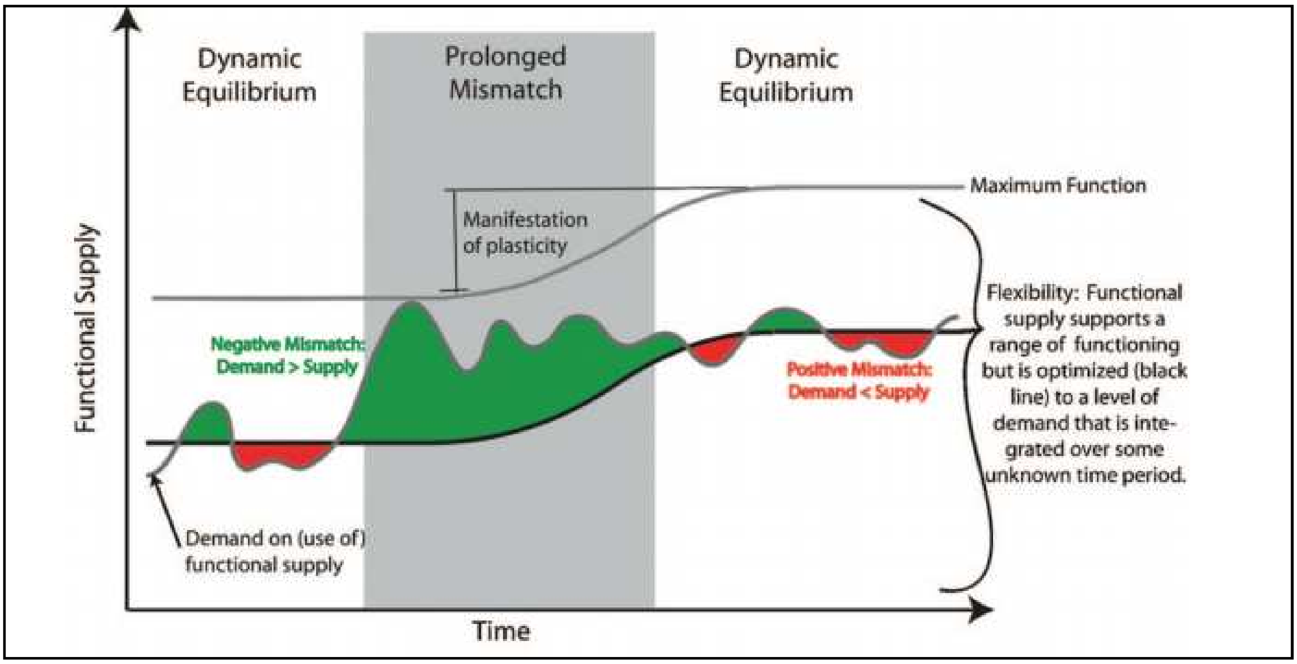
Figure 2.1. *Conceptual model of the Scaffolding Theory of Cognitive Aging (STAC). Adapted from Park & Reuter-Lorenz (2009).*



The idea that some type of neural or cognitive pool of resources could protect against age-related cognitive decline has important consequences both in cognitive and neural aging literature and has given the green light to a multitude of studies on specific experiences and activities, among which cognitive training interventions (for a review see Park & Bischof, 2013).

Before addressing the theme of cognitive training's benefits in aging, it is important to note that Lövdén, and colleagues (2010), have proposed differentiating the terms of *"cognitive plasticity"* and *"cognitive flexibility"*. The authors, with the first term, imply the brain's capacity to react to a prolonged mismatch between functional organismic supplies and environmental demands, through structural and anatomical changes. Plasticity typically requires substantial amounts of time and effort, as it has to overcome the inherent inertia of biological cognitive systems (Noack, Lovden, Schmiedek, & Lindenberger, 2009). Cognitive flexibility, instead, would be associated with changed neural activity in previously existing pathways. The latter represents the capacity to optimize the brain's performance within the limits of the current state of functional resources and would only constitute the starting point of potential and deeper cognitive plasticity (see figure 2.2).

***Figure 2.2**. Model of a mismatch between functional supplies and experienced environmental demands producing cognitive flexibility and cognitive plasticity. Adapted by Lövdén and colleagues (2010)*



The authors assumed that there is a dynamic equilibrium present between cognitive supplies and demands: if the cognitive system can respond to a specific demand with existing flexibility, no mismatch arises. When, instead, environmental demands overcome the aforementioned functional supplies -beyond a given level- and for a prolonged time, the cognitive system might respond with cognitive plasticity. Thereafter when supply meets demand, further impetus for change is lost.

The aforementioned distinction is fundamental when the results of cognitive training interventions, in terms of improved performances on a given task, are analyzed: according to the authors, cognitive flexibility could occur after using memory strategies, inducing optimization of available cognitive resources. On the other hand, cognitive training, based on demands and tasks that exceed the available resources, could induce cognitive plasticity.

The authors, however, assumed that the current range of flexibility could limit the capacity to reactive change: too simple as well as too difficult tasks might not induce plasticity: in this latter case, the individuals may indeed apply inappropriate processes to the task. In other words, demand-supply mismatch has to be collocated at an optimal level to trigger and direct plastic changes.

This theoretical framework permits us to make predictions about the generalization of training gains and the possibility to compensate for or increase individual differences after training (Lövdén, Brehmer, Li & Lindenberger, 2012):

1) First of all, it affirms that cognitive tasks used in cognitive training must be able to induce a prolonged mismatch between supplies and demands, in order to go beyond cognitive flexibility;

2) The task's difficulty has to be collocated at an optimal level and adapted to the current individual's capacity level;

3) Task difficulty, however, must be within the range of current flexibility and foster, from this point, a cognitive system until cognitive plasticity is achieved. Thus, cognitive tasks must be organized in such a way as not to be too easy or difficult.

4) Task difficulty has to be progressively increased, to respond to continuous adjustment between supplies and demands.

5) Individuals with a low initial capacity- for example, with a low Working Memory Capacity- may show greater training gains after easy tasks, rather than a person with a higher capacity. On the contrary, in very difficult tasks, people with a lower capacity might receive less impetus for change than people with a higher one.

Summarizing, once again, the studies on cognitive aging showed that:

i) learning new information or developing further capacities is also possible in aging.

ii) cognitive plasticity is present in later life and is considered as being the basis for developing cognitive interventions;

iii) differences in cognitive capacity or in the cognitive reserve might determine the aging process strength, thus the possibility, for a given individual, to be more or less resilient to losses and damage;

iv) cognitive interventions could be useful to improve capacities -subject to age-related decline- inducing cognitive flexibility or deeper cognitive plasticity.

v) cognitive interventions' effects could depend on the programme features *per se* as well as the level of cognitive capacity, achieved by an individual, at any given time.

2.2. Different approaches to WM training

A general overview about cognitive training will be offered in this paragraph. Then, Working Memory process based training will be taken into consideration and better described.

Although now outdated, a distinction between two typical families of cognitive interventions could be considered: on one hand, there are studies based on a *rehabilitative approach* - in which the aim is to enhance abilities subject to age-related decline - and, on the other hand, there are studies based on a *compensative approach*. In this latter case, the aim is to use the preserved abilities in order to support the ones that decline through aging (De Beni, 2009). These compensative training are based on studies showing, for example, that older adults, compared to young adults, utilize verbal knowledge to compensate for decreased speed and working memory abilities (e.g., Hedden, Lautenschlager, & Park, 2005).While the second family of cognitive training is scarcely used, the rehabilitative approach has been considered more frequently. Again, inside this approach, it is possible to make a further distinction among studies focused only on the use of effective strategies (*strategic training*) and studies that are also focused on other aspects: for example, metacognitive beliefs (*metacognitive training*), attentional and motivational aspects, social support, self-efficacy and so on (*multi-factorial training*). This approach also includes more recent *process based training*.

With reference to Working Memory (WM) Training, which represent the core of this work, two main approaches are usually considered in literature: these are strategic and process based WM training.

The importance of WM training derives from evidence showing that this ability-the capacity to store and, at the same time, process information (Baddley, 1986)- predicts performance in a wide range of cognitive tasks, for example, reasoning (Conway, Kane & Engle, 2003; Engle, Kane, & Tuholski, 1999; Oberauer, Süß, Wilhelm, & Wittmann, 2008), text comprehension (Daneman & Carpenter, 1980; Turner & Engle, 1989), problem solving (Willis,1996) and so on.

Moreover, WM changes could have a crucial role in age-related cognitive decline (Salthouse, 1994; Park *et al.*, 2002; Craik & Salthouse, 2011): WM, indeed, has been considered as one of the basic mechanisms -which have also been defined as *cognitive primitives*- accounting for age-related decline in cognitive function, together with processing speed, inhibitory functions and sensory functioning (Park, 2012). Further, WM training can induce improvements in performance in non-trained tasks -that rely on WM and attentional control (Klingberger, 2010)- that are also subject to cognitive decline.

Thus, interventions targeting WM - "*extensively characterized as a construct vital to higher cognition*" (Morrison & Chein, 2011) - could produce ample enhancement in cognitive functioning.

2.2.1 Strategic WM training

A more in deep revision of strategic training goes beyond this work's goals. Thus, only the theoretical assumptions that underpin these training will be mentioned.

Strategy training paradigms involve the teaching of effective strategies to encode, maintain, and/or retrieve information. Experimenters suggest strategies (both verbal such as rehearsal as well as visual strategies) that participants use in the following practical sessions (Morrison & Chein, 2011). Strategic training in aging are based on studies showing that older adults generally tend to use less strategies than young adults (e.g., Sanders, Murphy, Schmitt, & Walsh, 1980; Rogers, Hertzog, & Fisk, 2000) and that at least a part of the difficulties in memory tasks are due to the less efficient use of strategies (Light, 1991; Dunlosky & Hertzog, 2001). This *strategy deficit hypothesis* has been thoroughly studied in episodic memory, for example in paired- associate recall (e.g., Dunlosky & Herzog, 1998, 2001; Verhaeghen & Marcoen, 1994) but there are also studies that have illustrated this aspect in Working Memory tasks (e.g., Brébion, Smith & Ehrlich, 1997; Bailey, Dunlosky & Herzog, 2009; 2014). In a earlier study, Brébion and colleagues (1997) for example, found that older adults, in dual tasks, dedicate more attention to the elaboration phase, thus spending more time in reading sentences than in the storage phase, consequentially with less word recall. The authors also found that this effect was more evident in situations involving a greater memory load. This aspect, together with a decrease in the cognitive processing mechanisms in aging, could reduce older adults' performance on Working Memory tasks.

In their review on strategic memory training in older adults, Rebok and colleagues (2007) suggest distinguishing between i)"instant" single-strategy training and ii) extended, multiple-strategy training. Researchers usually provide, in the first type, a brief instruction on a single mnemonic technique over the course of a single or a maximum of two sessions. Instead the authors, in the second type, refer to the use of multiple strategies- often in a group setting- with a full dose of intervention provided over a number of sessions. The *Method of loci* and the name-face mnemonic are usually the most investigated techniques or strategies. Moreover, there are studies that involve more than one strategy, for example verbal rehearsal, mental imagery, items' categorization, and so on (for reviews see Verhaeghen, *et al*., 1992; Floyd & Scogin, 1997).

However, as pointed out by Morrison & Chein (2011), these strategic training procedures might not be strictly characterized as being WM training, because they are, rather, formulated in order to circumvent WM limitation - through the use of strategies- without any direct impact on the WM mechanisms *per se.* Despite this, there is evidence that strategic memory training could be successfully used to improve WM in older adults. In these studies, however, while specific (and also lost-lasting) effects in trained ability are shown, a "*narrow band of within ability transfer occur*" (Noack et al., 2009). In other words, with some exception (e.g., Cavallini, Pagnin, & Vecchi, 2003; Carretti, Borella & De Beni, 2007), training benefits did not generalize to other not directly trained abilities (Rebok, *et al.,* 2007).

2.2.2. WM process based training

More recently, limitations in transfer benefits after strategic training, as well as considerations about the weak strategies adopted by older participant even after this type of training, (e.g., Anschutz, Camp, Markley & Kramer, 1987; Scogin & Bienias 1988; O'Hara *et al.*, 2006), led to a shift in intervention design (Noack et *al*., 2009). Researchers have moved their attention from the use of explicit strategies to implicit practice-based interventions.

Process based training typically involves the repetition of demanding WM tasks that are designed to target domain-general WM mechanisms (Morrison & Chein, 2011). As suggested by recent reviews (e.g., von Bastian & Oberauer, 2013; Morrison & Chein, 2011; Au *et al.*, 2014), these interventions are specifically scheduled in order to avoid the use of context/ domain strategies, thus, also minimizing the risk of developing automatic processes through manipulation in task requirements. They also require maintenance of information in the face of interference and enforce rapid WM encoding of materials and their retrieval. Finally, their key feature is the involvement of high cognitive engagement and the inclusion of tasks or stimuli presented in different modalities (verbal, visuo-spatial or both modalities). Some of these WM process based training can be based on an adaptive procedure (e.g., von Bastian & Oberauer, 2012; Brehmer *et al.*, 2012): the task's difficulty is adjusted during training, for example, on the basis of the information that participants correctly remembered at a given level. In this way, training is always close to the subject's actual capacity, thus, avoiding too easy or difficult requests. This aspect could foster motivation towards the training task and ensure that participants are always trained at an optimal levels. Other studies have used a hybrid procedure in which a constant manipulation of the training requests is added to the adaptive procedure (e.g., Borella *et al*., 2010). The rationale behind the use of adaptive procedure is- as aforementioned- that cognitive plasticity is induced only by a ‘‘*prolonged mismatch between functional organismic supplies and environmental demands*’’ (Lovden *et al.*, 2010).

Some process based training -also defined as *core training*- takes a “kitchen-sink” approach, meaning that several tasks are included, with a broad difference in the type of stimuli used and the processes involved. If, on one hand this multi-domain approach could be useful involving multiple components, on the other hand, it makes it difficult to understand which specific WM mechanisms are affected and what components could eventually contribute to training effectiveness (Morrison & Chein, 2011; Karbach & Verhaeghen, 2014). A good example of this approach is the Cogmed study (Holmes, Gathercole, & Dunning, 2009), in which participants are trained using a large battery of WM tasks (this training is addressed to children). Again, in the COGITO study (Schmiedek *et al*., 2010) the participants were trained with WM tasks as well as tasks involving episodic memory and processing speed.

However, in training literature, the majority of the studies, have been conducted using a single paradigm regime in which specific WM aspects or functions such as updating or storage and processing are trained (for a review see von Bastian & Oberauer, 2013). According to several studies, training interventions focusing on the intensive practice of one WM aspect are possibly more effective than the practice of multiple aspects (von Bastian , Langer, Jäncke and Oberauer, 2012), although this issue deserves more attention. In the same way, the potential domain specificity of WM training is little known. The Melby-Lervag and Hulme's meta-analysis (2013) indicates that visuo- spatial WM training might lead to more persistent training and near transfer gains than verbal WM training: however this work includes different age groups and many different types of training.

It must be taken into consideration that only 5 studies (see table 2.1), conducted with older adults, were in verbal modality (with appreciable results) while the majority of training studies used a visuo-spatial modality or involved both modalities.

The WM process based training could differ for a number of aspect, thus, making it difficult to draw conclusions about their effectiveness. Together with divergences in training regimes, indeed, the substantial differences in both the duration and intensity of training, as well as the presence of a control group (a passive one rather than an active control group) could make comparison of different studies unclear. With reference to the first point, for example, the training session numbers ranged from only three (Borella *et al.,* 2010) to more than 100 (Schmiedek *et al*., 2010) across studies (Noack, Lövdén, & Schmied, 2014). Some authors have suggested a dose-dependent effects in WM training, indicating that a high number of training sessions might produce more benefits and transfer effects (e.g., Buschkuehl, Jonides, & Perrig, 2008). Again, there is evidences that distributed or spaced practice is more effective than massed practice (von Bastian & Oberauer, 2013). Some works, however, in spite of only having a few training sessions, provided promising results (e.g., Borella *et al.,* 2010).

Concerning the second point, a few studies included active control groups that succeeded in completing some alternative tasks, which were similarly challenging and as motivating as those performed by the training group (von Bastian *et al.,* 2012). Some of the studies, indeed, included, passive control condition, in which the subjects were re-tested at the same time as the experimental groups, without receiving any treatment; other studies, instead, included an active control group that received additional treatment, which could be not considered as training (the participants completed a questionnaire, or completed a physical training and played computer games or quizzes). Finally, some training also adopted a control group that performed the same activities as the training ones, but without any adjustment being made in task difficulties (e.g., Schmiedek et al., 2010).

Nonetheless, control and training condition should ideally be as similar as possible, in order to check for motivational and psychological effects, such as the Hawthorne effect (that is, the improvements in performance due to the participants' increased attention, see McCarney et al., 2007).

There is also a broad level of heterogeneity in the participants' age considered in the studies, an aspect that could mediate training benefits and transfer gains (Melby-Lervåg & Hulme, 2012)- More specifically, in studies conducted with older adults, only a few researchers have considered the differences between older adults (65-74 years) and the old-old (more than 75 years) (e.g., Buschkuhel *et al*., 2008; Borella *et al.*, 2013). Finally, studies have rarely taken the level of participants' cognitive abilities, at the baseline, into consideration (for an exception see Zinke *et al*., 2014). However, Zinke and colleagues (2014) showed, for example, the larger training gains achieved by individuals with a low baseline.

Currently, there are 16 studies on older adults, drawn up in table 2.1. As mentioned before the training differs according to the type and nature of tasks adopted, according to the participants' age and other aspects, which reflect divergences in transfer and maintenance effects (see figure 2.3). These latter issues have been addressed in the following paragraph.

2.3. Transfer and maintenance of process based WM training benefits

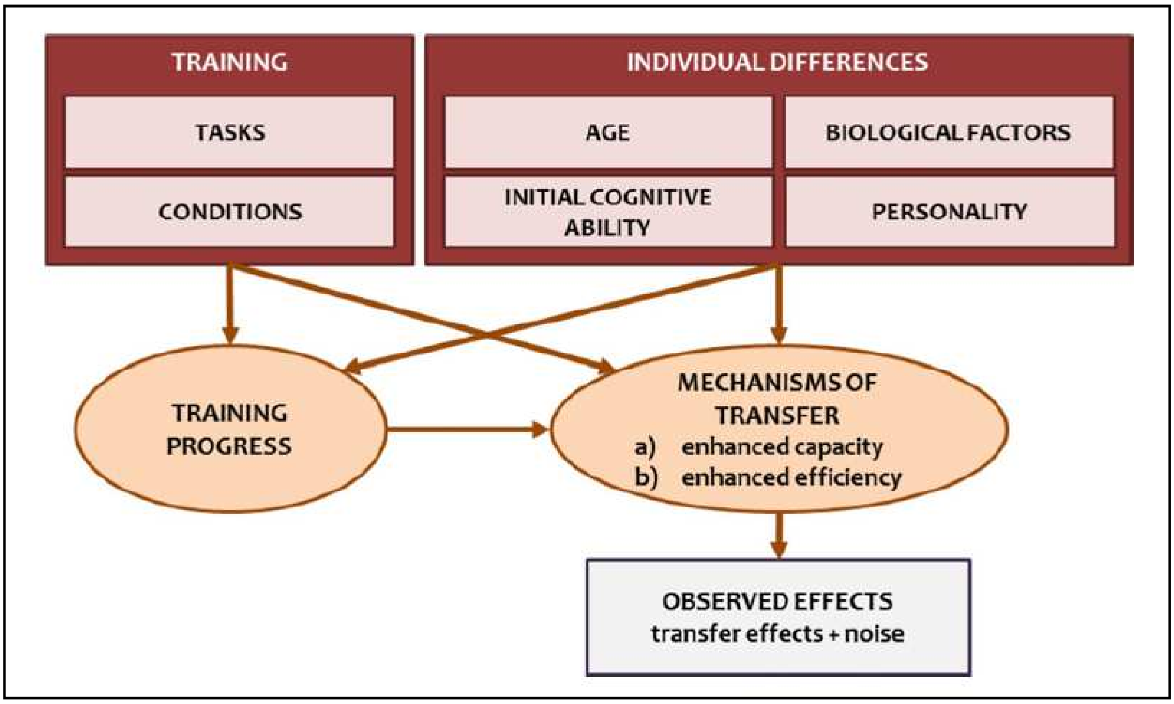
WM training benefits could be generalised to other abilities, which although they have not been directly trained, share the same WM structural areas or overlap the same neural networks (Buschkuehl, *et al.*, 2012; Lusting, Shah, Seidler, & Reuter-Lorenz, 2009). This "*overlap hypothesis*" confirms that transfer can only be expected if the trained task and transfer task share some overlap in neuronal activation (Noack *et al*., 2014). Dahlin and colleagues (2008) in their study showed, for example, that trained (updating) and transfer (n-back) tasks involved overlapping areas in the striatum. Furthermore, WM is believed to reflect general attentional resource limitation. Thus, if WM training is successful, transfer effects to untrained tasks should be proved: this kind of training should, indeed, lead to an increase in domain-general attentional capacity, critical to the performance of many, diverse tasks (Melvy-Lervag & Hulme, 2013).

Recent reviews have indicated two, possible mechanisms in WM training-induced changes (see figure 2.3). WM training could act i) ex*panding WM capacity* or ii) *enhancing WM efficiency* (e.g., von Bastian & Oberauer, 2013). The first mechanism is associated with cognitive plasticity and implies broad, potential transfer effects. In contrast, *enhanced efficiency* is expected to be material and/or process-specific and could reflect the use of strategies and changes in cognitive flexibility (see Lovden *et al.,* 2010; Holmes *et al.*, 2009). It is also possible that WM efficiency could be improved by a higher level of automatization in the process practiced, thereby, releasing cognitive resources for other concurrent demands. In these, latter cases, the transfer effects are expected to be less important.

In order to examine the occurrence of plastic changes, researchers should administer transfer tasks that vary in the degree of processing overlap with the practiced task in a pre-post-test assessment. The maintenance of training effects - in both trained and transfer tasks - should also be addressed. "*Without information on transfer and maintenance, it is difficult for one to discern whether intervention effects are restricted to the formation of a new skill, or whether cognitive mechanisms and capacities of general applicability have been enhanced"* (Li *et al.,* 2008)

According to Noack and colleagues (2014), (see also Barnett & Ceci, 2002), it is possible to distinguish *nearest transfer effects* (transfer within the same domain, for example from verbal to visuo-spatial WM tasks) *near transfer effects* (e.g., transfer from WM to short term memory) and *far transfer effects* (meaning the generalization of training benefits to other cognitive abilities related to WM, e.g., the fluid intelligence task). The stronger the correlation between WM and a given ability the larger the related transfer effect is expected to be. Once again, there is evidence that the degree of improvement in the training tasks correlated positively with the transfer magnitude (von Bastian & Oberauer, 2013; Zinke *et al.,* 2014).

Figure 2.3 *Factors that could influence the outcome of WM training and mechanisms of transfer. (Adapted from von Bastian & Oberauer, 2013)*



In all studies conducted on older adults, the specific, training effects in criterion tasks (trained tasks) have been shown (see table 2.1), independently of the training regime's features (verbal training, visuo-spatial training, multimodality training, updating training, and so on) or the participants' characteristics (older adults and old-old). Differently, evidence on near and far transfer effects are controversial: near transfer effects have been shown in all studies, but only in some of the measures considered in the assessment. Far transfer effects, instead, are more rarely shown (Borella *et al.*, 2010; Richmond *et al*., 2011; Carretti et al., 2013; Brehmer, *et al*., 2012; Zinke *et al*., 2014*)* and a number of studies have failed to obtain significant, far transfer benefits (e.g., Li *et al*., 2008; Chain & Morrison, 2010; Dahlin *et al*., 2008, Schmiedek *et al.*, 2010; Buschkuehl *et al.*, 2008).

A fundamental issue is whether WM training gains are reflected in changes in everyday life and, thus, in transfer effects that are more related to everyday functioning, such as language comprehension, problem solving, and so on. However, only three studies (involving older adults) have attempted to take this aspect into consideration, and will be discussed in more detail in chapter

3. The Study 1, presented in this work, has the objective of analysing the generalization of this WM training procedure to activities inherent in everyday life.

As mentioned above, the effects of WM training should also be demonstrated on the long term. Unfortunately, the majority of studies concerning WM training in aging did not take the maintenance effects or controversial results reported into consideration (for a review of the studies, see Borella, Carretti, Zanoni, Zavagnin & De Beni, 2013). Some studies revealed long lasting, sustained benefits after training (e.g., Borella *et al*., 2010; 2013); other training, instead, did not demonstrate any maintenance of the effects (e.g., Buschkuhel *et al*., 2008). Again, there are considerable differences in the timing of conducting follow up assessments, ranging from the three-month follow up performed by Li and colleagues (2008) and Brehmer *et al.* (2012) until the eighteen-months follow up carried out by Dahlin and colleagues (2008).

The fact that transfer effects have not been consistently observed has inspired debates on WM training efficacy, which have been dealt with in all the recent reviews published (Shipstead, Redick & Engle, 2012; Redick *et al*., 2013; Melby- Lervag & Hulme, 2013; von Bastian & Oberauer, 2013; Au et al., 2014; Karbach & Verhaeghen, 2014). These reviews, however, have not specifically addressed the effectiveness of WM training in older adults. An exception is represented by the work carried out by Karbach and Verhaeghen (2014).

In their meta-analysis - where studies on older adults, as well as studies on younger adults have been contemplated - they, tested the extent of cognitive benefits after process based training (both Executive Function training and WM training) and, furthermore, investigated the age-related differences in training and transfer effects between younger and older adults.

With reference to the first point, they concluded that process based training led to significant improvements in training criterion tasks (ranging from 0.9 sd to 0.5 sd, according to the fact that raw gains rather than net gains - gains obtained after subtracting the effects of control treatments - are studied). Again their results demonstrated clear near transfer effects in older adults (from 0.7 to

0.5 sd), but reduced, far transfer effects (about 2.0 sd). The authors, for all that, underlined that the majority of studies on WM training are underpowered, an aspect that makes it difficult to detect any possible effects.

Figure 2.4. *Data for older adults - comparing specific, near and far transfer effects after WM training- are presented. K represents the number of studies that contributed effect size (adapted from Karbach & Verhaeghen, 2014).*

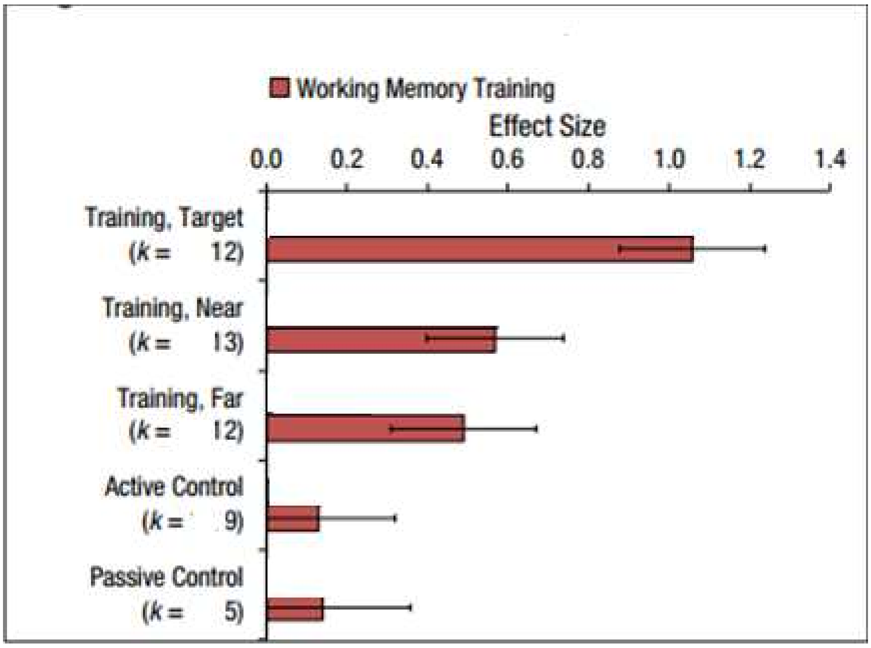


Table 2.1. *WM Process based training in older adults*

Authors	Nature of the training regime	Sample characteristics	Presence of control group	Training activities	Length of training session and frequency	Specific effects	Near transfer effects	Far transfer effects	Transfer effects to everyday life abilities	Maintenan-ce of training gains
1. Li et al., 2008	Visuo-spatial	Older adults (both young old and old-old) from 70 to 80 years old (M =74.5 ds= 2.8)	**No**	Spatial n-back task	45 daily sessions (15 min per day)	**Yes**	**Yes**: to the digit span and Visual Block Span	**No** to complex WM span tasks (operation and WM span tasks)	Not evaluated	*3 months follow up* **Yes** (in three back spatial task and in numerical n-back task)
2. Buschkuehl et al. 2008	Visual	39 Old old participants (M=80 ds=3.3)	Active control group: physical training	Visual WM Tasks	23 sessions, 2 sessions/ week, 45 min each	**Yes**	**Yes**: To the Digit Span Task but **No** to the visual block span	**Yes**: To visual free recall task but **No** to verbal free recall task	Not evaluated	*12 months follow-up* **No**
3. Dahlin, et al., 2008	Verbal	26 Yonger aduls (M=23.67, sd=2.92) and 29 Older adults M =68.38 ds=1.66	Passive control group	WM updating task (Letter memory task)	5 weeks, 3 sessions for week, 45 min for each session	**Yes** to the criterion task (Letter Memory Task both in younger and older adults)	**No** to WM tasks (Forward and Backward digit span, computation span and 3-back). Only for younger participant, transfer effect to 3-back was shown.	**No** transfer effects to processing speed (Digit Symbol Substitution), episodic memory (paired-associate learning), verbal fluency (Controlled Oral Word association test) and fluid intelligence	Not evaluated	*18 months follow up* **No** for older adults Only for younger adults, gains in criterion task were maintained

								(Raven's Advanced Progressive Matrices) were found		
4. Borella *et al.*, 2010	Verbal	40 Older adults 65–75 (M=69 ds3.18)	Active control group (alternative activities: questionnaires)	Verbal WM task (based on modified version of CWMS task)	3 sessions (2 days break between sessions), about 45 min each	**Yes**	**Yes,** nearest transfer effetcs to visuo-spatial WM (Dot Matrix Task) were found, as well as near transfer effect to Short term memory (Forward and Backward Digit Span)	**Yes**: to processing speed (Pattern Comparison Task) Inhibition (Stroop Test) and fluid intelligence (Cattell Test)	Not evaluated	*8 months follow up* **Yes.** Effects were maintained for all measure, except for Dot matrix task and Stroop color Task (performances come back to the baseline level).
5. Schmiedk, et al., (2010)	Multi-modality	101 younger adults 103 Older adults (both young old and old-old) from 65 to 80 years old (M =71.3 ds= 4.1).	Passive control group	Practice task included: WM tasks, Episodic memory tasks, Perceptual Speed task	100 sessions	**Yes,** for all practiced tasks expect than Episodic Memory Task in older adults.	Only to one of the three WM/updating tasks considered	**Yes**: to a fluid intelligence, and to episodic memory tasks	Not evaluated	Not evaluated
6. Richmond, et al., 2011	Multi-modality	40 Older adults (both young old and old old) from 60 to 80 yearsold (M=	Active: Trivia Training: participants	Verbal and spatial WM tasks	20 sessions (5 day a week), 30 min for each session	**Yes**	**Yes**: To a verbal WM task (Reading Span Task) but	**Yes** to repetition in California Verbal Learning Test	**No** effects were shown to test of everyday attention	Not evaluated

		66; ds not reported)	complete d online a list of quizzes.				**No** to shortterm memory tasks (the forward and backward Digit pan tests)	(long term memory) **No** to fluid intelligence, (Raven's SPM)	(TEA) where a ceiling effect was present. Ad hoc questionnair e scores indicated that trained participants reported an increase in attention	
7. Brehmer, *et al.*, 2012	Multi-modality	55 younger adults 45 Older adults from 60 to 70 years old (M=63.9; ds=3.4)	Active: Same WM training task with no variation in the task difficulty (low-level practice)	Verbal and non-verbal WM tasks	5 Weeks, 25 sessions of about 26 min	**Yes**	**Yes**, to Span	**Yes** to sustained attention (PASAT), but **No** to fluid Intelligence (Raven's SPM,) episodic memory (RAVLT) and inhibition (Stroop)tasks	**Yes:** to self-rating questionnair e on cognitive Failures (CFQ)	3 months **Yes**, for criterion task,Board backward and Digit Span Forward, for PASAT and CFQ.
8. Zinke, Zeintl, Eschen, Herzog & Kliegel (2012)	Multi-modality	36 Old-old participants (from 77 to 96 years old)	Passive control group	Both verbal (Digit Span Forward and Backward) and visuo-spatial WM tasks (Forward and; K-ABC icons task)	Daily sessions if 25-30 min over 2 weeks (in totale 10 sessions were administere d).	**Yes**	Not evaluated	**No** to inhibition (german version of the Stroop Color task) and fluid intelligence (Raven Colored Progressive Matrices).	Not evaluated	Not evaluated

9. Carretti, *et al.*, 2013	Verbal	Older adults (65-75 years old)	Active control group (Alternative Activities questionnaires)	Verbal WM task (Categorization WM span + WM updating during reading)	3 sessions (2 days break between sessions), about 45 min each	Yes	Yes: to for Working Memory Updating word span test;	Yes to listening Comprehensiof spatial descriptions; Fluid intelligence (Cattell Test)	Yes: to Language comprehension - Listening comprehension of spatial descriptions	6 moths follow up Yes, for Working Memory Updating word span test and Cattell Test
10. Borella *et al.*, 2013	Verbal	36 Old old (from 75 to 87 years old)	Active control group (Alternative Activities: questionnaires)	Verbal WM task (Categorization WM span)	3 sessions (2 days break between sessions), about 45 min each	**Yes**	**Yes** to Forward Digit Span but not to Backward digit span Shor term memory); Nearest tranfer effects were not showed for Dot Matrix Task (visuo-spatial WM)	**Y**es to Stroop color task. Not to processing speed (Pattern Comparison) and fluid intelligence (Cattell Test)	Not evaluated	8 moths follow up Yes for Forward Digit Span and Stroop Color Task
11. Carretti, *et al.*, 2013	Verbal	20 Individuals with Amnestic Mild Cognitive Iimpairment (aged between 65 and 75 years)	Active control group (Alternative Activities: questionnaires)	Verbal WM task (Categorization WM span)	3 sessions (2 days break between sessions), about 45 min each	**Yes**	**No** near transfer effects to Visuo-spatial WM (Dot Matrix Task) and Short term memory (Forward and Backward digit span)	**Yes** to fluid intelligence (Cattell Test) and episodic memory (List recall task) **No**t transfer effect to processing speed (Pattern comparison).	Not evaluated	Not evaluated

12.von Bastian, *et al.*, 2013	Multi-modality	66 younger adults 57 older adults (age range 61-77)	Active control group (low level practice)	The experimental training comprises one task for each functional category of WM capacity: Numerical complex span (storage and processing), Tower of Fame (relation integration) and figural task switching (supervision)	4 weeks, 20 sessions	**Yes** for all criterion measures except for Task switching	**Yes** ,to the verbal complex span task	**No** for fluid intelligence (Raven's Advanced Progressive Matrices and BOMAT test)	Not evaluated	Not evaluated
13. Zinke *et al.*, 2014	Multimodality	Older adults (both young old and old- old, aged from 65 to 95 years old; M=77.2; sd=8.1)	Passive control group	Visuo-spatial WM task; verbal WM tasks and executive control tasks	9 sessions of 30 min for each	**Yes** for all 3 criterion tasks (a picture grid tasks, the Subtract -2 span and Tower of London).	**No** nearest transfer effects to visuo-spatial WM (Block Span Task).**Yes** for verbal WM (Letter Span Plus Task)	**No** to inhibition (Stroop Task) **Yes** to fluid intelligence (Raven SPM)	Not evaluated	9 months follow up **Yes**, for all criterion tasks and for verbal near transfer task. **No**Transfer to fluid intelligence was not maintained.
14. Heinzel *et al.*, 2014	Visuo-spatial	30 Younger adults M=25.9;sd=1.9 30 older adults (M=66.07; sd=4.7)	Passive control group	N- back training in which the task's difficulty was modulated by introducing higher WM	4 weeks training session, 3 times a week.(about 45 min for each)	**Yes** both in younger participants than in older adults.	**Yes ,** to short term memory in older participants (Forward digit span)	**Yes**, todigit simbol task (processing speed) for both age groups. Younger participants	Not evaluated	Not evaluated

				loads and by shortening the interstimulus interval		However , whereas younger reached difficulty level 12, older participa nts did not exceeded level 5		showed transfer effects to Verbal Fluency (Executive Functions) whereas older ones to CERALD delayed recall. No transfer were found for fluid intelligence tasks (LPS figural relation Test and RSPM		
15. Stepankov a, *et al.*, 2014	Verbal	65 older adults (from 65 to 74 years old)	Passive control group	Verbal n- back task	5 weeks, 20 session s(25 min for each session)	**Yes**	**Yes** to Forward and Backward digit span and to Letter Number Sequencing (WM)	**Yes**, to Block Desing and Matrix Reasoning (visuo-spatial skills and fluid intelligence)	Not evaluated	Not evaluated
16. Borella *et al.*., 2014	Visuo-spatial	40 Older adults (age 65–75 years) 40 old-old (age 76–84)	Active control group (Alternati ve activities: questionn aires)	Visuo-spatial WM task (Matrix Task)	3 sessions (2 days break between sessions), about 45 min each	**Yes**	**Yes,** Nearest transfer to Verbal WM task (CWMS) - both in young older adults and in old-old- and to Visuo-spatial Short term memory (Forward and Backward Corsi Span), but only in young-old	**Yes**, to processing Speed (Pattern Comparison Task) but only in young old	Not evaluated	8 months follow up Benefits were maintained for Criterion Task andCWMS, both in young-old and in old-old.

Note: BOMAT: Bochumer Matrizen Test (Hossiep et al., 1999); CFQ: cognitive failure questionnaire (Broadbent et al., 1982); CVLT: California Verbal Learning Test (Delis, Kramer, Kaplan & Ober, 1987); CWMS: Categorization Working Memory Span Task (De Beni et al., 2008); K-ABC icons: Kaufmann Assessment Battery for Children (Melchers & Preuss, 1991); PASAT: Paced Auditory Serial Addition Test (Gronwall, 1977); RAVLT: Rey Auditory Verbal Learning Test (Lezak, 1983); TEA = Test of Everyday Attention (Robertson, Ward, Ridgeway & Nimmo- Smith,1994)

2.4. WM process based training conducted with the procedure of Borella and colleagues

In this paragraph are reassumed evidences derived from studies conducted using the hybrid procedure of Borella and collegues (2010; 2013; 2014). The choice to dedicate a specific space to these interventions is driven by the importance of this paradigm in this thesis.

As aforementioned, this procedure- scheduled in only 3 training sessions lasting about 40 minutes for each sessions- include an adaptive increase in the task's difficulty level, according to the individuals performances. Again, a continuous manipulation of the training task is required, in order to avoid the automatization of process involved in the tasks and the development of content specific strategies. Thus the intervention is based, in total, on only 2 hours of WM training, attended in a 2 week framework. Training activities require to perform with modified version of a specific WM tasks, that is the Categorization Working Memory Span Task (De Beni *et al.*, 2008).

Despite its shortness, promising results derived by the application of this procedure (see table 2.1). In their first study Borella and colleagues (2010) showed, in older adults, the possibility to improve WM performance and transfer benefits to Short term memory (Forward Digit Span and Backward Digit Span tasks) Pattern Comparison task (processing speed), Stroop Color Task (inhibition) and Fluid Intelligence (Cattell Test). Transfer maintenance gains were showed at 8 months follow up but only in fluid intelligence and processing speed tasks. Moving from these promising results, in 2012, Carretti and colleagues (2013) investigated -using a modified version of the previous procedure (WM and updating activities)- transfer effects on measures of WM updating, reasoning, and on text comprehension. Results showed gains in the criterion task and in reasoning and language comprehension performance. These benefits were maintained ad 6 moths follow up.

The effectiveness of this procedure was also demonstrated in individuals with amnestic mild cognitive impairment (Carretti et al., 2013). Trained individuals showed improvements in WM as well as near transfer effects on visuo-spatial WM tasks. Again, far transfer effects were shown in Cattell Test and in Long term memory task (List recall). Finally, Borella and colleagues (2013) tested the efficacy of this training procedure in old-old. Results showed an improvement in criterion task and- only at follow up level- an increase in the efficiency of inhibitory mechanisms.

In 2014, the efficacy of this procedure was tested also by administering training activities in visuo-spatial modality, both in young old and in old-old. This study showed weaker results, compare to the previous verbal studies, in terms of transfer gains. Near transfer effects occur-only for young old-in short term memory and processing speed tasks, without a maintenance at follow up.

Specific hypotheses about these latter weaker results are provided in chapter 4. These divergences, indeed, have constitute the starting point for the study 2 and 3 presented in this thesis.

CHAPTER 3

CAN WORKING MEMORY TRAINING ENHANCE COGNITIVE PERFORMANCE IN THE EVERYDAY LIFE OF OLDER ADULTS?

STUDY 1

3.1 Introduction

There is an increasing interest in intervention that might prevent cognitive decline or maintain cognitive functioning in older adults. Over the last few decades, in fact, due to the world 's population's aging, the development of memory training has become of primary importance in gerontological research.

A wide variety of training types have been proposed to date, demonstrating that older adults -by virtue of the cognitive plasticity that is also present in later life (Baltes & Willis, 1982; Baltes & Lindenberger, 1988) - could improve memory skills by using memory strategies or through practice with specific tasks (Rebok, et al., 2007).

There is considerable literature now that is focused on enhancing the Working Memory (WM)- the ability to retain and simultaneously process information to execute cognitive tasks (Baddeley & Hitch,1974; Miyake & Shah, 1999)- due its well documented decline in aging (e.g., Bopp & Verhaeghen, 2005; Park *et al*., 2002), and its importance in high order cognition and in everyday life abilities: WM, for example, is implicated in reading comprehension (Daneman & Carpenter, 1980), mathematical abilities (Bull & Sherif, 2001), planning and problem solving (Willis & Marsiske,1993), and its decline has been identified as being an early marker of dementia (Rosen, Bergeson, Putnam, Harwell & Sunderland, 2002).

Two different approaches have been adopted to train WM (see Morrison & Chein, 2011): i) strategic training aimed at promoting the use of domain-specific strategies (i.e. rehearsal or mental images), in order to better codify and remember stimuli (Cavallini, *et al.*, 2003; Carretti *et al.*, 2007) and ii) process based training, which involves practice with demanding WM tasks, designed to target domain general WM mechanisms, avoiding the use of context-specific strategies (e.g., Klingberg, Forsberg, & Westerberg, 2002). Positive evidence has been derived from both training approaches in terms of specific gains on trained tasks. Diversely, the question concerning the possibility of extending benefits to other abilities, which have not been directly trained, is still controversial. Whereas, transfer effects in strategic WM training have rarely been tested (Morrison & Chein, 2011), more promising results have been derived from process based WM *training.* Several findings indeed suggest that process based WM training could lead to an improvement in cognitive functions that are related to WM (e.g., attention, inhibition, executive control and fluid abilities). Once again, it has been shown that transfer effects can occur if the criterion task (the directly trained task) and transfer task engage specific overlapping processing components and brain regions (e.g., Dahlin, *et al.*, 2008; Olesen,Westerberg & Klingberg, 2003).

However, transfer effects evidence- derived from process based WM training studies- is mixed: whereas some authors have demonstrated far transfer effects (Borella *et al*., 2010; Richmond *et al.*, 2011*),* a number of studies have however failed to obtain significant transfer benefits (e.g., Chein & Morrison, 2010; Dahlin *et al*., 2008).

More importantly, as set forth in recent reviews (e.g., Kelly *et al*., 2014), is the lack of studies that evaluate generalization of memory training benefits to everyday life abilities: this aspect is rather surprising considering that these interventions are theoretically constructed in order to prevent age-related cognitive decline and sustain older adult's autonomy and quality of life. Despite this, the majority of trials do not include functional outcome measures. With specific references to WM training studies, in spite of having shown that there are strong correlations between WM and everyday cognition tasks (see Allaire & Marsiske, 1999) there are only three studies that have attempted to evaluate the effectiveness of WM training on everyday abilities (Morrison & Chain, 2010; Richmond *et al.,* 2011; Carretti *et al*., 2012; Brehmer *et al*., 2012). More efforts in this direction have been conducted through other types of cognitive training. The ACTIVE study (see Jobe *et al*., 2001; Ball *et al*., 2002; Willis & Schaie, 2009; Willis *et al*., 2006; Gross, Rebok, Unverzagt, Willis & Brandt, 2011; Rebok *et al.*, 2014) represents the most important work carried out, to date, in this sense. Ball and colleagues (2002) assessed the effectiveness of 3 types of training – based on verbal episodic memory, reasoning and processing speed respectively - on standard measures of cognitive abilities and on measures of everyday functioning, both subjective (Activity of Daily Life Scale -ADL; Instrumental Activities of Daily life scale -IADL) as well as objective ones (Everyday Problem Solving, Observed Task of Daily Life, Timed Instrumental Activities of Daily Life). Training was proved to be useful in enhancing targeted cognitive abilities but improvements, both in objective and subjective performances of everyday abilities, were not revealed. Ball, Edwards and Ross (2007) - by combining data from six studies -all using the same training program (the target was the processing speed) based on tasks similar to a subtest of the Useful Field of View test (UFOV)- showed that older adults improved not only their performance on the UFOV test, but also on everyday life abilitities' tasks (Road Sign Test- driving simulator-, Timed Instrumental Activities of Daily Life).

McDougall and colleagues (2010), through their *SeniorWISE study* (multi-factorial training in which meta-cognitive aspects were considered as well as both memory strategies and Health Promotion classes), showed a significant short term improvement in the everyday functioning of older adults (assessed by DAFS: direct assessment of functional status) and everyday memory (assessed by the Rivermead Behavioural Memory Test).

Cavallini and colleagues (2003) identified an improvement in activities that are more strictly related to everyday life (i.e. face-name recognition, memory for places) and everyday memory questionnaires in older adults, after strategic memory training and Loci mnemonic interventions. Gains in face-name recall were also found during the strategic training conducted by Cavallini, Dunlosky, Bottiroli, Herzog & Vecchi (2010). Hasting and West (2009), as well as, after their strategic memory training- both self help and group-based- showed an improvement in name and story recall.

With references to the aforementioned process based WM training only three studies have attempted to investigate the transfer effects on everyday competences. In 2012, Carretti and colleagues, combining the WM training schedule as envisaged by Borella and colleagues (2010), with an updating task, obtained transfer effects on reading comprehension assessed by the Nelson Denny Reading Comprehension Test. Richmond and colleagues (2011), after WM training, failed to obtain a transfer effect on a measure of Everyday Attention (TEA) but found that the training group participants were more likely to self-report improvements in everyday attention. Finally, Brehmer and collegues (2012) demonstrated far-transfer effects on the self-rating scale of cognitive functioning (CFQ) in both young and older adults.

Therefore, in summing up, the possibility of improving everyday life competences, defined as "*the ability to adequately perform those cognitively complex tasks, considered essential for living on one's own in this society*" (Willis, 1996)- after process based WM training is rarely investigated or only subjective measures of abilities are used (Richmond *et al.*, 2011; Brehmer *et al.*, 2012) . These measures, however, may contain distortions derived from the participants' expectations, opinions and needs (Moore, Palmer, Patterson & Jeste, 2007). There is evidence that older adults tend to overestimate their levels of everyday competences in comparison to their true performance. Furthermore, self-report benefits might only reflect the participants' expectations about the training and do not reflect older adults' real competences (Shipstead *et al.*, 2010).

Aims

This study's aims were to assess, in a sample of young old (between 65 and 75 years of age), the efficacy of verbal WM training - which was already tested by Borella and colleagues (2010)- in obtaining transfer effects on everyday life abilities and fluid intelligence tasks. In both cases, multiple indicators were used in an attempt to overcome the previous studies' limitations. Indeed, as suggested by Shipstead and colleagues. (2010), improvement in a single task makes it impossible to predict if general abilities have changed or only the performance in the specific task.

The training, envisaged by Borella and colleagues (2010), has been chosen due to the promising transfer effects previously shown on fluid intelligence, inhibition, processing speed (2010) and language comprehension (Carretti *et al.*, 2013) in old -old participants too (Borella *et al.*, 2013) and in older adults with amnestic mild cognitive impairment, aMCI (Carretti *et al.*, 2013).

First of all, we examined the transfer effect on objective performance based measures concerning everyday life competences (Everyday Problem Solving and Timed Instrument of Daily Life), which are less influenced by the aforementioned participants' expectation.

Recent works, have suggested that performance based measures are more predictive of the true functioning in specific IADLs domains and more sensitive in detecting intra-interindividual changes (Kimbler, 2013). Furthermore they appear to be more related to the standard measures of cognitive abilities, compared to IADLs (Willis, 1996).

We selected the Everyday Problem Test (EPT-Willis & Marsiske, 1993) and the Timed Instrumental Activity of Daily Life Scale (TIADL-Owsley, Sloane, McGwin, & Ball, 2002) for their brevity and due to the possibility of easily adapting them to the Italian culture (for a review about performance based measures of functional living skills, see Moore et *al*., 2007).

One further aim was to replicate the transfer effect on fluid intelligence tasks: these transfer effects are, theoretically, possible according to studies showing a common process, shared by WM and fluid intelligence, which is controlled attention (Engle *et al*., 1999). In both tasks WM and in fluid intelligence, subjects need to keep stimuli active under attentional control (Conway *et al*., 2003) and to simultaneously store and process information (e.g., Daneman & Carpenter, 1980). Furthermore, measures of WM are good predictors of intelligence (e.g., Conway, Kane & Engle, 2003).

Consistently with previous results (Borella *et al.*, 2010), we expected the training to improve the older adults participants' performance in the criterion task (Categorization Working Memory Span

Task). Moreover, according to studies that showed WM involvement in everyday life, transfer effects were expected in an everyday problem solving (EPT) task. Once again, transfer benefits were also anticipated for the TIADL task, in which activities related to everyday life must be performed with time constraints. Performances on this latter task are, in fact, related to processing speed as being the better predictor (Owsley et al, 2002) but also to memory and reasoning (see also Edwards, Ruva, O'Brien, Haley & Lister, 2013). Processing speed has been suggested as being one key component in a wide range of cognitive domains and is also related to WM (Fry & Hale, 2000). Previous studies have demonstrated the WM training's transfer effects (Borella *et al.*, 2010; Borella *et al.*, 2013) to a processing speed task, which is the Pattern Comparison Task .

Finally, we expected to replicate (according to Borella *et al.* 2010, in which transfer effects were shown using the Cattell Test) transfer effects on fluid intelligence using multiple indicators: we chose the Cattell Test and Raven's Standard Progressive Matrices, because, in psychometric studies of intelligence, they have been proved to load highly on a general factor (i.e., Spearman's g see Carroll, 1993).

3.2 Participants

Thirty- six older adults, aged between 65-75 years, participated in the study and were randomly assigned to the trained or active control groups. They were selected on the basis of a physical and a health questionnaire. None fitted the exclusion criteria proposed by Crook *et al.* (1986). All participants scored 27 or over on the Mini Mental State Examination (MMSE: Folstein *et al.*, 1975). Experimental and control group participants did not differ in demographic characteristics- that are age and years of formal education (Fs<1) - or in the Vocabulary test (Wechsler,1981), $F_{(1,34)}$ = 2.27, p= .14, $n\text{p}^2$ = .06. (See table 3.1 for demographic characteristics).

Table 3.1 *Trained and Control Groups' demographic Characteristics*

	Trained group (N=18)		Control group (N=18)	
Characteristic	M	SD	M	SD
Age	69.50	3.25	69.77	2.92
Education	9.94	2.50	10.50	3.09
Vocabulary	48.11	3.16	46.22	4.27

3.3 Method

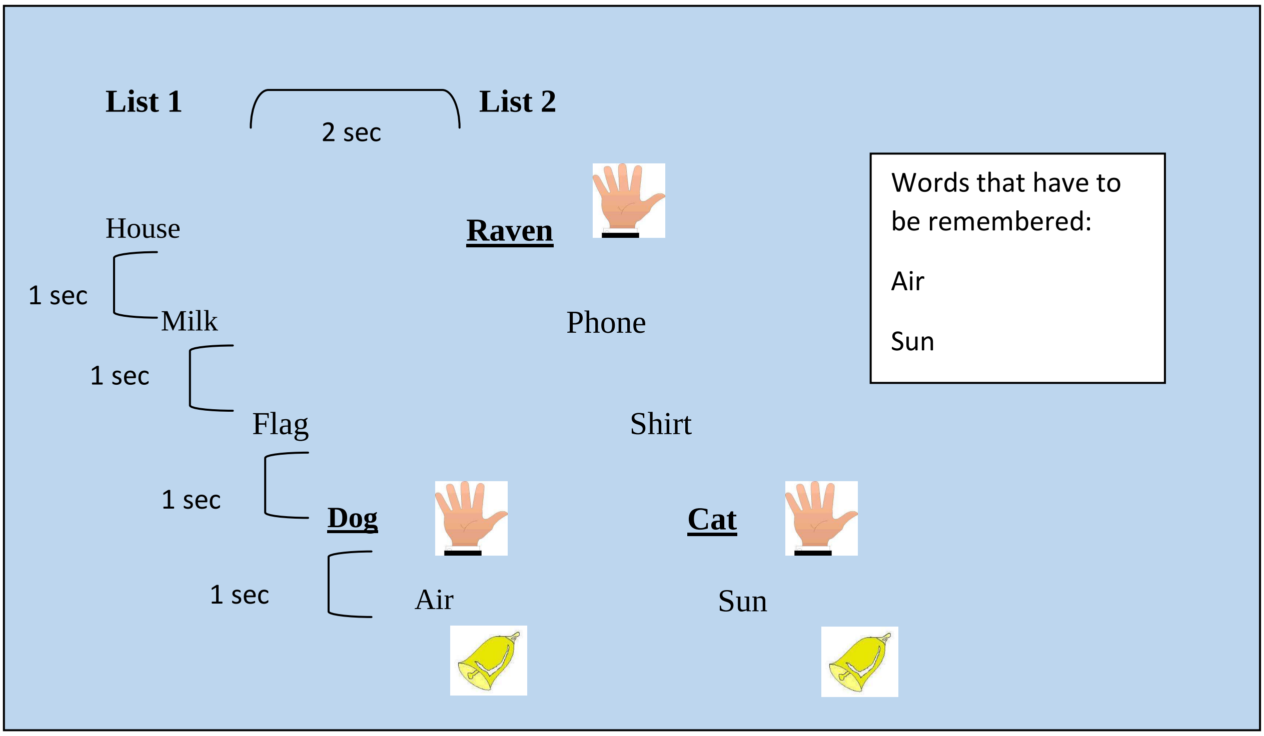
Materials

Pre-test, Post- test assessment

Criterion Task

Categorization Working Memory Span Task (CWST) (De Beni, Borella, Carretti, Marigo, & Nava, 2008). The material consisted in series of word lists containing five high-medium frequency words, organized in sets of different lengths (i.e., from two to six lists of words to be recalled). Each series contained zero, one, or two animal nouns, present in any position, including the last one. The participants listened to the audio-recorded word lists presented at a rate of 1 word per second, and were asked to tap their hand on the table whenever they heard an animal noun (processing phase). At the end of the sets of lists, the participants recalled the last word in each list in serial order (maintenance phase). The interval between the word lists was 2 sec. Each list ended with a sound. Two practice trials, on level 2, were given before the experiment started (see figure 3.1). The total number of correctly recalled words was used as the measure of WM performance (maximum score 20).

Figure 3.1. *CWMT: example based on level two.*



Transfer effects on everyday functioning tasks

Everyday Problem Solving (adapted from Willis & Marsiske, 1993, by Borella, Cantarella, Carbone & De Beni). The Everyday Problems Test (EPT) is a paper pencil test measuring an adult's ability to solve daily life activities (see also Cavallini *et al*., 2014). This version of the EPT has been adapted from the 42- item version by Willis and Marsiske (1993) to comply with the Italian culture. The 42 item-version was then split into three different versions (two of them have been used in this study), including, items concerning all the seven IADL domains that are: Household Management, Transportation, Meal Preparation/ Nutrition, Financial Management, Health, Consumer, Telephone Skills. In this way, each form includes 14 items grouped into 7 daily life situations/problems (see table 3.2). The problems are all constituted using "real life" materials, including phone bills, medicine bottle labels, and so on. For each proposed situation, the participants are asked to read problems and to answer 2 questions. The participant writes his/her answers directly on the test form. The final score is the sum of correct answers (maximum score 14).

Table 3.2: *EPT item used in versions A and B. The two versions were administered in counterbalanced order, between a pre-test and post-test assessment. Two questions were asked concerning each item (see appendix D).*

Version A		Version B	
ITEMS	IADL DOMAIN	ITEMS	IADL DOMAIN
Cereal Chart: Nutritional Facts	Meal preparation Scale	Instruction for preparing frozen vegetable	Meal preparation Scale
Medical History card	Health medication Scale	Cough Medicine	Health medication Scale
Telephone Service Application	Phone Scale	Compare phone charges	Phone Scale
Fill in a form: how to become an association's member	Consumer (shopping)Scale	Compare clothing costs	Consumer (shopping)Scale
How to programme the washing machine	Household Scale	To estimate the quantity of stain remover	Household Scale
Highway code	Transportation Scale	To calculate Taxi charges	Transportation Scale
Read and calculate a sales receipt	Financial management	To choose an item from a gift catalogue	Financial management

Timed Instrumental Activity of daily Life (TIADL) (adapted from Owsley, Sloane, McGwin & Ball, 2002 by Borella & Cantarella). The task is composed of 5 activities inherent in daily living, addressed to the following IADL domains: communications, use of money, cooking, shopping and self-medication (see table 3.3). The participants had to carry out the activities requested for each domains with time constraints applied (from 2 to 3 minutes according to the item); if the subject did not complete the task within this time period, testing on that activity was, in any case, terminated.

The participants have to simulate the actions required by the experimenter for each section, using the objects and other materials contained in a "kit" (composed of a little shelf where bottles, cans, a telephone directory, coins and so on are located).

According to the original version, all tasks, have used real everyday objects which have not been simulated, enlarged or illustrated. The examiner records the time (in sec) used to implement all the activities as well as the errors committed in performing the tasks. Three types of error codes were attributed: code "1" if participants correctly completed the task, within the time limits and without errors; code "2" if there are any minor errors (see table 3.3) and code "3" if participants made any serious mistake or the task was not completed within the time limits.

The completion time and errors codes were then combined as they were in the original test: subjects attributed code 3 on any given item, were assigned the maximum time allotted on that item. For those with a minor error code (2), a time penalty was added to their completion time (that is 1 SD, based on the data relative to all the participants who had completed that item with code 1).

Preliminary analysis of the 42 item EPT Italian version demonstrated an acceptable level of reliability (Cronbach $\alpha = 0.75$). For TIADL task $\alpha = 0.88$. In a previous study (unpublished work), these tasks were administered to 198 participants with the aim of: i) investigating the relation between the objective tasks and self-report measures of functional abilities (ADL -Katz, 1970- and IADL- Lawton & Brody, 1969); ii) investigating the relationship between performance based measures and cognitive abilities (using both fluid intelligence and crystallized intelligence tasks).

Table 3.3 *Tiadl Tasks (adapted from Owsley et al., 2002)*

IADL domain	Task description	Task materials	Instruction to subject	Time starts When	Time ends when	Examples of minor errors	Time limit, min
Communication	Finding a telephone number.	Real, residential phone directory	I will give you the name of a person I want you to lo up in the phone book. When you find the number, I want you to say it out loud so I can hear you. The name of the person I want you to lo up is XXX. . Will you repeat that name back to me? (If correct, proceed; if incorrect, name is repeated). Here is the phone bo. Go ahead and lo up the number for XXX for me. Remember, when you find the number, call it out loud so I can hear you.	Subject opens Book	Subject calls out last digit	Misreads a digit	3 min.
Finances	Making Change	- 3 coins of 10 cents; - 4 coins of 20 cents; - 5 coins of 5 cents; - 4 coins of 2 cents;	Are you left-handed or right-handed? Now I am going to give you a handful of coins. I want you to place 67 cents in change on the table so I can see it. Let me know as soon as you are finished. How much did I say you should place on the table? (If correct, proceed. If incorrect, repeat the amount). , here are the coins. Remember, let me know when you are finished putting67 cents on the table.	Coins are placed in subject's non dominant hand	Subject signals verbally or nonverbally that finished	Target total off by a few cents	2 min.
Food	Reading the first 3 ingredients on a can of food	3 cans of food	Now I am going to give you 3 different cans of food. I want you to read the ingredients on each can of food. It will say the word 'ingredients' on there. For each can, I want you to read the first 3 items listed under ingredients. Here is the first can. Read the first 3 ingredients listed out loud so I can hear you.	Can is handed to subject	Subject reads 3rd ingredient label	Slight reading error or initially read other information	2 min (per can)
Shopping	Finding 2 items on a shelf	A shelf of assorted food items built into the TIADL kit	Now I am going to show you a shelf full of food items. I want you to find 2 food items. The items I want you to find are a can of xxx and xxx. Show me you have found the items by touching them with your finger. Don't try to take them out, just touch them with your finger. It doesn't matter which of the two you touch first. What items will you be loing for? (If correct, proceed. If incorrect, repeated the 2 target items).	Kit is opened	Subject touches the second item	Selected wrong item before finding targets	2 min.
Medicine	Reading the directions on a medicine bottle	Two medicine containers with real prescription label affixed.	I want you to read the directions on 2 medicine containers. Please read the directions on this container out loud so I can hear you.	Container is handed to subject	Subject finishes last word of the directions	Minor reading errors or initially read other information	2 (per medicine container)

To do so, the tasks presented in table3.4 were administered over two sessions.

Table 3.4 *Tasks administered in a preliminar study in order to assess relationship between performances based measure and cognitive functioning*

Task	Ability assessed
SESSION 1	
- ADL Scale (Katz, 1970)	Self report measure of functional abilities (basic activities of daily life)
- IADL Scale (Lawton & Brody, 1969)	Self report measure of functional abilities (instrumental abilities of daily life)
- Vocabulary test (Wechsler, 1981)	Crystallized intelligence
- Everyday Problem test (Italian version)	Performance based measure of functional abilities (everyday problem solving)
- Listening Span Task (De Beni, Borella & Carretti, 2008)	Verbal Working Memory
SESSION 2	
- Pattern Comparison Task (Salthouse & Babcock, 1991)	Processing Speed
- Timed Instrumental Activities of daily Life Scale (Italian version)	Performance based measure of functional abilities
- Cattell Test (Cattell & Cattell, 1963)	Fluid intelligence
- Text Comprehension Task (De Beni, Borella & Carretti, 2008)	Text Comprehension

The results of this work showed that the EPT and TIADL tasks were significantly correlated between them and with the self-report questionnaires (see table 3.5).

Table 3.5. *Correlations between performance objective measure of functional abilities and self-report measures.*

	1	2	3	4
1.ADL	-	.80**	.30**	-.75**
2.IADL		-	.35**	-.70**
3.EPT			-	-.46**
4.TIADL				-

Note:** p<.01; The correlations with TIADL are negative because this task evaluates the speed in which everyday activities are conducted.

Furthermore, these objective measures are significantly correlated to fluid intelligence, Working Memory, Processing Speed and reading comprehension (see table 3.6).

Table 3.6. *Correlations between performance based measures of functional abilities and cognitive functioning*

	1	2	3	4	5	6
1. LST	-	-.63**	.64**	.46**	-.61**	.42**
2.Pattern Comparison		-	-.60**	-.39**	.87**	-.39**
3. Cattell Test			-	.56**	-.59**	.47**
4. EPT				-	-.46**	.52**
5.TIADL					-	-.39**
6.Reading Comprehension Task						-

Note: :** p<.01 The correlations with TIADL and Pattern Comparison are negative because these tasks evaluate the speed in which everyday activities/comparisons are conducted.

Transfer effects on fluid intelligence

Culture Fair test, scale 3 (Cattell & Cattell, 1963). Scale 3 of the Cattell test consists of two parallel forms (A and B). Each form is composed of 4 subtests that require between 2.5 and 4 min to be completed. In the first subtest (Series), the participants have to choose the ones that best complete a series of abstracted shapes from six alternatives . In the second subtest (Classifications) there are 14 problems each composed of 5 figures. The participants have to choose the 2 figures that do not fit with others 3from these, according to a logical criteria which they must identify . In the third subtest (Matrices), the participants have to complete 13 incomplete matrices -containing from four to nine boxes of abstract figures – choosing one figure from the 6 given alternatives. In the last subtest (Conditions), the participants see a model-figure composed of lines positioned in a given relationship. They have to find the a best alternative from 5 figures, following the same logical rule expressed in the model-figure. Before conducting each subtest, 3 examples were provided by the experimenter.

The dependent variable was the number of correctly solved items across the four subsets (maximum score 50).

Raven's Standard Progressive Matrices (RSPM-Raven, 1998). The participants see 3x3 matrices composed of abstract shapes, lines and figures. They have to select, the item that best completes the matrix from six to eight possible choices, according to a logical criteria. The task is self-paced. The dependent variable was the total number of correct answer (maximum score 20).

In order to avoid test-retest effects, for each task, parallel versions were developed and administered in a counterbalanced order across the sessions.

Procedure

Before the participants were enrolled for training, they underwent a physical and health questionnaire. The participants, in both groups, attended 5 individual sessions: the first and last for pre- and post-test assessment and the others for training purpose. In sessions 2 to 4, completed within a 2-week time frame, with a fixed two-day break between training sessions, the trained participants attended training while the control group carried out alternative activities. The schedule was identical for the two groups, enabling the amount of social interaction to be matched. The experimenter used standardized instructions to describe the rationale and benefits of both programs to keep the participants blinded to the study's goals. The training sessions' specific activities are described on Table 3.7. (see also appendix A).

Table 3.7 *Description of pre-post test assessment and training sessions by groups*

Session	Trained Group	Control Group
1.Pre-test	CWMS task, Cattell Test, EPT, Raven's Standard Progressive Matrices, TIADL	
2.Training	Sets of different lengths (from 2 to 5) each with three series of word lists, were presented. Participants had to recall the target words and tap the hand on the table whenever an animal noun was heard. The WM task included three phases presented sequentially: (I) recall the last words of each series; (II) recall the first words of each series; (III) recall the last words of each series;. In each phase, in case participants recall correctly the words in two of 3 series the length of series increase, up to length 5. In case of failure in one of the three phases, participants were presented the following phase starting from the easiest level and had to recall either the first (phase 2) or last word (phase 3).	Autobiographic Memory questionnaire (De Beni *et al.*, 2008)
3.Training	Sets of different lengths (from 2 to 5) each of four series of word lists were presented. Word series of length 2 could contain from two to eight animals noun, length 3 from four to nine, length 4 from six to 11, and length 5 from eight to 17. For each series, participants had to tap the hand on the table whenever an animal noun was heard and to remember each word followed by a sound, in serial order.	Memory Sensitivity (De Beni *et al.*, 2008)
4.Training	Sets of four series of two word lists. Participants had to tap the hand on the table whenever an animal noun was heard and had to recall in (i) the first series, the last words of each list; (ii) in the second, the first words; (iii) in the third, the last words; and (iv) in the fourth, the first words. The memory load increased progressively from two to five level, independently of participant performance.	Psychological Well-being (De Beni *et al*., 2008)
5.Post-test	CWMS task, Cattell Test, EPT, Raven's Standard Progressive Matrices, TIADL	

Note CWMS=Categorization Working Memory Span test; TIADL=Timed Instrumental Activities of Daily Life; EPT= Everyday Problem Solving;

The WM training consisted of three sessions, each lasting about 30-40 minutes, in which the participants were trained on a modified version of the CWMS task, presented in audio modality. The basic instructions were the same as those in the CWST task, or rather, to recall the last word in the lists and simultaneously tap their hand on the table whenever an animal noun appeared. Some manipulations were made during the three sessions to favor generalized transfer and limit the development of task-specific strategies (see table 3.7), changing the maintenance demand of the CWMS task (session 2) in an adaptive way (in the case of success the number of words to recall increased while in the case of failure the lowest memory load was presented) or varying the task request (recall the first or the last word of each series in session 2 and 4 and the words that were followed by a beep sound in session 3). The secondary task was also manipulated, varying the frequency of animal words in the lists (session 3).

The participants in the control group were asked to answer the questionnaires regarding memory. During session 2, they had to rate the vividness of the events they could remember from their childhood and adulthood or recent events (Autobiographical memory questionnaire). In Session 3, they recorded the frequency of their behavior dedicated to saving memories of life events (memory sensitivity questionnaire). In Session 4, they rated their personal satisfaction with their life, emotional competence, and coping strategies regarding everyday problems (well-being questionnaire). All these paper-and-pencil questionnaires were drawn from a standardized Italian battery for assessing wellbeing and memory in adulthood (De Beni *et al.,* 2008).

In both the experimental and control groups, no feedback was provided about their performances or the questionnaires' answers.

3.4 Results

Firstly, in order to interpret the differences between the two groups before training activities, separate analysis of variance (ANOVAs) was carried out on the pre-test performance on all tasks with group (trained and control) as the between subjects factor.

The results showed no significant differences between the groups' baseline performance (for all variables $Fs<1$).

Then, to assess the training effects, 2 (Group: trained, control) x 2 (Session: pre-test, post-test) mixed-design ANOVA was run for all the measures. Significant main effects and interactions were analyzed using pairwise comparisons, with Bonferroni’s adjustment for multiple comparisons. The α value was set at .05 for all the statistical tests. For the interactions it was set at α=.008 because six comparison were computed (.05/6).

Descriptive statistics are given in Table 3.8, and the ANOVA results are summarized in Table 3.9 .

Table 3.8 *Descriptive Data for Pre-test, Post-test assessment by group*

	Trained Group		Control Group		Trained Group		Control Group	
	Pre-test				Post-test			
	M	SD	M	SD	M	SD	M	SD
Criterion Task								
CWMS words correctly recalled (max=20)	8.72	1.27	8.66	1.60	11.27	1.12	8.77	1.21
Performances based measures of functional abilities								
EPT (max=14)	10.27	1.52	10.77	1.98	12.16	1.24	10.11	1.81
TIADL (sec)	436.51	84.94	424.01	107.96	391.57	77.67	400.23	88.26
Fluid Intelligence Tasks								
Cattell Test (max =50)	15.77	1.76	16.00	1.68	17.83	1.24	16.27	1.80
RSPM (max =20)	9.88	2.51	10.44	2.68	11.83	1.72	10.66	1.71

Note: CWMS=Categorization Working Memory Span Task; EPT=Everyday Problem Solving; TIADL=Timed Instrumental Activities of Daily Life; RSPM: Raven's Standard Progressive Matrices.

Criterion task: CWMS

The results, for the correct words recalled, revealed a main Group effect ($F_{(1,34)}$= 14.22; p=.001): the trained participants recalled more correct words than the control ones (M*diff*=1.27*; p*< .001). A significant main effect of the Session was also found ($F_{(1,34)}$= 22.61; p=.001) showing that performance at post-test was significantly higher than that at pre-test (M*diff*=1.33*;* p<.001). The Group x Session interaction was significant ($F_{(1,34)}$= 19.00; p< .001). Post-hoc comparisons showed that trained participants performed better at post-test than at pre-test (*Mdiff*=2.55, $p<.001$; C.I. 95% [1.75; 3.36]). No significant differences across sessions were instead found for the control group (*Mdiff*=.11, $p=.78$; C.I. 95% [-.91; .69]). At post test level, the performances of trained group were significantly higher than control group's ones (*Mdiff*=2.50, $p<.001$; C.I. 95% [1.70; 3.29]).

Far transfer effect to everyday abilities

For the EPT, the results - on the total number of correct answers - showed a not significant main effect of the Group ($F_{(1,34)}= 3.45$; $p=.07$). The effect of Session was also not significant ($F_{(1,34)}= 2.79$; $p=.10$). The Group x Session interaction was instead significant ($F_{(1,34)}= 12.20$; $p< .001$). Post-hoc comparisons showed that trained participants performed better at post-test than at pre-test (*Mdiff*=1.88, $p<.001$; C.I. 95% [.83; 2.94]). No significant differences across sessions were found for the control group (*Mdiff*= -.66, $p=.20$; C.I. 95% [-.71; .38]). At post-test level, performance of trained group was significantly higher than the one of the control group (*Mdiff*=2.05, $p< .001$; C.I. 95% [1.00; 3.10]).

For TIADL, concerning the total time spent to carry out activities, the main effect of Group was not significant ($F<1$). Differently, the main effect of Session was significant($F_{(1,34)}= 4.47$; $p< .05$) both groups improved performances at post-test level, reducing the time to complete the task (M*diff*= -34.35; $p<.05$). The Group x Session interaction was not significant ($F_{(1,34)}= .42$; $p=.51$).

Far transfer effect to fluid intelligence

For the Cattell test, the results of the analysis -on the number of correctly solved items across the four subsets- showed that the main effect of the Group was not significant ($F_{(1,34)}= 1.85$; $p=.18$). In contrast, the main effect of Session was significant ($F_{(1,34)}= 22.96$; $p< .001$), indicating a better performance at post-test than at the pre-test (M*diff*=1.16, $p<.001$). The interaction Group x Session was also significant ($F_{(1,34)}= 13.32$; $p<.001$): only the trained group showed consistently better performance from pre- to post-test (M*diff*=2.05, p<.001; C.I. 95% [1.35; 2.75]). The performance of the control group did not significantly differ between sessions (M*diff*=.27, p= .42 ; C.I. 95% [-.42; .97]). At post-test, performances of trained group were significantly higher than control group's performances (M*diff*=1.55, p=.005; C.I. 95% [.50; 2.60]).

For the Raven's Standard Progressive Matrices, results on the total number of correct responses, showed that the main effects of the Group was not significant (F<1). Instead, the main effect of the Session was significant ($F_{(1,34)}$= 11.04; p< .01): performance at post-test was higher than at the pre-test (M*diff*=1.08, p<.01). The Group x Session interaction was also significant ($F_{(1,34)}$= 6.97; p=.01). Post-hoc comparisons revealed that only the trained group improved performance at post-test, compared with pre-test (M*diff*= 1.94; p<.001, C.I. 95% [1.00; 2.88]. No significant differences resulted for the control group (M*diff*= .22; p<.63, C.I. 95% [-.71; 1.15]. However, at post-test, significant differences between the two groups did not emerge (M*diff*=1.12, p=.05, C.I. 95% [.002; 2.33]).

Table 3.9. *Mixed design 2X2 ANOVA results for the measures of interest, with group (trained and control) as between-subjects factor and session (pre-test, post-test) as repeated measure.*

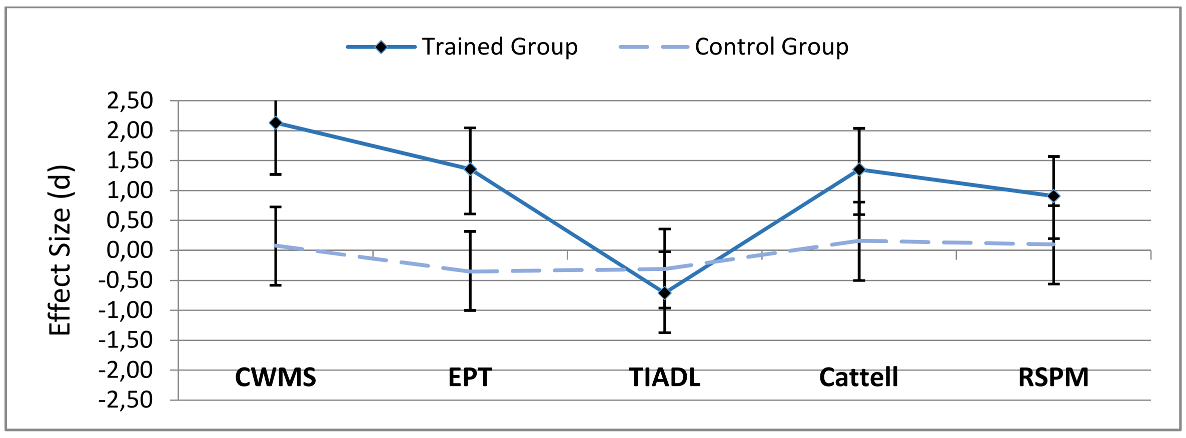
			$F_{(1,34)}$	*MSE*	*p*	ηp^2
Criterion Task: specific effect						
CWMS words correctly recalled	Between s.	Group	14.22	2.06	.001***	.29
	Within s.	Session	22.61	1.41	.000***	.39
		GXS	19.00	1.41	.000***	.35
Far transfer effects on performances based measures of functional abilities						
EPT	Between s.	Group	3.45	3.15	.07	.09
	Within s.	Session	2.79	2.40	.10	.08
		GXS	12.20	2.40	.001***	.26
TIADL	Between s.	Group	.00	11599.62	.94	.00
	Within s.	Session	4.47	4748.48	.04*	.11
		GXS	.42	4748.48	.51	.01
Far transfer effects on Fluid Intelligence Tasks						
Cattell Test	Between s.	Group	1.85	4.32	.18	.05
	Within s.	Session	22.96	1.06	.000***	.40
		GXS	13.32	1.06	.001***	.28
RSPM	Between s.	Group	.21	7.81	.64	.00
	Within s.	Session	11.04	1.91	.002 **	.24
		GXS	6.97	1.91	.01**	.17

Note: * p<.05; ** p<.01; *** p<.001; CWMS=Categorization Working Memory Span Task; EPT=Everyday Problem Solving; TIADL=Timed Instrumental Activities of Daily Life; RSPM= Raven's Standard Progressive Matrices; G=group; S= session.

In order to better understand the range of training gains between pre- and post-test, effect size- Cohen's d (1988, expressing the effect size of comparisons)- for within-subject comparisons (according to Morris and De Shon (2002)'s suggestions)- were computed.

Comparisons of gains from pre- to post-test -within each group- revealed for the trained group a large effect size (over .80) on the criterion task and in all transfer tasks except that for the TIADL, where a moderate effect (-.54) was found. For this latter task, negative values indicate that tasks required less time to be completed. Only small effect sizes were found in the control group (see Figure 3.2).

Figure 3.2. *Effect size Cohen's d, for pre- and post-test comparisons of specific and transfer effects by group (trained participants and controls)*



Note: TIADL values are negative because they represent time in task's execution. CWMS: Categorization Working Memory Span test; EPT: Everyday Problem Test, TIADL: Time Instrumental Activity of Daily Life; RSPM: Raven's Standard Progressive Matrices.

Then, in order to obtain the net treatment effect, as suggested by Dunst, Hamby and Trivette (2004) (see also Karbach and Verhaeghen, 2014), we computed the mean standardized differences between trained and control subjects at post-test, (Mtrained – Mcontrol)/SDpooled (see table 3.10). These values were calculated under the assumption that no group differences existed at pre-test (according to results of ANOVAs). However, this assumption has been also tested loing at treatment/control group standardized mean differences at baseline (see Au et al. 2014).

Results showed a larger gain after training, for the criterion task, the CWMS (*d*= 2.10) greater than training/control group difference at baseline (*d*= .04).

A large effect for one of the task of everyday life abilities, that is for EPT (*d*= 1.29) was shown, greater than training/control group difference at baseline (*d*= -.28), and for one of the fluid intelligence task, that is the Cattell Test *d*= .99 (at baseline difference was *d*= -.13).

A moderate effect size was found for RPSM, *d*= .67, associated with high variability -see confidence interval in table 3.10 (at baseline difference was *d*= -.22) , and only a small effect for TIADL, d= -.10 (at baseline *d*=.13).

Table 3.10 *Effect size (Cohen's d). Net gains after training*

	Cohen's *d*** *Trained Group - Control Group*	C.I. 95%	
		Low level	Upper level
Criterion Task: specific effect			
CWMS (Criterion Task)	2.10	1.28	2.91
Far transfer effects on performances based measures of functional abilities			
EPT	1.29	.57	2.01
TIADL	-.10	-.76	.55
Far transfer effects on Fluid Intelligence Tasks			
Cattell Test	.99	.29	1.68
RSPM	.67	.00	1.34

Note: CWMS=Categorization Working Memory Span Task; EPT=Everyday Problem Solving; TIADL=Timed Instrumental Activities of Daily Life; RSPM= Raven's Standard Progressive Matrices
* Computed as: (M trained group –M control group)/SD pooled, at post-test level; Cohen's d values corrected for sample size (Hedges & Olkin, 1985).

Discussion

This study's aim was to examine the efficacy of verbal WM training in the young old and, in particular, the transfer effects on everyday life abilities, using objective performance based measures.

The secondary aim was to investigate transfer benefits to fluid intelligence tasks, replicating the results obtained in previous studies, where the same training paradigm, adopted here, was used (Borella et al., 2010; Carretti et al., 2013; Borella et al., 2013). Two indicators were utilised, both for everyday competences and for the evaluation of transfer effects to fluid intelligence: this aspect might allow us to obtain more consistent results, thus, avoiding that any transfer benefits observed, may only be the outcome of changes in a specific task, without implying any changes in general domain resources. In view of the promising results achieved, further to the previous study, Borella and colleagues’ (2010) particular, hybrid procedure was adopted: diversely from other WM training, at the adaptive procedure - which, as suggested by Klingberg (2010), is associated with greater training efficacy- continuous manipulation of task requests has been added. The training task's difficulty was increased if the participants' performances, at a given level, proved to be successful. Otherwise, the lowest level was presented. Once again, in order to avoid incurring practice effects, there was constant variation in both the maintenance and processing task requests. Furthermore, this training paradigm might promote the involvement of multiple cognitive processes (attentional control, shifting), thus, enhancing the possibility of observing even more transfer effects.

The training group's performance was compared to the active control group one, who met the experimenter as often as the former, but did not practice the WM tasks.

This study's results have proved that training efficacy enhanced verbal, WM performance (CWMS- criterion task), and well replicated the results obtained in previous studies (Borella et al., 2010) and were consistent with literature on WM training.

With reference to the transfer effects, interesting results were obtained by the EPT task, which observed a considerable improvement in the training group's performance (very high pre-post-test gains, *d*=1.32). TIADL performances, on the other hand, led to a moderate effect size being found in the trained group (-.54) but, in consideration of the training group's net gains - after checking the control group's gains - this effect was reduced to a small entity (-.10). Both the trained and control groups decreased the time spent in attempting the task requests. This might be attributed to the test-retest practice effect, but might, more plausibly, be the result of the ceiling effect: room for improvement was limited in view of the fact that, at pre-test level, the performance was good (nobody exceeded the time constraints imposed for each task). It is possible that training focused specifically on processing speed provided more effective results, as shown by Edwards and colleagues (2002; 2005; 2007) and Ball *et al.*, (2002). In these studies, processing speed training improves performance in processing speed tasks (UFOV) - as a specific effect - but was also extended to TIADL, proving the possibility of enhancing everyday functioning. In the 2007 study, however, as discussed by the authors, the sample selected was based on initial processing speed difficulties, and the training effect size was greater than that identified in prior studies, including a sample without speed in processing difficulties (Edwards *et al.,* 2002; Ball *et al.,* 2002). Based on these results, it is possible to assume that considering an old-old sample, subject to more age-related processing speed slowness (Salthouse, 1996); we might obtain a greater effect through our training. Furthermore, it is also possible that in the case of healthy, older adults, living alone, this task was too easy. Thus, according to the results obtained by Edwards *et al.,* (2002) and Ball *et al*. (2002), this task might be more useful in investigating the benefits - after WM training or other types of interventions - on individuals who have difficulties.

As previously mentioned, the secondary aim of this work was to assess WM training transfer effects on fluid intelligence.

By replicating previous results, we found - only in the trained group's case - a significant improvement on the Cattell Test's performances, associated with a large effect size, Cohen's *d*= .99, as well as on the RSPM, where moderate effects were demonstrated (*d*=.67). This evidence is, however, in contrast with the study conducted by Richmond and colleagues (2011), where they failed, after training, to obtain transfer effects in this measure. Otherwise, our results are consistent with the previous study that adopted the same training regime (Borella *et al.,* 2010; 2013; Carretti *et al*., 2013) and with the meta-analysis performed by Karbach and Verhaegen (2014) which set forth findings that gains in the measurement of fluid intelligence were not negligible (Sd=0.35).

Overall, this particular training regime proved its effectiveness in enhancing WM performance and in obtaining the transfer effect to performance based measures of functional abilities (EPT), and to fluid intelligence (Cattell Test and RSPM).

This work, to our knowledge, is the first one that has specifically addressed evaluation of WM training transfer effects on everyday life abilities, using objective performance based measures. Indeed, despite the well-known relationship between WM, basic mental abilities and everyday functioning (Diehl, *et al.*, 1995), only a few studies have tried to assess if, through WM training, it is possible obtain gains in everyday performances and, self-report measures are usually used. The evaluation of transfer effects to everyday life activities, however, should be of primary importance, in order to understand WM training' effectiveness, beyond laboratory tasks, and if these interventions might really lead to more autonomy and, consequently, to a better quality of life in aging.

One of this study's strong points is represented by the use of two indicators for each assessed ability, an aspect that enables the attribution of training gains to changes in general mechanisms or resources and not to the development of abilities related to the specific tasks administered.

There are, however, several caveats that have to be taken into consideration, first of all, the lack of follow up assessment. Our principal aim was to assess WM training transfer effects on everyday life abilities, with the use of objective performance based measures on functional abilities. The findings that emerged from this study provided both interesting and positive results in this sense. Furthermore, our results should be treated with caution, due to the reduced sample size. However, although it was based on 38 participants, our sample size was consistent with the one used in other training studies.

In the future, studies will have to investigate maintenance of the transfer effects with the passing of time and to add, functional ability, self-report measures, which might corroborate the objective results, indicating the perception of changes in everyday life. Finally, there is evidences that everyday life competences might be related to self-efficacy (Artistico, Cervone & Pezzuti, 2003), an aspect that also deserves to be better investigated.

In conclusion, our results suggest that WM training might be useful in improving or preserving everyday life abilities, offering a promising approach to foster older adults' autonomy and quality of life.

CHAPTER 4

DOES THE NATURE OF THE TASKS AFFECT WORKING MEMORY TRAINING 'S EFFICACY?

In the following studies, the question about whether the nature of training tasks' activities- meaning the particular modality exercised (*verbal or visual-spatial*)- could affect WM training gains and related transfer effects, has been addressed. To do so, Borella and colleagues' visuo-spatial training procedure was adopted (2014). This particular procedure was exactly the same, in terms of tasks' requests and training programme, to the verbal one presented in study 1, with only manipulation of the modality in which stimuli were presented, that is visuo-spatial rather than verbal. Despite this, the results of a previous visuo-spatial study, conducted in 2014 with this procedure, provided weaker results compared to the verbal one (2010).

Studies 2 and 3, presented in this thesis, have tried to investigate whether the training tasks modality (visuo-spatial) *per se* rather than the particular type of visuo-spatial stimuli used- could act in establishing these divergences in results. Both studies were simultaneously conducted using the same procedure and pre-post assessment tasks. Otherwise, the type of stimuli used was different: in study 2 we tried to investigate if the introduction of more familiar stimuli (compared to the dots used in Borella and colleagues study, (2014) could foster WM gains; in study 3, instead, based on "positivity effects" in aging, we wanted to examine the role of positive emotional stimuli in enhancing WM training gains, an issue not yet investigated.

STUDY 2

Visuo-spatial WM training with neutral stimuli

4.1. Introduction

As previously discussed, the role of WM to perform complex tasks in everyday life is well known, as well as its decline in aging (Park *et al.*, 2000). Therefore, it is unsurprising that in the last few decades considerable efforts have been made to investigate the mechanisms of age-related decline in WM and how it might be possible to improve this component. Although there are age-related changes in brain structures and cognitive systems, training studies have suggested that older adults could improve their WM performance, by taking advantage of cognitive plasticity, which is present also in later life (Baltes & Willis, 1982; Verhaeghen, 2000).

In chapter 2, the theoretical justification for WM training and the different approaches (*strategic visuo-spatial process based WM training)* to improve this component have been widely discussed: process based training are based on the repetitive practice with a demanding WM tasks, aimed at ameliorate general domain mechanisms - such as attention or executive control- avoiding the use of domain-specific strategies (Morrison & Chein, 2010). If these general-domain mechanisms, after training, are improved, it should be possible to obtain transfer benefits not only in tasks similar to training activities (near transfer effects) but also on other cognitive measures that theoretically share the same resources, such as fluid intelligence tasks, reasoning, short-term memory and so on. With reference to the classical WM model proposed by Baddeley (Baddeley & Logie, 1999), WM is considered as being a multi-component system. The specialized components include a central executive that coordinates, controls and regulates information coming from domain-specific slave systems that store verbal (phonological loop) and visuo–spatial (visuo–spatial sketchpad) material.

Thus, bearing in mind the aforementioned model, we could assume that - disregarding the modality of the training tasks used and the following involvement of one of the slave systems - core training could produce increased WM capacity by focusing on the strengthening of domain-general WM processes (e.g., attentional resources and executive control).

Nevertheless, the majority of WM training in older adults has been conducted using a visuo-spatial modality (Buschkuehl *et al*., 2008; Li *et al.*, 2008; Dahlin *et al.*, 2008); some of them using a multi-modality approach (e.g., Schiedek *et al*,. 2010, Brehmer *et al.*, 2012; Richmond et al, 2011) and only a few studies using the verbal modality (Borella *et al.*, 2010; Carretti *et al.*, 2013) However, among studies conducted in visuo-spatial modality, far transfer effects are rarely shown, diversely from the verbal WM training' results .

Li and colleagues (2008), for example, using a visuo-spatial WM training based on n-back task, found only specific gains after training (and nearest transfer effects to a more demanding n-back task) without generalization on other measures, including complex span tasks. In the same way, Buschkuehl and colleagues (2008) found specific training effects in visuo-spatial domain in old-old, demonstrating the plasticity of the visuo-spatial WM system also in this particular sample- but no transfer effects to episodic memory and verbal free recall. These results indicates that these specific gains do not go far beyond an improvement in visuo-spatial WM.

Diversely, among studies conducted with double-modality (in which both verbal and visuo-spatial WM are trained through specific activities), near and far transfer effects have been observed more often. However, some aspects have to be taken into consideration: Richmond and colleagues (2011), for example, used both a verbal WM (requiring participants to make a series of word/non word decisions while intermittently encoding a sequence of letters for later recall) and a visuo-spatial WM task (requiring a series of symmetry/non symmetry decisions to be made about matrices and encoding a sequence of locations in the matrix for later recall) found that - although WM performance was generally higher before and after training on the verbal subtest- verbal and spatial WM showed similar levels of improvement with training. Transfer effects, however, were only assessed using verbal tasks (transfer effects were shown on the California Verbal Learning Test and Reading Span Test, but not in the Everyday Attention and Digit Span Tests), thus, it was impossible to discriminate if there had also been any WM training transfer effects in the visuo-spatial domain.

In spite of the fact that a multi- modal approach could reduce the possibility of using content-specific strategies, it became difficult to understand what component of WM training really works in terms of transfer benefits. Again, there is evidence that WM training targeting multiple functional categories are less efficient than WM training focusing on single processes (von Bastian & Oberauer, 2013; Zavagnin, M., 2013).

In the verbal WM training studies, in older adults, broader transfer effects are shown: for example, in Borella and colleagues' study (2010), far transfer effects on fluid intelligence, processing speed, inhibition and short term memory were shown. These results have also been well replicated in the following studies using the same paradigm (Carretti et al., 2013; Borella et al., 2013). Recently, Stepankova and colleagues (2014) showed that it is possible to improve WM performances and visuo-spatial skills (non verbal subtest of WAIS-III) through verbal WM training (verbal n-back task). Previously, however, Dahlin and colleagues (2008) using a verbal WM task (a letter updating task) did not obtain transfer effects in both younger and older adults.

Despite there are only few training studies that separately involved specific verbal or visuo-spatial WM tasks (or that attempt to compare directly the effects of training conducted in different modalities), seems that more promising results could derive, in older adults, by the use of verbal paradigms.

Divergences in the WM training transfer effects could be attributed - at least partially- to the larger age-related decline in visuo-spatial domain compared to the verbal one (e.g., Verhaeghen et al., 2002). According to several studies, older adults -compared to younger adults- are more impaired in carrying out tasks that require temporary storage and elaboration of visuo-spatial information. However, this issue again remains unclear: other studies have, indeed, shown a more important age-related decline for verbal as opposed to visuo-spatial material (e.g., Vecchi, Richardson, & Cavallini, 2005). Furthermore, other studies have shown that older adults' performances in WM tasks are susceptible to age-related decline, independently of the type of material presented (Borella, Carretti & De Beni, 2008; Park *et al.*, 2002). Discrepancies in these results could be derived from the study design methodology (transversal or longitudinal studies) and/or from the tasks used to assess visuo-spatial and verbal working memory. In one of Bopp and Verhaeghen's works (2007) however, using a perfectly similar task for both verbal and visuo-spatial modalities, the authors showed that age effects were higher for the visuo-spatial domain than for the verbal one. Consequently, it is plausible to assume that WM training in visuo-spatial modality, could induce less transfer effects, based on less preserved abilities and a reduction in cognitive flexibility in aging.

Important food for thought in this direction comes from the study of Borella and colleagues (2014): starting from the promising results achieved with their verbal WM training (2010), the authors compared the efficacy of this training with similar training administered in visuo-spatial modality (2014). This was the first study that directly compared the results of a verbal procedure with a visual-spatial one -using the same tasks- in an attempt to investigate whether the nature of the tasks could affect WM training efficacy. The results of their second study showed that the trained groups performed better than the untrained groups in WM measures and these gains were maintained after 8 months. However, the transfer effects (on short-term memory and processing speed) were more limited than after the training based on a verbal modality and these transfer effects were not preserved at the follow-up (in contrast with the outcomes of the verbal study). These weaker transfer effects might imply that visuo-spatial WM training did not foster an improvement in general cognitive flexibility, but only in WM task. This could be due -as mentioned above- to the nature of the training *per se* (and to the more accentuated decline of visuo-spatial abilities in aging), but also to the particular, abstract stimuli used in this study's training task (that required the positions of dots in a matrix to be remembered): indeed, it might be that the participants were less aware of both their improved recall and their errors because dot positions are less meaningful than words (e.g., Cornoldi *et al*., 2007). So they were probably less engaged in activities that prevent recall errors, such as the active control of irrelevant information. Again, the type of proposed activity, as suggested by the authors, may have been perceived as being too unfamiliar to older adults, unrelated to everyday life requirements or prior knowledge. Finally, the participants using dots did not view the training tasks as challenging, an aspect that could reduce motivation and interest in the activities.

Aims

This study was aimed at investigating the role of the stimuli used in WM training tasks: using the aforementioned visuo-spatial paradigm adopted by Borella and colleagues (2014), it examined whether the benefits of WM training conducted using a visuo-spatial modality can be fostered by using more familiar stimuli, such as images of common objects.

Specifically, it has been hypothesized that:

1) such images would be more familiar and more meaningful for older adults, sustaining attention to the tasks;

2) using images- different for each trial- training activities could be perceived as being novel and more challenging, fostering motivation.

3) finally, by using images that could be verbally encoded (Kaiser *et al.,* 2010), it may be easier to detect intrusion errors in WM and to activate control mechanisms, thus enhancing transfer effects on inhibition skills.

This study permits us to understand the role played by the features of the tasks' stimuli and, on the other hand, to investigate the role of task modality.

4.2. Participants

Thirty-seven older adults, aged 63-73 years, participated in the study and were randomly assigned to the trained or active control groups. All participants were healthy, native Italian speakers who lived independently, and who volunteered to take part on the study. They were selected on the basis of a physical and health questionnaire. None fitted the exclusion criteria proposed by Crook et al. (1986). The participants were screened for cognitive impairments using the short version of the Italian Checklist for the Multidimensional Assessment (SVAMA) of the elderly, used in the Veneto region (Gallina *et al*., 2006). All participants scored 9 or 10 on SVAMA, indicating good cognitive capacities.

The participants were also assessed on their subjective psychological well-being level using the Positive and Negative Affect Schedule (PANAS -Italian version; Terraciano, McCrae & Costa, 2003). The negative affect scale reflects unpleasant engagement and subjective distress including the adverse affects of fear and shame. The positive affect scale, instead, reflected the level of pleasant engagement, the extent to which a person feels enthusiastic, excited, and so on.

As demonstrated by one-way variance analysis (ANOVAs),the experimental and control group participants did not differ in age (F<1), years of education (F<1) or WAIS–R vocabulary scores (F<1). The participants did not differ in Negative ($F_{(1,35)}=3.06$, $p=0.09$, $np^2=.08$), and Positive Affect scores (F<1) (See table 4.1 for demographic characteristics).

Table 4.1. *The Trained and Control Groups demographic Characteristics*

	Trained group (N=18; 10=Female)		Controlgroup (N=19; 13=Female)	
	M	SD	M	SD
Age	68.50	3.31	68.57	2.89
Years of Education	11.77	2.51	12.15	2.38
Vocabulary	48.38	10.69	46.57	9.96
PANAS negative affect	21.22	5.41	17.78	6.42
PANAS positive affect	30.38	7.83	30.89	7.01

4.3. Method

Materials

In order to assess the role of the type of stimuli in training efficacy and on related transfer effects, the training paradigm has been maintained as in the study of Borella and colleagues (2014). A manipulation of the stimuli has been conducted using- both in the WM criterion task and in training activities - neutral images of common objectes taken from standardized databases instead of dots (all details about the stimuli have been provided in the specific section).

All participants, both before and after the intervention, were examined with the same set of tests to assess training - related performance gains in the criterion tasks (CWMS task) - and in transfer tasks. As suggested by Noack, and colleagues (2009), transfer effects were examined and classified along a continuum from near to far transfer effects. Thus the tasks hereafter are presented from the specific criterion task until the task used to assess reasoning ability.

To avoid test-retest effects, parallel versions for each task were devised and administered in a counterbalanced order across training sessions.

Specific effects

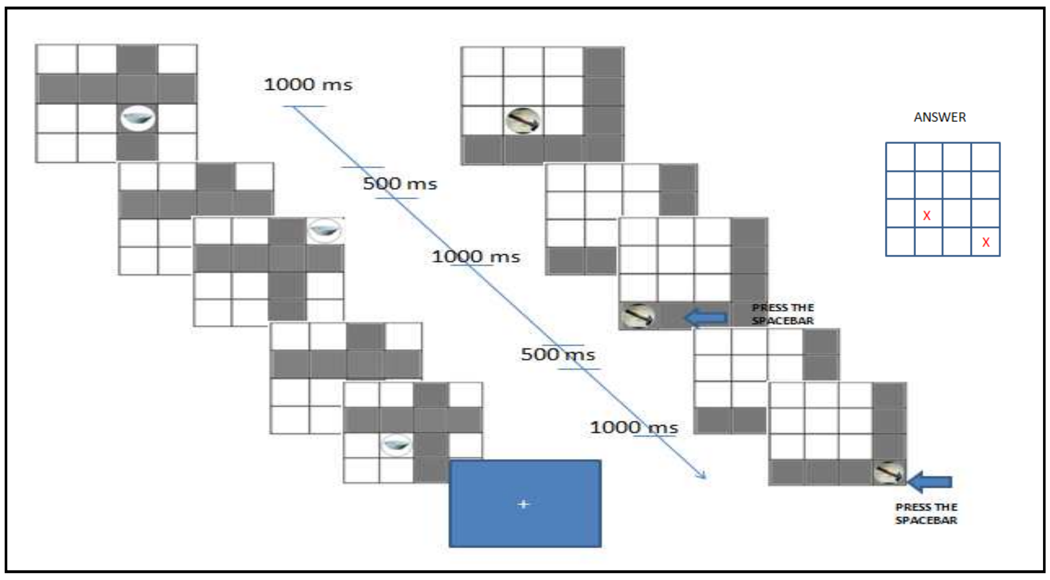
Criterion task: The matrix task (Cornoldi *et al.*, 2007; see also Borella *et al.*, 2014).

This is a dual task in which the maintenance and simultaneously elaboration of visuo-spatial information is required. It is a computer presented task and it consists in 60 4x4, matrices made up of black lines on a white background. Series of matrices, grouped in sets of different lengths, are presented, increasing the difficulty level (from two to six). In each series, an image is presented three times, in a different position on the matrix. Images - presented one after the other - were visible for 1000 ms, followed by an interval in which an empty matrix was presented for 500 ms. At the end of each series, a gray screen appeared for 500 ms. The participants had to recall the position of the last image they had seen in the series of matrices (maintenance phase). Again, in each matrix, one row and one column (selected randomly) were coloured grey. Whenever images occupied grey cells, participants had to press the spacebar (processing phase). After a set ended, an empty matrix appeared on the screen (and remained until all positions had been chosen) and the participants had to indicate the positions of the last images seen in each of the series. A fixation point marked the start of a new series.

In summing up, the participants had to remember a minimum of two up to a maximum of six image positions (according to the difficulty level) and press the spacebar when images appeared in the grey cells (see figure 4.1).

The total number of correctly recalled image positions was considered as being the measure of the participant's WM capacity (maximum score 60).

Figure 4.1 *Example of the stimuli used in the visuo-spatial working memory task (the matrix task). Set of two series of matrices.*



Nearest transfer effects: verbal WM

Categorization Working Memory Span Task (CWMS; De Beni, Borella, Carretti, Marigo, & Nava, 2008): see the description in materials' section of study 1.

Emotional Operation Working Memory Span Task (E-OSPAN; Mammarella, Borella, Carretti, Leonardi & Fairtfield, 2013).

This is a dual task in which is required to solve a series of maths operations (processing phase) and to remember a set of unrelated words (maintenance phase). The participants see, on a computer monitor, strings composed of a maths operation, followed by a word. They have to solve the operation- deciding if the reported solution is true or false- and to remember the word presented. The participants have to read the operation and the word aloud. Immediately after, the participant reads the word, the next operation–word string is presented. The task's difficulty increased progressively: sets of three to six items were presented. Differently from the classical Operation Span Task (Turner & Engle, 1989) not only neutral but positive and negative valence words were presented in this task as well (maximum score is 18).

Near transfer effects: Visuo-spatial short-term memory tasks.

Forward and Backward Corsi Span (adapted from Corsi Task, 1972).

This task consists of nine blocks positioned randomly on a wooden tablet. The experimenter sequentially tapped the blocks, at the rate of one cube per second (the blocks were only numbered on the experimenter's side of the board, to facilitate the test's administration) and the participant had to reproduce the sequence in the same order as the presentation (Forward condition) or in reverse order (Backward condition). The difficulty level increased progressively: from a minimum of three blocks to a maximum of 8 blocks in the first condition and from a minimum of two to a maximum of seven blocks in the latter condition. Two sequences of the same length are presented for each level of difficulty: the task was interrupted after two consecutive recall errors. Two practice trials were provided before test- for each condition- started.

The total number of correctly recalled sequences was considered as the final score (maximum score 12, for both tasks).

Far transfer effects: processing speed (pattern comparison test), inhibition-related processes (Stroop color task) and fluid intelligence (Cattell test).

Pattern comparison task (adapted from Salthouse & Babcock, 1991). This task consists of two pages of 30 items for each. Items are composed by arrangements of line and segments (from three to nine lines), positioned on the left and right of the page. Participants had to decide if the stimuli presented on both sides were identical or not, more quickly is possible. The experimenter used a stopwatch to record the time to complete each page. Three practice trial were provided before the task begun. The dependent variable was the total time taken to complete the two pages.

The Stroop color task (adapted from Trenerry, Crosson, De Boe, & Lever, 1989). The task, administered on paper, consists of six cards divided into 3 conditions (2 cards for each condition): in the congruent condition, participants had to read the names of colors printed with congruent ink, in incongruent conditions, the names of colors were printed in incongruent ink and, under control conditions, the participants had to read the color of a series of color patches. The participants were asked to name the color of each stimulus and process the stimuli as fast as possible, whilst also being as accurate as possible. The experimenter recorded response latencies for all the conditions by using a stopwatch, as the interval between naming the first and last stimuli. The interference effect was calculated as the relative difference, adjusted for baseline individual differences (see Ludwig, Borella, Tettamanti, & de Ribaupierre, 2010), between the Incongruent and Control conditions calculated in terms of time, as follows: [(incongruent condition - control condition)/control condition]. A higher score, thus, implied greater difficulty in controlling the prepotent response in the incongruent condition.

Culture fair test, scale 3 (Cattell & Cattell, 1963): see the description in the materials' section of study 1.

Procedure

The participants, both in the trained and control groups, attended five, individual sessions: the first and last session (lasting about sixty minutes) for pre-test and post- test assessment (see table 4.2 for the task's order presentation), whereas in the central ones, the training or control activities were administered. These latter sessions (lasting about 40 minutes) were conducted within a 2- week time frame, maintening a 2-day break between one session and the next.

The schedule and duration of the sessions were the same for both trained and control groups, in order to match the quantity of social interaction (see table 4.2).

Training activities

Participants in the trained group were trained (sessions 2, 3 and 4) using modified versions of the Matrix Task (criterion task). Training was developed, in compliance with the schedule and features in Borella and collegues' verbal one (2010) and the previous, visuo-spatial study (2014) (see also appendix B).

A hybrid procedure was also maintained in this study: task difficulty was manipulated in an adaptive way and task's requests were continuously varied among sessions, in order to foster motivation toward the activities and minimize the risk of simple, practice effects.

Activities for each sessions are presented below:

- *Session 2*: this session was divided up into three phases. 11 sets of stimuli were presented, in each phase, containing between two to five matrices. An image that changed position three times was presented in the matrices, just as it was in the criterion test. The participants had to remember the last position (for the first and third phases of this session) occupied by images and, then, tap the spacebar whenever they were found in a grey cell. Alternatively, they had to remember the first position (second phase). In this session, the task was organized in adaptive way: if the participants correctly reported all the positions in two of the three sets, at a given level, the set difficulty increased (from level two to five). Otherwise, the lowest level was presented (level 2)

Session 3: During this session, 16 sets - from two to five matrices in each, according to the level of difficulty - were presented (4 sets for each level). The task was the same as the one during the previous session, but the processing requirement (pressing the space bar when a dot appeared in a grey cell) was manipulated by varying the number of grey cells: so, 2 sets were composed of matrices for each level of difficulty, in which numerous grey cells were present, and the other ones by matrices, where the participants rarely performed the secondary task.

Each level was presented independently of the participant's performance level.

Session 4: The participants were also trained with 16 sets (4 sets for each level) during this session. In this instance, the participants was required to alternatively remember the images' first and last positions.

This session was also not adaptive, just like the second one.

Control Group activities

The control group's activities, as previously mentioned, were scheduled in the same way as the training one, in order to check the amount of social interaction. The participants were involved in three sessions, where they completed questionnaires about memory and well-being (see a description of the same in study 1).

Session 2: During this session, the participants completed the "Autobiographic memory questionnaire" (from De Beni *et al.*, 2008).

Session 3: The "Psychological well-being questionnaire" (De Beni *et al*., 2008) was completed

Session 4: Finally, during this session, the participants were administered the "Memory sensitivity questionnaire" (from De Beni *et al*., 2008)

A selection of the stimuli used in the criterion and training tasks:

To ensure that the trained tasks were always perceived as being challenging and motivating, repetition in stimuli presentation was avoided: for this reason, neutral images were taken from different standardized databases (see appendix C). In particular, the criterion task was composed using 60 images drawn from the *International Affective Picture System* (IAPS - database; Lang, P. J., Bradley, M. M., & Cuthbert, B. N.,1998). Two-thirds of the images represent common objects and one-third neutral faces. The images were selected on the basis of two,important criteria:

1) stimuli neutral valency;

2) stimuli high visibility: due the need of using images in matrices, only stimuli that could be easily identified were selected, therefore, avoiding more complex images (the stimuli size in the matrix was 2.3 x 2.3 cm).

In order to construct training tasks, stimuli were selected from other databases (111 for the first, training session, 56 for the second and 56 for the third training session):

i) Nencky Affective Picture System (NAPS - Marchewka, Żurawsky, Jednoróg & Grabowska, 2013): this database contains 1356 realistic, high-quality photographs that are divided up into five categories (people, faces, animals, objects, and landscapes).

Affective ratings were collected from 204, mainly European participants and the normative rating is perfectly comparable with the IAPS database: rating validation was obtained by using - as IAPS - the Self-Assessment Manikin (values ranging along a continuum from 0 to 9; 0 = indicating a low level of arousal, the images were perceived as being unpleasant; 9 = positive images, or characterized by a high level of arousal).

ii) *Geneva Affective Picture System* (GAPED - Glauser & Scherer, 2011*).* This database - composed of 730 pictures - was created, as set forth by the authors, with the specific aim of providing researchers with some additional, emotional or neutral pictures. The neutral images all depict inanimate objects. The values for images are expressed from 0 (the images are perceived as being unpleasant or low levels of arousal were elicited) to 100 (the images are perceived as being pleasant or high levels of arousal are elicited). The values associated with valence and arousal were proportionally converted - according to the previously, described database- along a continuum from 0 to 9.

iii) *Emotional Picture Set* (EmoPicS- Wessa *et al.*, 2010): this database is composed of 378 images. All images are rated for valence and arousal along a continuum from 0 to 9.

Overall, the valence mean values were 5.15 (ds= 0.43) and 3.53 (ds=0.83) for arousal, with reference to all the images considered in this study;

Table 4.2 *Structure of training and control activities (adapted from Borella et al., 2014)*

Session	Training Group	Control Group
1.Pre-test	Health interview, SVAMA, PANAS, Vocabulary test, Forward and Backward Corsi tasks, Pattern comparison test, CWMS task, Stroop color task, Matrix task, Cattell test, Emotional OSPAN	
2. Training	WM training: Increasingly long series comprising from two to five sets of 4 X 4 matrices, presented one after the other. Participants had to remember the positions of last presented image and press the spacebar when an images occupied a gray cell. The WM training task included three phases, completed sequentially for each level of difficulty (or length of the series): In Phase 1, participants had to recall the position of the last image in each series of matrices; in Phase 2, they recalled the position of the first image in each series of matrices; and in Phase 3, they recalled the position of the last image again. In each phase, if the position of the image to recall was correctly remembered, the task's difficulty was increased, up to sets containing five series of matrices. If a mistake was made in one of the three phases, participants were presented with the next set of matrices, starting from the easiest level.	Autobiographic Memory questionnaire (De Beni *et al*., 2008)
3. Training	WM training: Four sets of matrices for each different length (from two to five). The complexity of the task was manipulated by reducing or increasing the number of gray cells. For each matrix, participants had to press the space bar whenever an image occupied a gray cell, as well as remembering the position of the last image displayed in each matrix.	Memory Sensitivity (De Beni *et al*., 2008)
4. Training	WM training: Four sets of different difficulty (involving from two to five positions to recall). Participants were asked to press the space bar whenever an image occupied a gray cell, and had to recall in (a) the first set, the last positions displayed; (b) the second, the first positions; (c) the third, the last positions; and (d) the fourth, the first positions.	Psychological Well-being (De Beni *et al.*, 2008)
5. Post-test	PANAS, Vocabulary test, Forward and Backward Corsi tasks, pattern comparison test, CWMS task, Stroop color task, Matrix task, Cattell test, Emotional OSPAN.	

4.4 Data analyses and Results

In order to identify possible differences between training and control group at pre-test, preliminary analyses were conducted (Oneway ANOVA for each of the measures used for the assessment). Results shown that there were no significant differences at pre-test between the two groups for any variable of interest. For all tasks Fs<1, except for Stroop color response time in the neutral condition ($F_{(1,35)}$=2.85, p=.10), and for recalled words in E-OSPAN ($F_{(1,35)}$=1.48, p=.23). Also in the Matrix Task ($F_{(1,35)}$=2.02, p=.16).

Then, to examine training-related gains, separate 2 (group: trained, control) X 2 (session: pre-test, post-test) mixed-design ANOVA was run, for each dependent variable. Post hoc analyses were corrected with Bonferroni's adjustment for multiple comparisons. The α value was set at .05 for all statistical tests. For interactions instead was set at .008 because six comparisons were conducted (.05/6= .008). See table 4.3 for descriptive data at pre-test and post-test and table 4.4 for the ANOVAs' results.

Table 4.3 *Descriptive Data for pre-test and post-test assessment by group*

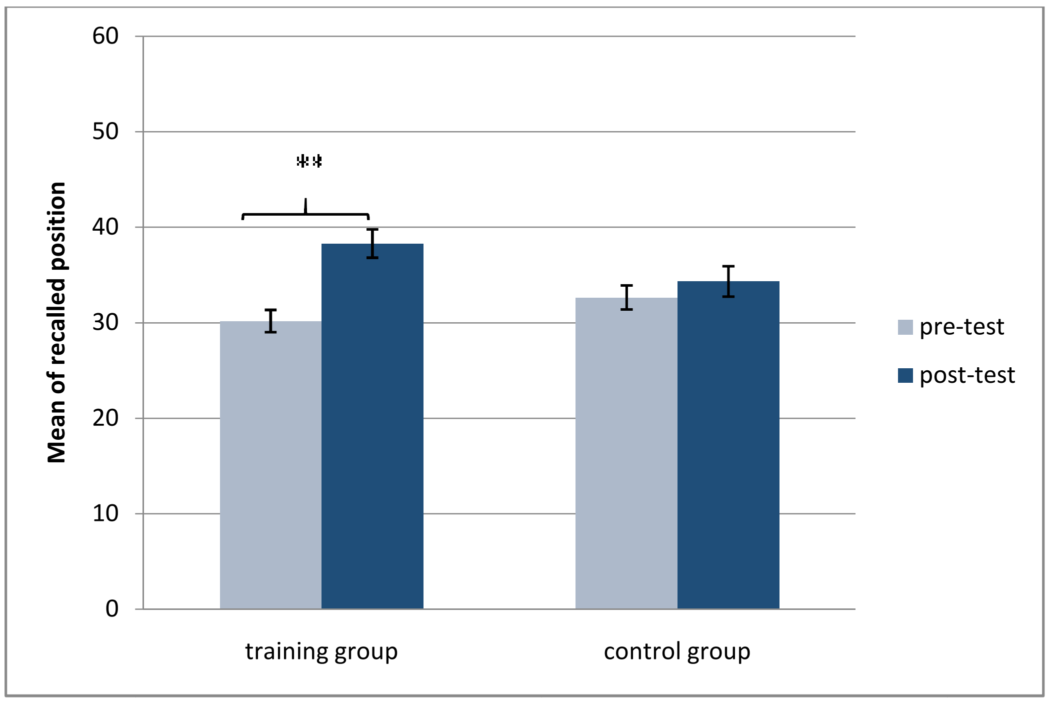
	Training Group (n=18)				Control Group (n=19)			
	Pre-test		Post-test		Pre-test		Post-test	
Variable	M	SD	M	SD	M	SD	M	SD
Matrix Task max=60	30.16	4.97	38.27	6.31	32.63	5.51	34.31	6.97
CWMS max=20	11.11	4.07	11.67	3.51	9.57	2.98	9.94	3.64
E-OSPAN max=18	10.44	3.76	10.27	3.80	9.05	3.18	8.94	3.11
Forward Corsi Span max=12	5.22	1.35	5.77	1.21	4.78	1.27	5.21	1.96
Backward Corsi Span max=12	5.88	1.99	6.33	1.74	5.84	1.89	6.36	2.00
Pattern Comparison (sec)	166.16	40.81	148.16	41.69	163.73	44.01	143.89	42.12
Stroop Color Task Incongruent RT (sec)	24.83	5.28	22.72	4.79	25.44	4.61	23.72	5.09
Stroop Color Task Control RT (sec)	16.41	4.12	13.86	2.14	14.50	2.65	13.28	2.95
Cattell Test max=50	16.72	3.96	18.88	4.04	17.63	4.27	17.84	4.84

Note: CWMS: Categorization Working Memory Span test; E-OSPAN: Emotional Operation Span test; RT: response time

Specific effects on criterion task (Matrix task)

The main effects of group was not significant, *(F<1)*, instead the main effect of session was significant $F_{(1,35)} = 40.84$, $p<.001$, $\eta p^2=.53$. All participants performed better at post-test than at pre-test (M*Diff*= 4.89, p<.001). The Group X Session interaction was also significant (see Figure 4.2), $F_{(1,35)} = 17.58$ $p<.001$, $\eta p^2=.33$. Post hoc comparisons indicated that trained group improved performance from pre-test to post-test (M*Diff*=8.11, $p<.001$, 95% C.I. [5.88;10.34]). Diversely, no significant differences across sessions were found for the control group (M*Diff*=1.68, *p*= .12). No significant differences -between training and control group- were found, both at pre-test and post-test (M*diff*=3.96, *p*=.07, 95% C.I. [-.48; 8.41]):

Figure 4.2 Matrix Task*: Mean values of the correctly recalled positions by trained and control group, at pre-test and post-test. Error bars represent standard error*.



Nearest transfer effect.

The CWMS task: The main effects of group ($F_{(1,35)}$ = 2.25, *p*= .14, ηp^2=.06) and session ($F_{(1,35)}$ = 1.04, *p*=.31, ηp^2=.02) were not significant, as well as Group x Session interaction (*F<1)*

The E-OSPAN task: The main effects of group ($F_{(1,35)}$ = 1.61, *p*= .21, ηp^2=.04) and session ($F_{(1,35)}$ =.11, *p*=.73, ηp^2=.00) were not significant. The group x Session interaction was also not significant, (*F<1).*

Near transfer effects.

Forward Corsi task: only the main effect of session was significant ($F_{(1,35)}$ = 4.89, p<.05, ηp^2=.12). Participants, in both trained and control group, performed better at post-test compared to pre-test (M*Diff* =.48, p= .05)

The main effect of the group was not significant ($F_{(1,35)}$ = 1.31, p=.25, ηp^2=.03). Group x Session interaction was also not significant (F<1).

Backward Corsi task.: The main effects of group (F<1) and session ($F_{(1,35)}$ = 2.84, p=.10, ηp^2=.07) were not significant, as well Group x Session interaction significant, (F<1).

Far transfer effects

Pattern Comparison: the main effect of session was significant ($F_{(1,35)}$ = 21.98, p<.001, ηp^2=.38). Participants, of both groups, performed the task at post-test more quickly that at pre-test (M*Diff.*= -18.92, p< .001). On the contrary the main effect of the group (F<1) and the Group x Session interaction (F<1) were not significant.

Stroop Task: concerning the interference Stroop color interference index (RT in incongruent condition - RT in control condition/ RT in control condition), the main effect of the group was significant ($F_{(1,35)}$ = 4.93, p<.05, ηp^2=.12). The control group, showed a greater interference compare to the training one (M*diff*= .21, p<.05). The main effect of the session ($F_{(1,35)}$ = 1.93 , p=.17, ηp^2=.05) and Group x Session interaction were not significant ($F_{(1,35)}$ =.31 , p=.57, ηp^2=.00),.

Considering only time employed to name stimuli in incongruent condition the main effect of session was found ($F_{(1,35)}$ = 7.45 , p<.01, ηp^2=.17). Training and control group's participants, spent less time at post-test -compared to pre-test- for naming incongruent stimuli (M*Diff.*= -

1.91, $p< .01$). The main effect of group instead was not significant ($F<1$). The Group x Session interaction was not significant ($F<1$).

Also considering the time spent naming stimuli in control condition, the main effect of session was significant ($F_{(1,35)}= 15.52$, $p<.001$, $\eta p^2=.30$). Training and control group's participants, spent less time at post-test -compared to pre-test- for naming control stimuli (M*Diff*.= -1.88, $p< .001$). The main effect of group was not significant ($F_{(1,35)}= 1.98$, $p=.16$, $\eta p^2=.05$). Group x Session interaction was also not significant, $F_{(1,35)}= 1.98$, $p=.16$, $\eta p^2=.05$

Cattell Test: the main effect of Group ($F<1$) and Session ($F_{(1,35)}= 2.50$, $p=.12$, $\eta p^2=.06$) were not significant. Also Group X Session interaction was not significant, $F_{(1,35)}= 1.69$, $p=.20$, $\eta p^2=.04$).

Finally effect size -Cohen's d for within-subject data was computed with the methods prescribed by Morris and DeShon (2002), that is: (Mpost-test –Mpre-test)/SDpooled, for each group. Results showed a large specific effect after training, for experimental participants d= 1.40 (95% C.I. [0.67;2.12]) compare to the control ones, d=0.27 (95% C.I [-0.38. 0.90]) on the criterion task.

Overall results showed only specific effect after training for participant in experimental group, without any transfer effect (see the table 4.4)

Table 4.4 *Mixed design 2X2 ANOVA results for the measures of interest, with group (trained and control) as between-subjects factor and session (pre-test, post-test) as repeated measure*

Variables			$F_{(1,35)}$	*MSE*	*p*	np^2
Criterion Task: specific						
Matrix Task	Between s.	Group	.16	61.20	.68	.00
	Within s.	Session	40.84	10.85	.000***	.53
		GXS	17.58	10.85	.000***	.33
Nearest transfer effects:						
Verbal WM	Between s.	Group	2.25	21.68	.14	.06
CWMS	Within s.	Session	1.04	3.78	.31	.02
		GXS	.04	3.78	.83	.00
E-OSPAN	Between s.	Group	1.61	21.19	.21	.04
	Within	Session	.11	2.91	.73	.00
		GXS	.00	2.91	.93	.00
Near transfer effects: Visuo-spatial short term memory						
Forward Corsi Span task	Between s.	Group	1.31	3.51	.25	.03
	Within s.	Session	4.89	.90	.03*	.12
Backward Corsi Span task		GXS	.09	.90	.76	.00
	Between s.	Group	.00	5.80	.99	.00
	Within	Session	2.84	1.53	.10	.07
		GXS	0.2	1.53	.88	.00
Far transfer effects						
Processing Speed: Pattern Comparison Task	Between s.	Group	.06	3261.23	.80	.00
	Within s.	Session	21.98	301.06	.000***	.38
		GXS	.05	301.06	.82	.00
Inhibition: Stroop Color Task						
Incongruent RT	Between s.	Group	.30	39.96	.58	.00
	Within s.	Session	7.45	9.09	.01**	.17
		GXS	.07	9.09	.78	.00
Control RT	Between s.	Group	1.98	14.41	.16	.05
	Within s.	Session	15.52	4.22	.000***	.30
		GXS	1.98	4.22	.16	.05
Stroop Color Interference Index*	Between s.	Group	4.93	.16	.03*	.12
	Within s.	Session	1.93	.04	.17	.05
		GXS	.31	.04	.57	.00
Fluid intelligence: Cattell Test	Between s.	Group	.00	26.61	.95	.00
	Within s.	Session	2.50	10.42	.12	.06
		GXS	1.69	10.42	.20	.04

CWMS=Categorization Working Memory Span Task; E-OSPAN: Emotional Operation Span Task; RT: reaction time; GXS: group x session interaction;.

* Stroop color Interference index: (RT incongruent condition- RT congruent condition)/ RT incongruent condition

4.5 Discussion

The study's goals were twofold: on one hand, it aimed at better clarifying if the stimuli features used in visuo-spatial, WM training tasks could affect training efficacy. On the other hand, the results of this study, have enabled us to add knowledge about WM training in aging (and the related transfer effects), when a visuo-spatial modality is used, compared to a verbal one.

WM training are theoretically built in order to target general domain abilities, independently by the nature - verbal or visuo-spatial - of the training tasks used (Morrison & Chein, 2010). Most part of WM training studies in older adults, however, based on visuo-spatial tasks (Buschkuehl *et al*., 2008; Li *et al*., 2008; Brehmer *et al.*, 2008) provided weak evidence of generalization to ability related to WM. On the contrary, the few studies conducted with a verbal paradigm (Borella *et al*.,2010; Stepankova *et al*., 2011) demonstrated more promising results. Based on these controversial results, the issue as to whether the nature of training tasks might affect WM efficacy and transfer effects deserves to be addressed.

An interesting cause for reflection is derived from the study conducted by Borella and colleagues (2014), where visuo-spatial, WM training was used, maintaining the same procedure as the previous, verbal, WM training (Borella *et al*.,2010): the results showed that visuo-spatial, WM training induced less transfer effects compared to the latter one.

A possible explanation for these results, as previously mentioned, consists in the reduced flexibility of visuo-spatial, WM, which is more subject to age-related decline compared to verbal, WM; diversely, it may be possible that Verbal, WM training, based on abilities better preserved in age, might more easily induce transfer effects. Once again, according to some studies conducted, verbal WM might be better related to crystallized abilities, therefore, to previously learned knowledge and experiences (Haavistoa & Lehto, 2004). It is possible that in visuo-spatial, WM training, more cognitive resources are required to elaborate visual stimuli (Sharps & Gollin, 1987), thus, eliciting more specific effects. Divergences in results might also be derived from the particular type of visuo-spatial stimuli adopted in this study (2014), which is less familiar for older adults and meaningless (black dots in matrices). Despite the fact that the tasks were continuously varied across training sessions, it is possible that - by merely using dots - tasks may appear to be lacking in challenge, thus, affecting motivation toward the activities.

This, latter hypothesis was taken in consideration in this work: we expected that by using neutral images of common objects or faces - and continually changing stimuli - WM training gains might have been positively affected.

It was also feasible that images - being more ecological materials - could better favour generalization towards other abilities.

In this study, therefore, we investigated the efficacy of visuo-spatial training and its potential transfer effects to verbal WM, visuo-spatial, short term memory, processing speed, inhibition and fluid intelligence.

literature on WM training, we found gains in the criterion task (the task that was practiced), suggesting that this particular training procedure might be useful in increase visuo-spatial , WM performance in older adults. This result was, in fact, in line with the previous studies conducted by Borella and collegues on visuo-spatial (2014) and verbal modalities (2010)

Contrary to our hypothesis, no transfer effects were identified that indicated that the use of images instead of dots favoured the transfer of training gains. Diversely, from the previous, visuo-spatial study, no transfer effects were found concerning verbal WM, visuo-spatial short term memory and processing speed. Only the main, session effect was found for the Pattern comparison test and the Forward Corsi Span task, indicating test-retest effects. These results suggested that this visuo-spatial , WM training might favour the capacity of processing information in WM, but not the general flexibility.

The demographic characteristics of training and control group participants in the actual studies and in the previous one (Borella *et al*., 2014), were comparable between studies, as well as the particular training procedures and tasks, with only the manipulation of stimuli adopted. Thus, it could be assumed that the type of stimuli used in training activities might only play a marginal role in establishing visuo-spatial, WM training efficacy.

It is also possible that by requiring to see images, attentional resources were devoted not merely to the location of objects on the matrices, but also to the stimuli features, different from the previous training where the participants only had to pay attention to the position of the dots. Both studies required maintenance (to remember locations) and simultaneously process information – by tapping the spacebar- when the images/dots were in located in grey cells. However, in the actual study, it is questionable if the efforts required to attempt the criterion task and training activities were greater than in the previous one: there is, indeed, some evidence as to an age-related deficit in object–location binding (Cowan, Naveh-Benjamin, Kilb, & Saults, 2006; Mitchell, Johnson, Raye, Mather, & D'Esposito, 2000b). Furthermore, according to several studies carried out, binding performance is selectively affected by sequential versus simultaneous presentation of memory items (as in the actual case), suggesting that inter-item interference and the need to overwrite and update information might negatively affect binding (Brown & Brockmole, 2010; Allen, Baddeley, & Hitch, 2006; Logie, Brockmole, & Vandenbroucke, 2009). Moreover, these difficulties might be especially distinct when contextual or irrelevant visuo-spatial information is involved (Mammarella, Fairthfield, De Beni & Cornoldi, 2009). Thus, even if not specifically required, it may be possible that participants spent more attentional resouces in processing the stimuli presented, decreasing the level of attention directed towards spatial locations. It would have been possible to check this impression, at least partially, by analyzing the number of images recalled by the participants, by carrying out a final, incidental memory task, an aspect which was, unfortunately, not taken in account.

Previous WM studies have already used similar, visuo-spatial tasks, requiring maintenance and the processing of the stimuli presented in 4x4 matrices: however, stimuli were constituted by abstract materials, without any salient features (often dots or highlighted cells). An exception to this rule was represented by the recent work conducted by Rudebeck, Bor, Ormond, O' Reilly and Lee (2012), where participants (younger adults) monitored real scenes presented across 8 picture frames, located in a three-dimensional (3D) room. The results showed an improvement in fluid intelligence scores and on the episodic memory task after training. These results were, however, limited to the younger population.

Another aspect that might be implicated in the lack of generalization effects in this study is the eventual use of content specific strategies. It is possible that this type of visual stimuli (neutral images), are more prone to be verbally codified compared to dots. This might permit strategies being developed. Their use could, on one hand, compensate for difficulty in a visuo-spatial critereion task, but, on the other hand, could prevent general domain flexibility. Some participants, both in the experimental and control groups, claimed to have used verbal strategies (i.e., trying to verbally reproduce the sequential order of stimuli presentation, after having assigned a verbal code to each cell in the matrices) during the criterion task or having attempted to do so, without obtaining any appreciable results. Furthermore, the participants in the trained group reported that the training activities - although interesting- were particularly demanding in terms of their mental resources.

To conclude, these findings showed that older adults can benefit from WM training conducted in visuo-spatial modality, as demonstrated by specific gains in the trained task. They also suggested, however, that the efficacy of visuo-spatial WM training in inducing flexibility is weaker than verbal WM training, as highlighted by the lack of transfer effects. The use of neutral images, instead of dots, does not improve - in contrast to what had initially been hypothesised - training efficacy.

STUDY 3

Visuo-spatial WM training with positive emotional stimuli

4.6 Introduction

Recent studies have been focused on transfer effects to other abilities - not directly trained - that could be derived from WM training: as previously discussed, the idea behind this is that WM shares the same neural network that is implicated in a wide range of cognitive tasks (reasoning tasks, cognitive control, attention, inhibition) – located, in particular, in the prefrontal cortex and parietal areas (Olesen,Westerberg, Klingberg, 2003). Repeated practice on a given task that recruits these brain regions should, thus, not only improve performance on WM, but should also lead to transferable gains in performance on tasks that depend on the same neural substrates. Transfer effects to fluid intelligence, inhibition related process and short-term memory have been investigated in the customary way.

Recently, researchers have also investigated the possibility of increasing emotion regulation after WM training (Schweizer, Hampshire & Dalgleish, 2011; Schweizer, Grahn, Hampshire, Mobbs, & Dalgleish, 2013), based on the observation that emotion regulation and WM tasks largely overlap the frontoparietal network (Ochsner & Gross, 2004; Duncan, 2010).

Schweizer and colleagues (2011) tested this hypothesis in younger adults using a dual 2-back training programme with affective components (emotional visual and verbal stimuli): the results demostrated that the trained participants performed better on WM training tasks compared to the control group ones and that they were also more capable in reducing negative affective responses. At neural level, increased activation in the prefrontal areas was shown in performing both the emotional WM and emotion regulation tasks. Previously, authors (Schweizer *et al.*,2011) proved that participants trained on Emotional WM tasks, not only improved their performance in WM tasks, but also obtained transfer gains in the emotional Stroop Task. The latter effect was, however, not observed in participants trained using a neutral version of the WM task, suggesting that transferable gains to affective tasks requires training with material congruent to those contexts.

Studies on emotional regulation transfer effects could have important implications for the utility of WM training in clinical settings too, due to evidence that affective cognitive control capacity (e.g., the ability to regulate emotions or manipulate emotional material) is relevant to various real life purposes i.e., decision making, interpersonal behaviour). The possibility of enhancing emotional regulation in older adults - through affective WM training - has not yet been investigated, and the little evidence set forth above is restricted to younger adults. Furthermore, based on the well known phenomenon "*positivity effect in aging*", it is also possible that the use of affective stimuli in older adults could play a compensative role in WM, and then affect WM training gains and transfer effects. This latter hypothesis was addressed, for the first time, in this work.

By the expression "*positivity effects*", authors mean the tendency for older adults to remember more positive information than neutral and negative data (for a review, see Carstensen & Mikels, 2005). This *positivity effect* in older adults' memories seems to be due to their greater focus on emotion regulation and supported by cognitive control mechanisms that enhance positive and diminish negative information (Mather & Carstensen, 2005). Indeed, despite cognitive control declines in aging - due to deterioration in the prefrontal brain regions (Braver & Barch, 2002) - emotional control is not impaired (Gross et al., 1997). Thus, although it seems paradoxical that, if the same areas are involved both in cognitive and emotional control - the first declines in aging, while the latter functioning is preserved. A possible explanation might consist in the different allocation of mental resources in aging (Carstensen & Mikels, 2005): older adults generally focus more resources on positive emotional stimuli, according to the Socioemotional Selectivity Theory. As affirmed by this theory, aging's constraints in time horizons might shape human motivation (Carstensen, Isaacowitz, & Charles, 1999) driving older adults towards a preferential selection (and consequentially, towards increased processing and retention) of materials that might preserve their psychological well being.

As people approach the end of their lives, goals associated with emotional meaning and well-being may become more salient, thus, producing positivity effects in cognition, observed both in memory and attentive tasks.

There are a lot of studies that have shown that “emotional” materials are better remembered, compared to neutral ones, a phenomenon known as “*salience effect*”, but, in 2003, the first study conducted by Charles, Mather & Carstensen,.- confronted the use of “positive” and “negative stimuli” and by comparing different age groups (Young, middle aged and older adults) – demonstrated young adults’ preference for negative materials and positive ones in older adults.

The positivity effect might involve both automatic (bottom up) and controlled (top down) processes, regulated, respectively, by the amigdala and frontal lobes (LaBar & Cabeza, 2006). Mather & Carstensen, (2005) in one study, showed, by way of an example, that both in young and older adults attention was automatically allocated toward negative stimuli, but the fixation time in older adults for negative images was less than for young adults, indicating the involvement of control processes in order to avoid negative information. In 2004, Mather and collegues, however, showed that amigdala activation in younger and older adults was greater in relation to both positive and negative images than for neutral ones, but that, in older adults, the amigdala showed significantly greater activation for positive images than for negative ones. Again, in the dot-probe experimental paradigm (Mather & Carstensen, 2003), the authors showed that older adults tended to respond faster when dots - on the screen - were positioned in the same location aspreviously presented happy faces, compared to the negative faces and also faster for neutral faces,compared to negative ones. Hahn, Carlson, Singer & Gronlund (2006) again demonstrated that older adults are more efficient than young ones in avoiding negative stimuli and, in particular, are better able to inhibit angry facial expressions in their tasks.

Thence, overall, these findings suggest that this age-related preference for positive information occurs in attentional as well as memorial processes. It is important, however, to underline that there are also studies that found no positivity effect, but only a general emotional salience effect (e.g., Murphy and Isaacowitz, 2008), without any difference between positive and negative stimuli. These inconsistencies might be derived from a wide range of domains and procedures in which the positivity effects have been tested. (Gruhn, Smith, & Baltes, 2005).

Evidence concerning the positivity effect also emerged during the WM Task. Mikels, Larkin, Reuter-Lorenz and Carstensen (2005). An n-back task for visual neutral or visual emotional images - showed them that despite an age-related deficit in WM, when positive emotional images were involved, older adults were able to obtain the same level of performance as younger adults Diversely, in the condition with neutral stimuli, they indentified the classical age-related decline in WM.

Moving on from this evidence, we might speculate that well preserved functioning in emotive stimuli processing might be useful in compensating the mechanism that declines with aging, such as in the Working Memory (Dolcos et al., 2004). An alternative hypothesis, called *Cognitive Emotive Trade Off hypotheses* (Mammarella, 2010), expected that older adults, by allocating more resources to emotional materials, could subtract resources for the non-emotional information analysis, leading to diminished performance, when neutral material processing is required. In this hypothesis, it has been argued that emotional processing and regulation has a significant cost. For example, Mather and colleagues (2006) - in a study conducted with younger adults - showed that when participants had to remember an object's position on screen (IAPS images), the higher the level of arousal associated with the images, the less the performances were. This study showed that emotional arousal impaired feature binding in the Working Memory task. In this experiment, however, an arousal effect was present, but not of any stimuli valence (negative or positive).

Bearing in mind the two aforementioned hypotheses, this work examines the role of positive emotional stimuli in visuo-spatial WM training As in the previous study (study 2), Borella and colleagues' (2014) visuo-spatial training procedure was used.

The idea – presented for the first time in this work- was that if emotional regulation processes are well preserved in aging and they share the same neural network as Working Memory, then it should be possible to compensate decline in WM performance by using of emotive materials, and, at the same time, to foster benefits and the transfer effects of visuo-spatial training. The poor transfer effects obtained from visuo-spatial WM training - compared to the transfer benefits obtained through verbal WM training - might be explained as mentioned above in study 2 - by the reduced plasticity of the visuo-spatial domain, which is more subject to age-related decline (e.g., Myerson *et al*., 2003). Training programs, however, could help older adults' brains to build a compensatory scaffold in response to age-related changes (Park & Reuter- Lorenz, 2009), only if they are focused on abilities that are more age-resilient and that might constitute foundations for cognitive flexibility (Borella *et al*., 2014). This might be the case of emotional stimuli processing, which is well preserved in aging. In other words, it has been expected that using positive images in visuo-spatial WM training, could possibly foster cognitive flexibility, asserting a lever on the emotional regulation mechanisms unimpaired in aging.

Aims

In summing up, this study has aimed at investigating the role of positive emotional stimuli used in WM training tasks: using the aforementioned visuo-spatial training paradigm adopted by Borella and colleagues (2014), the latter examined whether the benefits of WM training might be fostered by the use of positive emotional stimuli . It has been hypothesized that:

1) emotional images might sustain attention towards tasks based on the aforementioned positive effects on older adults; this aspect might foster motivation and efforts in order to comply training activities. Thus, more gains in criterion task have been expected after training.

2) emotion regulation processes are well preserved in aging. Thence, by asserting a lever on these mechanisms visuo-spatial WM training should lead to easier cognitive flexibility, resulting in transfer effects to other domains.

However, based on evidences showing a decrease in WM performance, when older adult participants have to consider both emotive and non-emotive materials at the same time (e.g., Mather et al., 2005), it is also possible that fewer gains will be obtained after training.

This study has allowed us to improve our knowledge concerning the positivity effects in WM tasks and, on the other hand, to investigate the possibility of using positive stimuli to foster WM training gains.

4.7 Participants

Forty healthy older adults (63-74 years old) participated voluntarily in the study. They were all native Italian speakers, recruited from Third Age Universities and cultural circles, and were selected on the basis of a physical and health questionnaire. None fitted the exclusion criteria propsed by Crook et al. (1986) which were: they should not have used of benzodiazepines in the previous 3 months or have any visual, auditory, and/or motor impairments; problems or diseases that migh potentially cause cognitive impairments. They were screened for cognitive impairments using the Italian Checklist for the Multidimensional Assessment (SVAMA) of the elderly, used in the Veneto region (Gallina *et al*., 2006). All participants scored 9 or 10 on the SVAMA, indicating good cognitive functioning. Finally they were randomly assigned to one of the two experimental conditions (trained or active control groups**).**

As in the previous study, the participants were assessed on their level of subjective psychological well being, using the Positive and Negative Affect Schedule (PANAS – the Italian version; Terraciano, McCrae & Costa, 2003).

As demonstrated by the one-way variance analyses (ANOVAs), the experimental and control group participants did not differ in age, years of formal education, or WAIS–R vocabulary scores. Furthermore, the Participants did not differ in Negative, and Positive Affects (All *Fs* <1) (See table 4.5 for demographic characteristics).indicating a good cognitive functioning. Finally they were randomly assigned to one of two experimental conditions (trained or active control group**).**

Table 4.5 *Demographic Characteristics of the Trained and Control Groups*

	Trained group (N=20; 14 =Female)		Control group (N=20; 15=Female)	
	M	SD	M	SD
Age	68.05	3.28	69.00	3.44
Years of Education	11.30	2.95	11.25	2.91
Vocabulary	48.90	7.78	48.75	8.30
PANAS positive affect	31.30	6.38	31.45	6.91
PANAS negative affect	19.30	6.74	17.90	5.78

4.8 Method

The pre-post test assessment was conducted as in study 2. The same tasks were used and in the same order. Parallel versions were used for each task, in order to avoid the test-retest effect.

The training schedule was also the same (see table 4.1), with the sole exception that affective positive stimuli were used.

Selection of the stimuli used in criterion task and training activities:

To ensure that trained tasks were always perceived as challenging and motivating, repetition in stimuli presentation was avoided: positive affective images were collected, thus considering different standardized databases (NAPS - Marchewka, Żurawsky, Jednoróg & Grabowska, 2013; EmoPics- Wessa et al., 2010, GAPED - Glauser & Scherer, 2011). See thr dedicate section in study 2 (see also appendix C).

For the criterion task, 60 images from the *International Affective Picture System* (IAPS-database; Lang, P. J., Bradley, M. M., & Cuthbert, B. N.,1998) were considered.

Two-thirds of the images represent animals, flowers and food and one-third positive faces (in particular babies' ones). This choice were maede according to studies that showed that social stimuli are usually more salient than non social ones (e.g., Charles, Carstensen & Mather, 2003). This effect might be even higher for older adults, according to the Socio-emotional selectivity theory. Thus, in order to control this confounder, both in the previous study (study 2) and in this one, the same proportion of social (1/3) and non social stimuli (2/3) was used.

As mentioned above, the images were selected on the basis of two important criteria, the:

1) positive stimuli valence;

2) high stimuli visibility, due to the need of using them in matrices

Overall, the mean values for valence were 7.20 (ds= 0.47) and for arousal 5.27 (ds=0.76),concerning all images considered in this study.

4.9 Results

First of all, Oneway ANOVA for each task was conducted at pre-test level, in order to identify eventual differences between the experimental and control group. Results shown that there were no significant differences at baseline for measures of WM that are the Matrix Task (F<1), CWMS ($F_{(1,38)}$= 2.61 , p=.11, ηp^2=.06), and E-OSPAN ($F_{(1,38)}$= 3.12 , p=.09, ηp^2=.07). Again, no differences were shown for short term memory task, both considering forward Corsi Span ($F_{(1,38)}$= 3.16 , p=.08, ηp^2=.07), and Backward Corsi Span (F<1). Again no significant differences were shown for the task assessing processing speed (Pattern Comparison F<1) and inhibition (both for time of lecture of stimuli in control and in incongruent conditions Fs<1).

To assess the effects of training, each variable of interest was analyzed with a 2(group: trained and control) X 2(session: pre-test; post-test) mixed design analysis of variance. The α value was set at .05 for all statistical test. To test interactions post hoc pairwise comparison with Bonferroni correction were run, adjusted for multiple comparison. Thus, for interactions α value was set at .008 because six comparisons were conducted (.05/6= .008). Descriptive statistics at pre-test and post-test are given in table 4.6; ANOVA results are summarized in table 4.7 (the exact values of F and p are provided in table).

Table 4.6 *Descriptive Data for Pre-test, Post-test assessment by group*

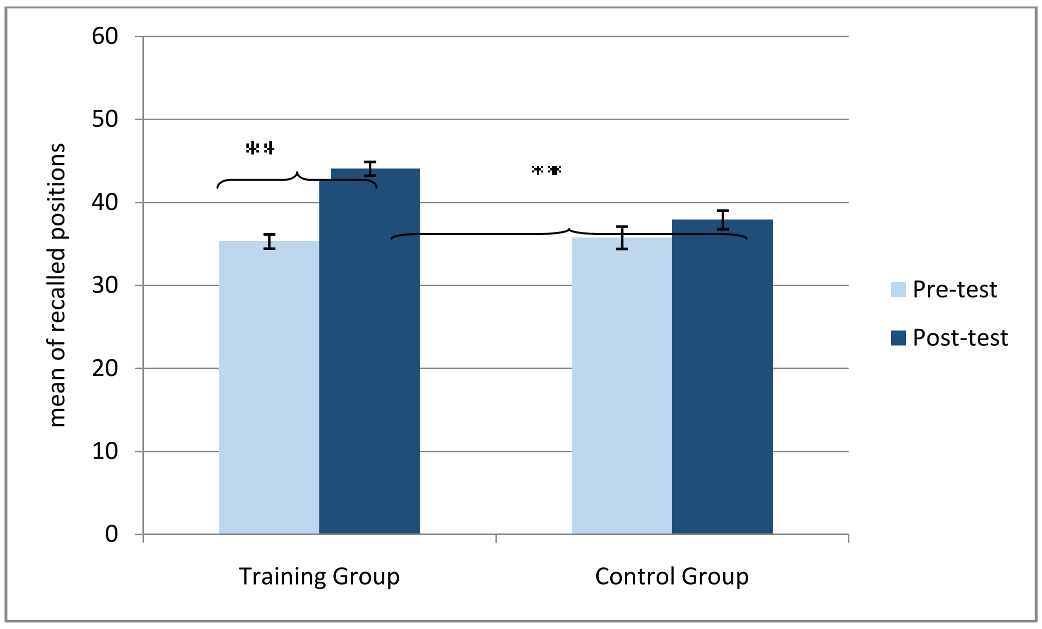
	Training Group (n=20)				Control Group (n=20)			
	Pre-test		Post-test		Pre-test		Post-test	
Variable	M	SD	M	SD	M	SD	M	SD
Matrix Task max=60	35.50	3.83	44.05	3.74	35.75	6.07	37.90	5.05
CWMS max=20	13.35	2.73	14.15	3.16	11.95	2.87	12.65	2.68
E-OSPAN max=18	12.20	2.19	12.90	2.51	10.80	2.78	11.15	2.27
Forward Corsi Span max=12	5.10	1.11	5.50	0.88	4.45	1.19	4.55	1.19
Backward Corsi Span max=12	5.40	.99	5.60	1.09	5.60	1.78	5.70	1.94
Pattern Comparison (sec)	147.50	31.53	140.55	18.52	152.10	35.98	142.80	26.11
Stroop Color Task Incongruent RT (sec)	24.54	3.34	22.42	2.08	23.89	5.18	22.58	4.65
Stroop Color Task Control RT (sec)	13.74	1.90	12.47	1.60	14.13	2.59	12.74	2.14
Cattell Test max=50	20.55	2.76	21.90	2.67	19.70	3.43	20.55	2.68

Note: CWMS: Categorization Working Memory Span test; E-OSPAN: Emotional Operation Span test; RT: response time

Specific effect on criterion task (Matrix task)

The main effect of Group was significant $F_{(1,38)} = 4.47$, $p<.05$, $\eta p^2=.10$) as well the main effect of the Session $F_{(1,38)} = 85.39$, $p<.001$, $\eta p^2=.69$). The Group X Session interaction was also significant, $F_{(1,38)} = 30.54$, $p<.001$, $\eta p^2=.44$ (see the figure 4.2). No significant differences were shown, at pre-test, between trained and control group whereas, at post-test, the trained group performed better than the control one (M*diff*=6.15, p<.001; 95% C.I [3.30;8.99]. For both groups significant improvements occurred between sessions but, correcting for multiple comparison only the differences in training group remain significant. For trained participants, M*diff*==8.55, p<.001; 95% C.I [6.89;10.20], instead, for the control group M*diff*=2.15, p<.01; 95% C.I [.49;3.80].

Figure 4.2 *Matrix Task: Mean values of the correctly recalled positions by trained and control group, at pre-test and post-test. Error bars represent standard error.*



Nearest transfer effect.

The CWMS task: The main effects of Group was not significant ($F_{(1,38)}$= 3.02, *p*= .09, ηp^2=.07). A significant main effect of Session was observed ($F_{(1,38)}$= 4.33, *p*<.05, ηp^2=.10). For both trained and control participants better performance were shown at post-test (M*diff*=.75, *p*<.05).

Group x Session interaction was also no significant $F_{(1,38)}$ =.01, *p*= .89, ηp^2=.00.

The E-OSPAN task: The main effects of group was significant ($F_{(1,38)=}$ = 5.07, *p*< .05, ηp^2=.11), indicating that overall, trained participants had better performance compare to the control ones (M*diff*= 1.57, *p*<.05). The main effect of session ($F_{(1,38)}$ = 2.45, *p*=.12, ηp^2=.06) and of Group x Session interaction ($F_{(1,38)}$ = .27, p=.60, ηp^2=.00) were however not significant.

Near transfer effects

Forward Corsi task: the main effect of the session was not significant ($F_{(1,38)}$ = 3.57, p=.06, ηp^2=.08) as well as the Group X Session interaction ($F_{(1,38)}$ = 1.28, p=.26, ηp^2=.03). The main effect of Group was instead significant ($F_{(1,38)}$ = 6.12, p<.05, ηp^2=.13). Overall, participants of trained group had better performance compare to the control ones (M*diff*= .80, p< .05).

Backward Corsi task.: The main effects of Group was not significant as well as the main effect of Session. Group x Session interaction was also not significant, (All *Fs*<1).

Far transfer effects

Pattern Comparison: the main effect of session was significant ($F_{(1,38)}$ = 4.70, p<.05, ηp^2=.11). Participants, of both groups, performed the task at post-test more quickly that at pre-test (M*diff*= -8.12, p<.05). On the contrary the main effect of the group (*F*<1) and the Group x Session interaction were not significant (F<1).

Stroop Task: concerning the interference Stroop inferferemce index (RT in incongruent condition - RT in control condition/ RT in control condition), the main effect of the group was not significant ($F_{(1,38)}$ = 1.23 , p=.27, ηp^2=.03). The main effect of the session was instead significant ($F_{(1,38)}$ = 60.62 , p<.001, ηp^2=.61), Group x Session interaction was not significant ($F_{(1,38)}$ = 1.47 , p=.23, ηp^2=.03).

Considering only time employed to name stimuli in incongruent condition the main effect of session was found ($F_{(1,38)}$ = 15.01, p<.001, ηp^2=.28). Training and control group's participants, spent less time at post-test -compared to pre-test for naming incongruent stimuli

(M*diff*= -1.70, $p<.001$). The main effect of group instead was not significant ($F<1$). The Group x Session interaction was also not significant ($F<1$). Also considering the time spent naming stimuli in control condition, main effect of session was found ($F_{(1,38)}= 38.48$, $p<.001$, $\eta p^2=.50$). Training and control group's participants, spent less time at post-test -compared to pre-test- for naming control stimuli (M*diff*= -1.32, $p<.001$). The main effect of group was not significant ($F<1$).as well as the Group x Session interaction (*F<1).*

Cattell Test: the main effect of Session was significant ($F_{(1,38)} = 5.69$, $p=.02$, $\eta p^2= .13$). The main effect of Group ($F_{(1,38)}= 1.91$, $p=.17$, $\eta p^2=.04$) and Group X Session interaction (F<1) were not significant.

Effect size Cohen's d was finally computed on the scores in criterion task. Results showed a large effect size for the training group (*d*=2.21, 95% C.I.[1.43;3.00]). Diversely, weaker effect was shown for control group (*d*=.38, 95% C.I.[-025;1.01]).

As in the study 2, also in this case only a specific effect on the criterion task was shown, without any transfer effects.

Table 4.7 *Mixed design 2X2 ANOVA results for the measures of interest, with group (trained and control) as between-subjects factor and session (pre-test, post-test) as repeated measure*

Variables			$F_{(1,38)}$	*MSE*	*P*	*n*p^2
Criterion Task: specific						
Matrix Task	Between s.	Group	4.47	38.91	.04*	.10
	Within s.	Session	85.39	6.70	.000***	.69
		GXS	30.54	6.70	.000***	.44
Nearest transfer effects: Verbal WM						
CWMS	Between s.	Group	3.02	13.89	.09	.07
	Within s.	Session	4.33	2.59	.04*	.10
		GXS	.01	2.59	.89	.00
E-OSPAN	Between s.	Group	5.07	9.77	.03*	.11
	Within	Session	2.45	2.24	.12	.06
		GXS	.27	2.24	.60	.00
Near transfer effects: Visuo-spatial short term memory						
Forward Corsi Span task	Between s.	Group	6.12	2.08	.01**	.13
	Within s.	Session	3.57	.35	.06	.08
		GXS	1.28	.35	.26	.03
Backward Corsi Span task	Between s.	Group	.10	4.13	.74	.00
	Within	Session	.97	.46	.32	.00
		GXS	.10	.46	.74	.00
Far transfer effects						
Processing Speed: Pattern Comparison task	Between s.	Group	.17	1376.14	.68	.00
	Within s.	Session	4.70	280.67	.03*	.11
		GXS	.09	280.67	.75	.00
Inhibition: Stroop Color task						
Incongruent RT	Between s.	Group	.04	28.16	.83	.00
	Within s.	Session	15.06	3.87	.000***	.28
		GXS	.84	3.87	.36	.02
Control RT	Between s.	Group	.27	7.83	.60	.00
	Within s.	Session	38.47	.91	.000***	.50
		GXS	.08	.91	.77	.00
Stroop Color Interference tndex*	Between s.	Group	1.23	.06	.27	.03
	Within s.	Session	60.62	.03	.000***	.61
		GXS	1.47	.03	.23	.03
Fluid intelligence: Cattell Test	Between s.	Group	1.91	12.64	.17	.04
	Within s.	Session	5.69	4.25	.02*	.13
		GXS	.29	4.25	.59	.00

CWMS=Categorization Working Memory Span Task; E-OSPAN: Emotional Operation Span Task; RT: reaction time; GXS: group x session interaction;.
* Stroop color Interference index: (RT incongruent condition- RT congruent condition)/ RT incongruent condition

4.10 Conclusions

The work's aims were i) to evaluate the efficacy of visuo-spatial WM training in older adults and ii) to investigate the role of the stimuli used in training activities, in particular, positive emotional materials. As mentioned in Study 2, the issues about the nature of training (verbal visuo-spatial visuo-spatial), as well as the role of the stimuli used in training tasks, have not yet been investigated. Furthermore, despite the well known "positivity effects" in aging, the potential use of positive emotional stimuli in WM training paradigm has not been taken into account yet. The few studies that have examined the role of positive materials in WM tasks, and, in particular in WM training, indeed are limited to younger adults. In the latter, however, the specific aim in WM training was to investigate the possibility of improving emotional regulation after training (Schweizer, *et al.*, 2011; Schweizer, *et al.*, 2013), based on the observation that emotion regulation and WM tasks largely overlap the frontoparietal network (Ochsner & Gross, 2004; Duncan, 2010).

For the first time, in this work, instead, the hypothesis has been advanced that WM training gains and relative transfer effects - in older adults – might be fostered by the use, in training activities, of positive emotional materials. It was assumed that if emotional regulation processes are well preserved in aging, they might constitute the basis to sustain cognitive flexibility and compensate difficulties in WM training activities. Again, positive emotional stimuli, would be more salient for older adults, fostering attention and motivation toward the tasks. This aspect might, however, be particularly important in WM training, where the visuo-spatial modality is used, and which shows reduced gains, due very probably, to a more exacerbated age-related decline and to reduced flexibility in visuo-spatial WM (e.g., Bopp and Verhaegen, 2007).

This hypothesis was investigated by using the visuo-spatial WM paradigm adopted by Borella and colleagues (2014), as in study 2. In this work, activities were adapted with the involvement of positive emotional stimuli.

Consistently with the results obtained in study 2, only specific gains were shown for the criterion task in this work, without transfer effects to tasks evaluating verbal WM, processing speed, inhibition and fluid intelligence.

Only participants in the training group significantly improved their performances in the Matrix Task, thus indicating the possibility of improving visuo-spatial WM in older adults, through using this training. The presence of an active control group, which met the experimenter for the same number of sessions as the trained group ensures that any gains could be attributed to WM training.

Diversely, the transfer effects to verbal WM, assessed by the Categorization Working Memory Span and the Emotional Operational Span Tasks, were not shown. The main effect of session, indeed, only showed a test-retest effect. In the case of the Emotional Operation Span Task, again, no differences were identified between the pre-test and post-test assessments. Similar results were also shown for the Pattern comparison task (processing speed), the Stroop color Task (inhibition) and the Cattell Test (fluid intelligence), where only the main effect of session was present. Again, no differences were found between sessions for the Corsi Forward and Backward Span (short-term memory). The lack of transfer effects might indicate that this WM training, despite gains showed in visuo-spatial WM, does not lead to an improvement in general flexibility.

This pattern of results might suggest (and which has also been corroborated by the results of study 2 and the results achieved by Borella and colleagues, 2014) that the training task modality (visuo-spatial rather that verbal) used to train WM, influenced the training efficacy in terms of transfer effects. Alternative hypotheses are, however, possible. As in study 2, the use of strategies has been reported in this case too: some of the participants saw that they tried to use particular spatial strategies that might permit improvement in the task performance for which they were developed (Matrix Task), but, at the same time, might reduce generalization to other tasks or stimuli.

As reported in the discussion of study 2, it is also possible that the particular tasks used, involving the sequential recollection of the position of items on the matrix, might require additional efforts: it is possible that the participants who were allocated more mental resources on the stimuli presented, reduced attention toward the stimuli locations. This aspect might partially explain the differences in terms of transfer effects between the actual study (and in study 2 too) and the first study conducted by Borella and colleagues (2014), where, instead, far transfer effects on the Corsi Span (forward and Backward), Pattern Comparison and Categorization Working Memory Span Task were shown (see table 5.1 in the final chapter for a comparison of the effects identified among the three studies). Furthermore, this latter aspect might even be important when emotional positive stimuli are taken into considation. It is, in fact, important to note that together with studies that have shown that positive stimuli migh compensate difficulties in WM tasks (Mikels *et al.*, 2005), there is other evidence that shows that their processing might subtract resources from the analysis of non-emotional information (Mather *et al.*, 2007). Relevant gains were however shown, by the trained group, on the criterion task, suggesting that this latter hypothesis, might only marginally explain differences in transfer effects. This, seems more plausible that the nature of the training tasks, rather than that the type of stimuli used (both neutral and positive stimuli) might influence WM training benefits.

CHAPTER 5

GENERAL DISCUSSION AND CONCLUSIONS

5.1 Main findings

A number of changes occur as people age, implying both biological and psychological modifications. Researchers have agreed on the multi-dimensionality and multi-directionality of the aging process thus affirming that, in all phases of life gains and losses are present (Baltes, 1980). In cognitive aging, it is also possible to identify components that present an age-related decline and other ones that are well preserved or even enhanced: thus, age-related decline is not considered as being uniform across all cognitive domains and in all individuals. Furthermore, the presence of cognitive plasticity has also been recognized in later life, implying the opportunity of intervening on abilities subject to age-related decline.

Among the cognitive components that decline in aging, the Working Memory (WM) has been considered of particular relevance and has received particular attention in studies on cognitive interventions.

WM is a multi-componential construct that has been hypothesized as playing a fundamental role in age-related cognitive decline. Evidence suggests that WM is one of the critical factors accounting for age differences (together with processing speed and inhibitory functions defined as cognitive primitives) on a broad range of cognitive tasks that involve memory, reasoning, comprehension and problem solving (Park *et al.*, 2002). Furthermore, many complex everyday tasks require the integration and reorganization of information from a variety of sources, which are possible thanks to WM (Riddle, 2010).

Despite the presence of several WM models (for a review see Miyake & Shah, 1999), all researchers have agreed on the limited capacity of this system that permits the storage and manipulation of information maintained on the attentional focus (Baddeley, 2000). The WM capacity shows a downward trajectory across the life span: decline starts when an individual is in his 20s, with a gradual and regular decrease during each decades (e.g., Salthouse & Babcock, 1991). This decline might be related to changes in the prefrontal cortex that shrinks with aging (Raz, 2000).

Given its important role, recent studies have been focused on interventions that could potentiate the WM system. As mentioned in chapter two, different types of interventions have been formulated but, among these, WM process based training has offered promising results in different target populations among which older adults, both when considering healthy older adults and individuals with pathologies (e.g., Carretti *et al.,* 2013).

These studies have shown that is possible to potentiate WM through repetitive practice on given tasks that underlie this component (see table 2.1 in chapter two). Some of these studies have shown transfer effects on abilities that have not been directly trained, but in which WM is involved or overlaps the same WM cognitive resources or structural areas (von Bastian & Oberauer, 2013). However, these results are controversial and a number of issues concerning WM effectiveness remain unresolved. Based on literary evidence, it is actually impossible to establish the WM training's features that might produce wide ranging effects in terms of cognitive plasticity and, then, significant effects on cognitive functioning. WM training studies, in fact, differ from many points of view, related both to the procedures adopted and to the participant's characteristics. The studies differ due to the eventual presence of an active control group (and the type of control), the intensity and duration of training, the modality trained and the tasks used to assess the benefits. Concerning the differences that have originated among the participants, instead, the role of baseline capacities, and the possible differences between older adults and the old-old, has already been discussed.

In this thesis, 3 studies have been proposed, with the aims of clarifying: i) whether it is possible and to what extent the effects of WM training also has on everyday life abilities; ii) if the modality exercised (verbal rather than visuo- spatial WM) and the type of stimuli (more or less familiar) might affect WM training efficacy and the related transfer effects and

iii) finally, if the use of positive emotional stimuli might foster WM training benefits, based on the "positivity effect" in aging.

The possibility of extending training benefits to everyday life, as discussed in chapter three, is largely under investigated, so it is impossible to understand if the claim associated with this type of training is related to a true improvement in everyday cognition and, thus, to a better quality of life in aging. In study 1, by adopting Borella and colleagues' verbal training procedure (2010), we aimed to assess transfer benefits to everyday life through the use of performance based measures of functional abilities. We used objective tasks involving real life activities. This choice was based on previous evidence showing that self-report measures- although correlated to objective tasks (Klimber, 2013)- might be inaccurate. Often, indeed, older adults tend to overestimate their functional abilities (Willis, 1990) and these latter measures might also be affected by the influences of social desiderability (Owsley, Sloane, McGwin, Ball, 2002). Furthermore, as suggested by Shipstead and colleagues (2010), improvements into self-report measure's score might only reflect participant's expectation on cognitive training. We selected, different objective measures from among the ones present in literature, those that could be used with healthy older adults, who had good psychometric characteristics and who had been previously used in training literature (EPT and TIADL were also used in the ACTIVE study) Then- for the EPT task- stimuli were selected that best adapted to the Italian population, and *ad hoc* situations were created representing real life activities that older Italian adults have to solve in their daily lives.

The results of this first study confirm the efficacy of Borella and colleagues' verbal WM training in both laboratory tasks and beyond. Transfer benefits, indeed, occurr in the Everday Problem Solving Task, where trained participants showed an increasing in their scores.

Our further aim was to replicate transfer effects on fluid intelligence, by using multiple indicators: our results confirm the previous ones obtained in 2010. Transfer effects occurred in both the Cattell Test (previously used in 2010) and in the Raven Standard Progressive Matrices.

Overall, the results of this first study, suggest that WM training might represent a promising approach in increasing cognitive functioning in older adults. They might impact their capacity to face everyday activities, fostering autonomy and quality of life.

In the second study, the possible role of the WM training modality (verbal vs visuo-spatial) was investigated. This study started with the consideration that, in older adults, only a few studies used a verbal modality while the majority of them used visuo-spatial tasks or a multi-modality approach. Divergences in results, however, derived from the use of verbal rather the visuo-spatial modality (see the study conducted by Borella *et al.,* 2014).

The results of this study showed that, although a specific effect in the criterion task is present (comparable in terms of effects size, to the results obtained with the verbal procedure) no significant transfer effects occur. Thus, also by manipulating the stimuli's characteristics, it is possible to conclude that this visuo-spatial WM training paradigm might induce fewer effects compared to the verbal one, described in study 1. The visuo-spatial procedure might only induce changes in trained activities. Among several explanations, however, it might be possible to speculate that the more accentuated decline in visuo-spatial WM is (although this issue is once again object of debate), it might mediate the transfer of benefits. According to Lovden and colleagues (2010)'s theory, cognitive plasticity might only occur after a prolonged mismatch between individual supplies and external demands but, it is mediated by the levels of current cognitive flexibility (see chapter two). Thus, it is possible that the activities proposed in this training are too difficult for older participants and that they are beyond their current levels of flexibility. This hypothesis deserves, however, further investigations and the results obtained required cautions: the trained participants observed, in fact, the use of strategies while performing the tasks. This aspect might have reduced the transfer possibilities of this training. It might be possible, in future, to investigate this latter aspect by using questionnaires testing the potential use of strategies during training tasks.

A cause for reflection might also be derived from the comparison of these results with the ones previously obtained using the same training paradigm in which dot stimuli are manipulated (Borella et al., 2014): although the effects in criterion task are comparable the transfer effects are divergent (see the table 5.2 for a comparison among the studies). The use of images instead dots seems to further reduce transfer effects. A possible explanation might be that picture stimuli processing might require additional efforts, subtracting resources from the recollection of stimuli locations.

This study has confirmed, on one hand, the efficacy of WM training in enhancing visuo-spatial WM in older adults, but on the other hand, suggests that when a visuo-spatial modality is used, weaker transfer effects might occur in older adults. Otherwise, the type of stimuli used only plays a marginal role.

Finally, in the last study, the role of positive emotional stimuli in a WM training paradigm was investigated based on the evidence about positive effect in aging (see chapter 4). Our initial hypotheses (of a possible enhancement that could be derived from the use of positive stimuli in WM training) was not supported by the data obtained. On the contrary, only specific gains in the criterion tasks were proven, without any transfer effects. Beyond the use of positive stimuli, as discussed above, the visuo-spatial nature of training activities might have established this pattern of results. Further studies could be conducted investigating the role of positive stimuli in verbal WM training paradigms.

Table 5.1. *A comparison among visuo-spatial WM training studies.*

		Borella, Carretti, Cantarella, Riboldi, Zavagnin & De Beni, 2014	**Study 2 of this thesis**	**Study 3 of this thesis**
		Stimuli used: dots	Stimuli used: neutral pictures (images of familiar objects or neutral faces)	Stimuli used: positive emotional pictures (images of animals, flowers etc. or happy faces)
Tasks	Abilities			
		Specific effects		
Matrix Task	Visuo- spatial WM	✓	✓	✓
		Near transfer effects		
Forward Corsi Span	Visuo-spatial Short term memory	✓*	X	X
Backward Corsi Span	Visuo-spatial Short term memory	✓*	X	X
		Far transfer effects		
Pattern Comparison Task	Processing Speed	✓*	X	X
Stroop Color Task	Inhibition	X	X	X
Cattell Test	Fluid intelligence	X	X	X

Note: * These transfer effects were not maintained at follow-up level

5.2 Strengths, limitations and future directions

Our findings have theoretical and applied implications. First of all, they can furnish researchers with relevant information on cognitive processes in aging and on WM training features which might lead to transfer benefits. Our results have provided evidence concerning the role played by the modality exercised during training activities: when verbal WM is trained, even far transfer effects occur including benefits in everyday life abilities; by adopting exactly the same procedure in the visuo-spatial modality, instead, only specific effects appeared, without any regard to the type of stimuli adopted (dots rather than familiar images of common objects or positive emotional stimuli). These results could indicate that visuo-spatial WM - although susceptible to being improved through specific activities - it is less flexible in older adults (e.g., Myerson *et al.*, 2003). Future studies should investigate should, however, investigate the possible use of spontaneous strategies that might affect transfer effects in visuo-spatial WM training. Once again, the possibility of prolonging the duration of this particular WM training procedure -when the visuo-spatial modality is used- has to be taken into consideration. It is in fact possible, that due to the more accentuated decline of visuo-spatial WM in aging, more time is required to stimulate cognitive plasticity. Finally, future studies could also examine, as aforementioned, the use of positive emotional stimuli in verbal WM training.

On the contrary, our results suggest that when the verbal modality is used, it is also possible to achieve wide ranging benefits with only brief training (in only 3 sessions) . The verbal WM training could possibly act, on the general domain mechanism, fostering the ability to allocate cognitive resources and inhibit irrelevant information (Borella *et al.*, 2010).

Furthermore, the results of the first study respond to the lack of literature about training transfer effects in everyday life (Kelly *et al*., 2014). Our findings have indicated that verbal WM training might constitute a significant resource in improving the capacity of older adults to live independently. In future, however, transfer effects on everyday skills should also be assessed in an old-old sample.

One of the first study's strengths is the use of objective measures of everyday life competences, specifically formulated to adapt with the Italian culture. Moreover, by using fluid intelligence's multiple indicators, it is possible to exclude that any gains are only due to changes in the specific task administered (Schmiedek *et al*., 2010). The use of parallel versions of tasks- in all three studies- used in counterbalanced order across the session, ensure that gains are not merely the results of test-retest effects. In the same way, the inclusion of a control group that met the experimenter as many times as the training group (and that is enrolled in alternative activities), allow us to exclude the effect of the participant's expectation.

Some methodological limitations should be considered when the results of these studies are interpreted. First, the reduced sample size. Although comparable with other studies on WM training, the small sample did not permit implementing different statistic analysis that could allow us to explore possible moderating factors or individual differences at the baseline (e.g. Zinkle *et al.* 2013). Therefore, results (especially for study 1) should be replicated using a larger sample. Once again, the lack of follow up analysis, did not permit us to draw a conclusion about the temporal stability of the observed training and transfer effects.

In spite of several limitations, this work could add important knowledge about WM training efficacy, offering innovative prospects into the development of intervention revolved to older adults.

Abstract

A growing body of studies shows that working memory (WM) in older adults can be improved by means of specific process-based training, while the results in terms of transfer effects are more controversial. The benefits of WM training on other, untrained abilities, are generally examined using single indicators for each ability assessed, and benefits on everyday tasks have rarely been considered. One of the aspects that might favor transfer effects is the type of stimuli used in the training. Thanks to the "positivity effect" in aging, it may be possible to enhance the benefits of training and transfer effects by using emotional stimuli. This possibility has yet to be researched.

Three studies were conducted to address the above mentioned issues. The aim of the first was to assess the efficacy of a verbal WM training and its far transfer effects on everyday life abilities; performance-based measures of functional abilities were used. In the second and third studies, involving a visuo-spatial WM training, the characteristics of the training stimuli were manipulated using first neutral and then positive emotional stimuli (in studies 2 and 3, respectively).

The results of the first study showed transfer effects of the verbal WM training on everyday abilities, whereas the visuo-spatial WM training in studies 2 and 3only induced specific effects on criterion tasks.

Overall, WM training in aging has promise as away to improve abilities related to everyday living. Attention has to be devolved to the type of stimuli and the task modality (verbal rather than visuo-spatial).

Riassunto

Un crescente numero di studi mostra che è possibile migliorare le prestazioni di Memoria di Lavoro (MdL) degli anziani attraverso training "process-based". Più controverse sono le evidenze rispetto alla generalizzazione dei benefici ottenuti: i benefici dei training di MdL ad

abilità non direttamente allenate sono infatti solitamene valutati i) utilizzando singole prove per ogni abilità esaminata; raramente attraverso prove di funzionalità quotidiana. Tra gli aspetti che potrebbero favorire gli effetti di trasferimento dei benefici vi è la tipologia di stimoli utilizzata nei training: rispetto a ciò, l'utilizzo di stimoli emotivi a valenza positiva potrebbe essere efficace, sfruttando il noto "effetto positività" nell'invecchiamento, aspetto non ancora indagato.

Per indagare gli aspetti menzionati sono stati condotti tre studi. Lo scopo del primo era di valutare l'efficacia di un training di MdL verbale e gli effetti di trasferimento ad abilità quotidiane. Allo scopo sono state utilizzate misure oggettive di valutazione funzionale. Nel secondo e terzo studio, utilizzando un training di MdL visuo-spaziale, sono state manipolate le caratteristiche degli stimoli, usando stimoli a valenza neutra o positiva (rispettivamente nello studio 2 e 3).

I risultati del primo studio mostrano effetti di trasferimento alle competenze quotidiane mentre l'utilizzo di un training visuo-spaziale solo un effetto specifico alla prova criterio.

I training di MdL rappresentano quindi un approccio promettente per il miglioramento di abilità legate alla vita quotidiana. Attenzione deve essere devoluta al tipo di stimoli utilizzato e alla modalità di training (verbale o visuo-spaziale).

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APPENDIX

A. VERBAL WORKING MEMORY TRAINING

Il training consiste in versioni modificate del Categorization Working Memory Span Task (De Beni et al., 1998). Come per il CWMS le parole sono audio registrate e presentate a distanza di 1 secondo l'una dall'altra e di 2 sec. da una lista all'altra.

PRIMA SESSIONE

Il primo incontro di training è suddiviso in 3 parti: ogni parte è composta da 11 set contenenti da due a cinque sequenze di cinque parole ciascuna, l'ultima parola di ogni lista è seguita da un segnale acustico. Per ogni livello di difficoltà sono presenti tre set di sequenza di parole (ad esclusione del livello 5 per il quale sono presenti solo 2 set). Se il partecipante ricorda correttamente tutte le "parole target" di due dei tre set di un determinato livello di difficoltà si passa al livello superiore altrimenti la prova si interrompe e si passa alla parte successiva dal livello di difficoltà più basso (set da 2 liste).

Il compito dei soggetti è diverso a seconda della parte a cui ci si riferisce:

_ nella PRIMA PARTE il soggetto deve battere la mano in presenza di nomi di animali e ricordarsi l'ULTIMA parola di ogni sequenza;

_ nella SECONDA PARTE il soggetto deve battere la mano in presenza di nomi di animali e ricordarsi la PRIMA parola di ogni sequenza;

_ nella TERZA PARTE il soggetto deve battere la mano in presenza di nomi di animali e ricordarsi l'ULTIMA parola di ogni sequenza.

SECONDA SESSIONE

Nel secondo incontro di training vengono presentati ai partecipanti 16 set di sequenze di cinque parole ciascuna. Ogni set varia da un livello di due ad un massimo di cinque sequenze e viene manipolato il numero di volte in cui deve essere svolto il compito secondario (battere la mano sul tavolo in presenza di un nome di animale) per un totale di quattro set di parole (due in cui è poco frequente e due in cui è molto frequente).

In questa seconda sessione viene chiesto al partecipante di memorizzare le parole seguite dal suono la cui posizione varia all'interno della lista. Per evitare di confondere il partecipante, in questa sessione la fine di una sequenza è indicato da una pausa di silenzio di 2 sec.

I partecipanti svolgono la prova in tutta la sua lunghezza.

TERZA SESSIONE

Il terzo incontro prevede una prova composta da 16 set composti da sequenze di cinque parole: sono presenti 4 set per ogni livello di difficoltà (da 2 a 5 parole da ricordare).

Ai partecipanti viene chiesto, per ciascun set, di ricordare alternativamente l'ultima o la prima parola della sequenza. Anche in questa prova è richiesto il compito secondario, ovvero di battere la mano in presenza del nome di un animale.

I soggetti svolgono la prova in tutta la sua lunghezza.

SESSIONI DI TRAINING PER IL GRUPPO SPERIMENTALE

PRIMO INCONTRO

Consegne per il partecipante: *"Questo primo incontro si divide in tre parti durante le quali si eserciterà con delle liste di parole. Di volta in volta le specificherò quale sarà il suo compito."*

PRIMA PARTE

Il compito del partecipante è quello di ricordare **l'ultima parola di ogni lista** (in grassetto) e battere la mano sul tavolo quando sente il *nome di un animale* (in italico). Il partecipante viene avvisato che il numero di parole da ricordare durante la prova aumenterà progressivamente (il partecipante è avvertito del numero di parole che dovrà ricordare).

Lo sperimentatore deve presentare i set annotando le parole ricordate dal partecipante ed eventuali errori nel compito secondario (errori di battuta). Se il partecipante ricorda correttamente il primo set di un determinato livello di difficoltà (es. due parole da ricordare) verrà presentato il secondo set e in caso di ricordo corretto si passerà al primo set di livello superiore (es. 3 parole da ricordare), se invece il partecipante non ricorderà correttamente il primo o il secondo set verrà presentato anche il terzo.

Consegne per il partecipante: *"Ora le farò ascoltare delle liste di parole: il suo compito sarà quello di ricordare l'ultima parola di ogni lista. La fine della lista sarà segnalata da un suono. Di volta in volta le indicherò il numero di parole da ricordare. Inoltre ogni volta che sentirà il nome di un animale dovrà battere la mano sul tavolo.*

Riassumendo lei dovrà ricordare l'ultima parola della lista (quella seguita dal suono) e battere la mano ogni volta che sentirà il nome di un animale."

CANE	FRATE	LIBRO	FOTO	**FOGNA**
MUFFA	STRADA	BANANA	MARITO	***CAVALLO***

NATURA	*LEONE*	SPIGOLO	*RAGNO*	**CERA**
CORO	LUNA	*BALENA*	NUCA	**SONNO**

UVA	*ANATRA*	CAFFE'	PELLE	**ASILO**
TIGRE	LAMPADA	PANCA	*RICCIO*	***BUE***

3

LUPO	CENERE	DIVANO	ONDA	**TARGA**
GERANIO	PACCO	*CONIGLIO*	SEDIA	**CILIEGIA**
CASA	DIGA	*MUCCA*	CUBO	**GIACCA**

SABBIA	CAROTA	CRESTA	SPIEDO	**VAPORE**
POLLICE	*TROTA*	SETA	VASCA	**MELA**
SENO	*GALLO*	NEVE	ACQUA	**PRATO**

SFERA	*VERME*	NUBE	CITTA'	**BIRRA**
PERA	ROCCIA	VIALE	MANO	***DAINO***
CACCIA	GRANO	*VITELLO*	NANO	**ANGELO**

4

BRUCO	UOVO	MATITA	PIANTA	**TORTA**
MAMMA	GIGLIO	CAPRA	CUOIO	***SCIMMIA***
VENTO	NAVE	CRANIO	TRENO	**PADELLA**
SERPENTE	MOGLIE	TOSSE	NOCE	**SCUDO**

CANDELA	*FALCO*	AIUTO	ESTATE	**CHIESA**
PETTINE	FESTA	CIELO	ORMA	***GABBIANO***
ABETE	VASO	TIMONE	PUGNO	**TORRE**
CANGURO	PATATA	MUMMIA	LACCIO	**FUOCO**

PIATTO	CASSA	*APE*	TENDA	**STUFA**
MUSCHIO	QUADRO	SELLA	DONNA	**TASCA**
COLLO	DISCO	GUANTO	SACCO	***GRILLO***
MENTO	*CIGNO*	AGLIO	PUNTA	**COPPA**

5

NIDO	PALO	*RANA*	PADRE	**GABBIA**
CERVELLO	BOMBA	FIBBIA	*SQUALO*	**VETRO**
PIETRA	TAVOLO	*TORO*	PIPA	***TALPA***
BASTONE	PIANETA	SPECCHIO	ORZO	**TANA**
CUSCINO	TRAVE	*GIRAFFA*	LUCE	**GARZA**

SIEPE	ONDA	COCCO	*CAMMELLO*	**POLSO**

MOSCA	MONDO	PISCINA	OVATTA	**PALCO**
ANGUILLA	GUERRA	STALLA	RUGGINE	**FIGLIO**
ZINGARO	NODO	UFFICIO	TETTO	***BISCIA***
PALUDE	CINEMA	BEFANA	*MAIALE*	**FUNE**

SECONDA PARTE

Il compito del partecipante è quello di ricordare la **prima parola di ogni lista** (in grassetto) e battere la mano sul tavolo quando sente il *nome di un animale* (in italico). Il partecipante viene avvisato che il numero di parole da ricordare durante la prova aumenterà man a mano

Le consegne dello sperimentatore sono le stesse della parte precedente.

Consegne per il partecipante: *"Ora le farò ascoltare delle liste di parole: questa volta il suo compito sarà quello di ricordare la prima di ogni lista. La fine della lista sarà segnalata da un suono. Di volta in volta le indicherò il numero di parole da ricordare. Inoltre ogni volta che sentirà il nome di un animale dovrà battere la mano sul tavolo.*

Riassumendo lei dovrà ricordare la prima parola della lista e battere la mano ogni volta che sente il nome di un animale."

2

ERBA	*PINGUINO*	*MERLUZZO*	GINOCCHIO	ALUNNO
LINEA	CASTELLO	DENARO	SIGARO	*LUMACA*

SCORPIONE	PALAZZO	TOVAGLIA	VALIGIA	DOCCIA
GOBBA	PANNO	LIMONE	AULA	LATTE

DELFINO	SCARPA	CRISTALLO	RUOTA	PESCA
PALATO	*MANZO*	STELLA	*SALMONE*	FOGLIA

3

CORALLO	BRODO	FIAMMA	*AQUILA*	FIENO
PENTOLA	*TOPO*	SCIARPA	FIUME	*ZANZARA*
FOLLA	MANO	PAGINA	*COBRA*	LAGO

DRAGO	FARINA	VAGONE	FUCILE	EDERA
SAPONE	ALTARE	*INSETTO*	SORELLA	*ORSO*
VELLUTO	BURRO	GENTE	MINESTRA	STAMPA

SETE	*TACCHINO*	GIORNO	ORTICA	*ALCE*

FETTA	GIARDINO	TELA	ANELLO	PORTA
PIEDE	CARTA	*CINGHIALE*	IMBUTO	ALBERO

4

TAPPETO	VETTA	*MULO*	PRIGIONE	SCHIUMA
ANTENNA	GONNA	PALMA	ZAMPA	*VIPERA*
VINO	SCUOLA	ZUPPA	BIBITA	NASO
PEPE	TAVERNA	*ZEBRA*	TESTA	ELICA

TROMBA	PARETE	NEBBIA	*PECORA*	BUCCIA
VERME	UOMO	CACAO	PERLA	SERA
PIUMA	MIELE	NOTTE	PISTOLA	*CERVO*
BARBA	FANALE	ALLUCE	VELA	*PANTERA*

PICCHIO	GELATO	MOTORE	UNGHIA	TANA
CELLA	TERRA	*POLPO*	TASTO	CHIODO
DESERTO	*RENNA*	LANCIA	PEDALE	MENTA
PIOPPO	ZAINO	CERCHIO	FORNO	*PANDA*

5

CRANIO	*CICALA*	VOCE	GRUPPO	*FOCA*
PALA	*LEPRE*	MULINO	GHIACCIO	LANA
PAVONE	FANGO	SCHIAFFO	FARO	ORTO
TUTA	CUORE	RIVA	*VOLPE*	SUGO
PONTE	*CORVO*	GOLA	SPADA	CIRCO

ANATRA	SUORA	CESTO	NUVOLA	TRONO
PRUGNA	NONNO	*GUFO*	PIOGGIA	*GRANCHIO*
MADRE	PANE	MARE	*GATTO*	BOCCA
LAPIDE	COMETA	AEREO	ATLETA	CHIAVE
OCA	SPIGA	PENNA	SPILLO	GOCCIA

TERZA PARTE

Il compito del partecipante è quello di ricordare **l’ultima parola di ogni lista** (in grassetto) e battere la mano sul tavolo quando sente il *nome di un animale* (in italico). Il partecipante viene avvisato che il numero di parole da ricordare durante la prova aumenterà man a mano.

Le consegne dello sperimentatore sono le stesse della parte precedente.

Consegne per il partecipante: *“Ora le farò nuovamente ascoltare delle liste di parole: il suo compito sarà quello di ricordare l’ultima parola di ogni lista come ha fatto precedentemente. La fine della lista sarà segnalata da un suono. Di volta in volta le indicherò il numero di* *parole da ricordare. Inoltre ogni volta che sentirà il nome di un animale dovrà battere la mano sul tavolo.*

Riassumendo lei dovrà ricordare l'ultima parola della lista (quella seguita dal suono) e battere la mano ogni volta che sente il nome di un animale."

2

GUANCIA	*ASINO*	**COCCO**	CODA	***PULCE***
PAPERA	FRECCIA	*PICCIONE*	GOMITO	**SCALA**

ACETO	CIPRIA	SANGUE	STATUA	**SPUGNA**
FARFALLA	SCHIENA	MONETA	VASSOIO	**AGO**

RADIO	ARANCIA	PORTO	*ROSPO*	**CALZA**
PULEDRO	SOLE	DITO	BANCA	**MONTE**

3

PRUGNA	NONNO	*GUFO*	PIOGGIA	***GRANCHIO***
ORZO	PANE	MARE	*GATTO*	**COMETA**
LAPIDE	BOCCA	AEREO	ATLETA	**CHIAVE**

MAIALE	FUNE	PALUDE	CINEMA	**BEFANA**
OCA	SPIGA	PENNA	SPILLO	**GOCCIA**
ZINGARO	NODO	MONDO	TETTO	***BISCIA***

SPIAGGIA	BORSA	FRAGOLA	CAMINO	***CRICETO***
CIMICE	ROSA	PASTA	BARCA	**MAPPA**
MANICA	OCCHIO	*AGNELLO*	FIORE	**TOSSE**

4

RUGGINE	GOBBA	STUFA	*CAMMELLO*	**UFFICIO**
PISCINA	OVATTA	SIEPE	ORO	***MOSCA***
ANGUILLA	GUERRA	STALLA	POLSO	**NIDO**
PADRE	TAVOLO	*TORO*	OLIO	**PALO**

MADRE	BASTONE	*RANA*	SPECCHIO	**SEME**
CERVELLO	TIGLIO	FIBBIA	*SQUALO*	**BOMBA**
PIETRA	BARBA	TRAVE	PIPA	***TALPA***
CUSCINO	PIANETA	*GIRAFFA*	LUCE	**GARZA**

BUCA	*MERLO*	LEGNO	CATENA	**CONO**
LABBRO	COLTELLO	CORDA	CASSETTO	**GOMMA**
SEPPIA	PINO	MENTE	GIORNALE	**TARGA**
ASTA	CASCO	TROFEO	*CICOGNA*	**RETE**

5

FUCILE	*CICALA*	VOCE	GRUPPO	***FOCA***
RIVA	GOLA	TIMONE	TORRE	**PUGNO**
FANGO	CENERE	MUMMIA	*VOLPE*	**TUTA**
LEPRE	GHIACCIO	MULINO	CUBO	**SUGO**
PONTE	*CORVO*	CIRCO	SPADA	**LACCIO**

CILIEGIA	DIGA	SEDIA	ORTO	**AULA**
PALA	GERANIO	*CONIGLIO*	*MUCCA*	**LANA**
PAVONE	PANNO	SCHIAFFO	CASA	**FARO**
LUPO	CUORE	DIVANO	ORO	**CRANIO**
FIGLIO	LIMONE	GIACCA	PACCO	***AQUILA***

SECONDO INCONTRO

Il compito del partecipante è quello di ricordare la **parola seguita dal suono** (in grassetto), che può trovarsi in qualsiasi posizione all'interno della lista, e battere la mano sul tavolo quando sente il *nome di un animale* (in italico). Il partecipante viene avvisato che il numero di parole da ricordare andrà da 2 a 5 e che lo sperimentatore gli dirà quando il numero di parole da ricordare aumenterà.

Lo sperimentatore deve presentare i set annotando le parole ricordate dal partecipante ed eventuali errori di battuta.

Consegne per il partecipante: *"Ora le farò ascoltare delle liste di parole: il suo compito sarà quello di ricordare la parola seguita dal suono che potrà essere in qualsiasi posizione all'interno della lista. Per non creare confusione questa volta non ci sarà il suono ad indicare la fine della lista ma una pausa di silenzio di qualche secondo. Il numero delle liste varierà da un minimo di 2 ad massimo di 5 e di volta in volta le indicherò il numero di parole da ricordare. Come sempre dovrà battere la mano sul tavolo ogni volta che sentirà il nome di un animale.*
Riassumendo lei dovrà ricordare la parola seguita dal suono e battere la mano ogni volta che sente il nome di un animale."

2 COMPITO SECONDARIO POCO FREQUENTE

PAGINA	TUTA	**PIUMA**	TRAVE	PANE
ORSO	PIETRA	FARINA	**NODO**	MONDO

VIPERA	NOTTE	**ELICA**	PADRE	CRESTA
SIEPE	MARE	**ZUPPA**	BOMBA	NIDO

2 COMPITO SECONDARIO MOLTO FREQUENTE

GUFO	**PERLA**	SIGARO	MIELE	*LUMACA*
GUERRA	*MOSCA*	PIOGGIA	*TORO*	**MANO**

NONNO	*BRUCO*	**CUORE**	*LEPRE*	GHIACCIO
CERVO	ONDA	*TALPA*	**SPADA**	ORTO

3 COMPITO SECONDARIO POCO FREQUENTE

SABBIA	**CAROTA**	VOCE	SPIEDO	VAPORE
POLLICE	*TROTA*	DENARO	**NEBBIA**	MELA
SENO	BUCCIA	**UOVO**	*CORVO*	PRATO

CUOIO	*SCIMMIA*	PETTINE	**GRUPPO**	MAMMA
PALMA	**FESTA**	TOSSE	CIELO	*FOCA*
PANNO	STRADA	GENTE	MINESTRA	STANZA

3 COMPITO SECONDARIO MOLTO FREQUENTE

SAPONE	**ALTARE**	*RAGNO*	DIVANO	ORO
CONIGLIO	PACCO	SEDIA	**VETTA**	*CAVALLO*
NUCA	BURRO	*GALLO*	BANANA	**MARITO**

CANE	FRATE	LUNA	*BALENA*	FOGNA
MUFFA	*LEONE*	**UOMO**	SEME	**CENERE**
NATURA	SPIGOLO	*VERME*	**SONNO**	CERA

4 COMPITO SECONDARIO POCO FREQUENTE

AQUILA	**VETRO**	PALAZZO	ANTENNA	CRANIO
SETA	VASCA	**FOTO**	LINEA	FUCILE
DIGA	*LUPO*	TOVAGLIA	NAVE	**LUCE**
GERANIO	**CILIEGIA**	GONNA	ERBA	*FALCO*

CASA	*DRAGO*	NEVE	**CUBO**	GIACCA
CORO	**AULA**	*PECORA*	ACQUA	GIGLIO
TOPO	PALCO	**FOLLA**	BRODO	FIENO
BIBITA	TARGA	LACCIO	**VASO**	SCUDO

4 COMPITO SECONDARIO MOLTO FREQUENTE

PALO	*INSETTO*	**MATITA**	CAMINO	TORTA
TRENO	**FIBBIA**	*CAPRA*	ESTATE	*GABBIANO*
VENTO	SCUOLA	**FUOCO**	*PINGUINO*	PADELLA
SERPENTE	MOGLIE	*MUCCA*	**NOCE**	CORALLO

CANDELA	*ZEBRA*	**AUTO**	*MULO*	CHIESA
GARZA	*MERLUZZO*	**VINO**	ORMA	*COBRA*
ABETE	**PEPE**	PIPA	TORRE	**GABBIA**
CANGURO	PATATA	MUMMIA	*RANA*	NASO

5 COMPITO SECONDARIO POCO FREQUENTE

CERVELLO	**TAVOLO**	STALLA	*GRANCHIO*	BARBA
BASTONE	PIANETA	**SPECCHIO**	BOCCA	FIGLIO
TAPPETO	**UFFICIO**	*GIRAFFA*	GOBBA	TANA
ANGUILLA	CINEMA	STUFA	**TETTO**	POLSO
ZINGARO	CASTELLO	**MADRE**	PISCINA	*GUFO*

PALUDE	CUSCINO	**BEFANA**	SPILLO	*BISCIA*
SCORPIONE	TAVERNA	LIMONE	*CAMMELLO*	**LIBRO**
VAGONE	PARETE	**FIAMMA**	OVATTA	ALUNNO
VELLUTO	FANALE	*CICALA*	RUGGINE	**DOCCIA**
PENTOLA	ALLUCE	DONNA	**PUGNO**	LATTE

5 COMPITO SECONDARIO MOLTO FREQUENTE

CRANIO	*ORSO*	MULINO	*ZANZARA*	**LAGO**
PALA	**CESTO**	PISTOLA	VALIGIA	*ANATRA*
ZAMPA	EDERA	*CANE*	**RIVA**	SERA
PONTE	*TALPA*	**GOLA**	VELA	*ROSPO*
PAVONE	TROMBA	**FANGO**	*SQUALO*	LANA

PRUGNA	*RAGNO*	TESTA	**SUORA**	FARO
ORZO	*LUMACA*	AEREO	**FUNE**	*LEONE*
LAPIDE	**SPIGA**	TIMONE	*VOLPE*	CIRCO
OCA	*MAIALE*	PENNA	**NUVOLA**	TRONO
GOCCIA	*GATTO*	ATLETA	***CERVO***	*LUPO*

TERZO INCONTRO

Il compito del partecipante è quello di ricordare la alternativamente **l'ultima o la prima parola di ogni lista** (in grassetto) e battere la mano sul tavolo quando sente *il nome di un animale* (in italico). Il partecipante viene avvisato che il numero di parole da ricordare andrà da 2 a 5 e che lo sperimentatore gli dirà quando il numero di parole da ricordare aumenterà e se deve ricordare le prime o le ultime parole delle liste.

Lo sperimentatore deve presentare i set annotando le parole ricordate dal partecipante ed eventuali errori di battuta.

Consegne per il partecipante: *"Le farò ascoltare le liste di parole: il suo compito sarà quello di ricordare alternativamente l'ultima o la prima parola di ogni lista. La fine della lista sarà*

segnalata da un suono. Di volta in volta le indicherò la posizione della parola da ricordare. Il numero di liste varierà da un minimo di 2 ad un massimo di 5. Come sempre ogni volta che sentirà il nome di un animale dovrà battere la mano sul tavolo.
Riassumendo lei dovrà ricordare la prima o l'ultima parola di ogni lista e battere la mano ogni volta che sente il nome di un animale.
Ora le farò ascoltare due liste delle quali lei dovrà ricordare l'ultima parola di ogni lista."

2 RICORDA ULTIMA

VELLUTO	*GUFO*	PALO	CUBO	**PRATO**
SABBIA	DIGA	CRESTA	SEDIA	**GOCCIA**

2 RICORDA PRIMA

SERPENTE	NAVE	AUTO	ESTATE	*SCIMMIA*
CANDELA	MOGLIE	VETTA	*BRUCO*	SCUDO

2 RICORDA ULTIMA

CORO	*GRANCHIO*	CRANIO	FIENO	**CERA**
DIVANO	ORO	SPILLO	VASCA	**SONNO**

2 RICORDA PRIMA

CICALA	STRADA	MUFFA	NUCA	FOGNA
SENO	*LEONE*	FOTO	NATURA	*CAVALLO*

3 RICORDA ULTIMA

CINEMA	VASO	ALLUCE	LACCIO	***GABBIANO***
BUCCIA	*CORVO*	MULINO	PIOGGIA	**TRONO**
CANE	PARETE	MELA	PIUMA	**CUOIO**

3 RICORDA PRIMA

MULO	*TROTA*	MATITA	PRIGIONE	PIETRA
TRENO	UOVO	*CAPRA*	OVATTA	PALMA
BRODO	TORTA	RIVA	*AQUILA*	GIACCA

3 RICORDA ULTIMA

CUSCINO	BOMBA	PERLA	LUCE	***ROSPO***
SIEPE	TAVOLO	*TORO*	BANANA	**PIPA**
MOSCA	PIANETA	SPECCHIO	GRUPPO	**FIGLIO**

3 RICORDA PRIMA

SPIGOLO	GALLO	SETA	NOCE	CERVELLO
CASA	FIAMMA	*MUCCA*	FUOCO	CRANIO
BALENA	CIELO	POLLICE	FIBBIA	CAROTA

4 RICORDA ULTIMA

ZUPPA	FUNE	DONNA	*RAGNO*	**RUGGINE**
ORZO	PISTOLA	MARE	SUORA	**NOTTE**
ANGUILLA	ONDA	PISCINA	SIGARO	***ANATRA***
GOBBA	MANO	GABBIA	TAPPETO	**LAGO**

4 RICORDA PRIMA

VINO	ANTENNA	*ZEBRA*	*GATTO*	SERA
NASO	MIELE	NEBBIA	ORTO	*CERVO*
PEPE	FANALE	SEME	*VOLPE*	FARO
TROMBA	*LEPRE*	BURRO	SPADA	SUGO

4 RICORDA ULTIMA

PADELLA	COMETA	LIBRO	*PECORA*	**ELICA**
PAVONE	TAVERNA	LUNA	MINESTRA	***FOCA***
PONTE	SPIGA	UOMO	*TOPO*	**PATATA**
LAPIDE	MUMMIA	PENNA	*CONIGLIO*	**STUFA**

4 RICORDA PRIMA

TALPA	CORALLO	UFFICIO	ZINGARO	*MAIALE*
STALLA	PRUGNA	VETRO	*CANGURO*	PENTOLA
CESTO	ACQUA	*LUPO*	NONNO	LATTE
CAMMELLO	CUORE	ATLETA	VOCE	PACCO

5 RICORDA ULTIMA

DRAGO	FRATE	*INSETTO*	ZAMPA	**SCHIUMA**
SAPONE	GONNA	GENTE	TESTA	***VIPERA***
GUERRA	VAPORE	MONDO	TUTA	**PALCO**
BARBA	BIBITA	SCHIAFFO	*COBRA*	**LIMONE**
SCORPIONE	PANNO	PIUME	CIRCO	**BOCCA**

5 RICORDA PRIMA

VERME	FANGO	*PINGUINO*	NUVOLA	POLSO
ABETE	*FALCO*	TOSSE	VELA	CHIESA
PALA	DENARO	PANE	GINOCCHIO	STANZA
ORMA	GHIACCIO	*OCA*	CHIAVE	AEREO
GERANIO	*RANA*	GOLA	FESTA	SCUOLA

5 RICORDA ULTIMA

VENTO	GIGLIO	NEVE	TORRE	**SPIEDO**
NIDO	CAMINO	TIMONE	*SQUALO*	**PUGNO**
BASTONE	LANA	CENERE	MARITO	**PAGINA**
PALUDE	TRAVE	*GIRAFFA*	TETTO	**MAMMA**
GARZA	TOVAGLIA	BEFANA	PETTINE	***LUMACA***

5 RICORDA PRIMA

PADRE	CILIEGIA	NODO	TANA	*BISCIA*
ERBA	CASTELLO	*MERLUZZO*	VALIGIA	ALUNNO
LINEA	PALAZZO	MADRE	VAGONE	DOCCIA
ORSO	FARINA	TARGA	FUCILE	EDERA
FOLLA	*ZANZARA*	AULA	SORELLA	ALTARE

B. VISUO-SPATIAL WORKING MEMORY TRAINING

This training procedure was used in study 2 and 3. Instead of dots were used neutral (study 2) and positive (study 3) emotional stimuli. The spatial locations were the same hereafter presented. Both neutral and positive stimuli, used in these activities, were then presented.

Primo incontro

Consegne per il partecipante: *"Questo primo incontro si divide in tre parti durante le quali si eserciterà con delle matrici. Di volta in volta le specificherò quale sarà il suo compito."*

PRIMA PARTE

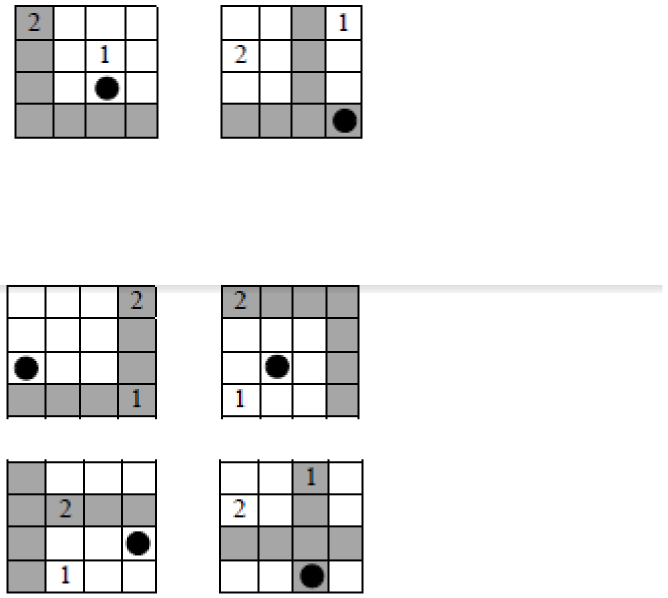
Il compito del partecipante è quello di ricordare **l'ultima posizione del pallino in ogni matrice** (che corrisponde alla terza posizione ed è indicata con un pallino) e battere la mano sul tavolo quando il pallino cade in una cella grigia. Il partecipante viene avvisato che il numero di posizioni da ricordare durante la prova aumenterà progressivamente.

Lo sperimentatore deve presentare i set annotando le posizioni ricordate dal partecipante ed eventuali errori nel compito secondario (errori di battuta). Se il partecipante ricorda correttamente il primo set di un determinato livello di difficoltà (es. due posizioni da ricordare) verrà presentato il secondo set ed in caso di ricordo corretto si passerà al primo set di livello superiore (es. 3 posizioni da ricordare), se invece il partecipante non ricorderà correttamente il primo o il secondo set verrà presentato anche il terzo.

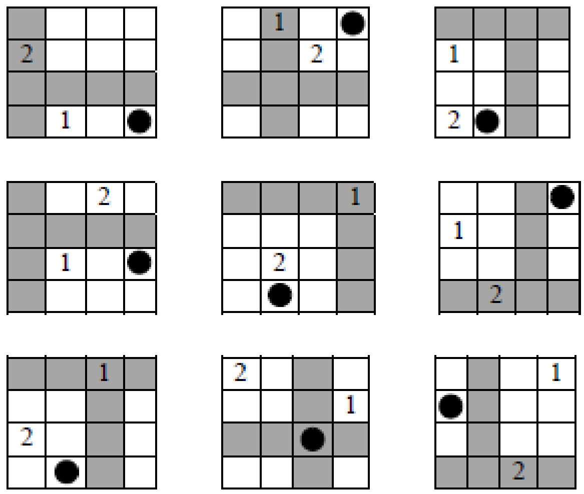
Consegne per il partecipante: *"Ora le farò vedere al computer una serie di matrici all'interno delle quali ci sarà un pallino nero che si sposterà per 3 volte: il suo compito sarà quello di ricordare la posizione finale del pallino all'interno di ogni matrice. Alcune celle della matrice saranno di colore grigio: se il pallino cade all'interno di una di queste celle lei dovrà battere la mano sul tavolo. Il passaggio tra una matrice e la successiva sarà segnalato da una schermata grigia. Alla fine della presentazione apparirà sullo schermo una matrice bianca nella quale lei dovrà indicare l'ultima posizione del pallino in ogni matrice. Di volta in volta le indicherò il numero di posizioni da ricordare.*

Riassumendo lei dovrà ricordare l'ultima posizione del pallino per ogni matrice e battere la mano ogni volta che il pallino cadrà all'interno di una cella grigia."

SET DA 2



SET DA 3



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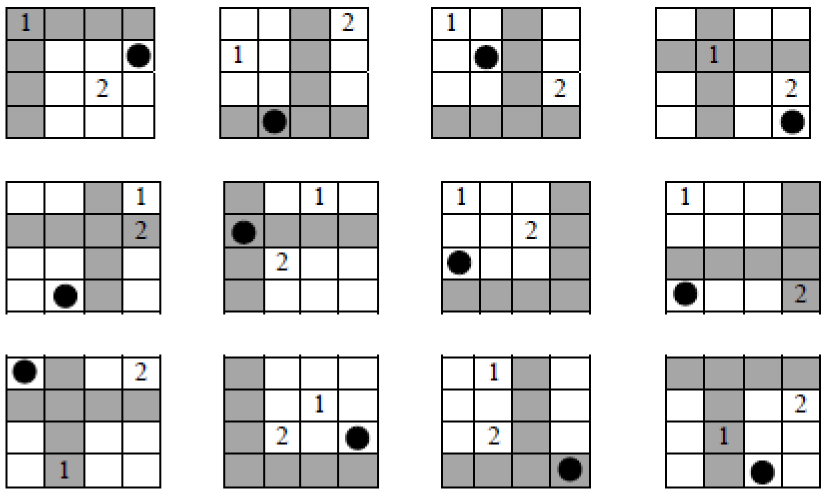

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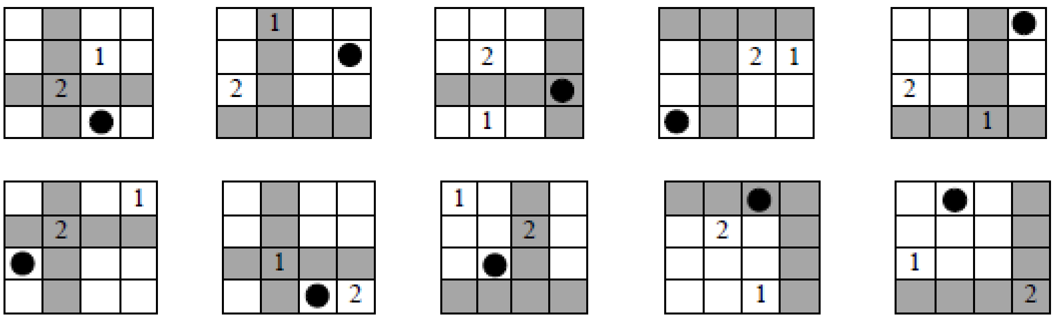


SECONDA PARTE

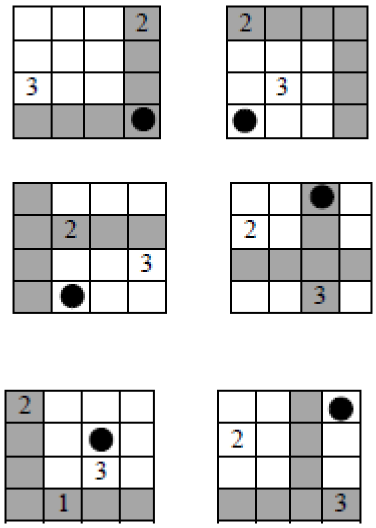
Il compito del partecipante è quello di ricordare la **prima posizione di ogni matrice** (indicata con un pallino) e battere la mano sul tavolo quando il pallino cade su una cella grigia. Il partecipante viene avvisato che il numero di posizioni da ricordare durante la prova aumenterà man a mano.

Le consegne per lo sperimentatore sono le stesse della parte precedente.

Consegne per il partecipante: *"Le farò nuovamente vedere una serie di matrici all'interno delle quali ci sarà un pallino nero: questa volta il suo compito sarà quello di ricordare la prima posizione del pallino all'interno matrice. Alcune celle della matrice saranno di colore grigio: se il pallino cadrà all'interno di una di queste celle dovrà battere la mano sul tavolo. La fine di ogni serie sarà segnalata da una schermata grigia. Alla fine della presentazione apparirà sullo schermo* *una matrice bianca nella quale lei dovrà indicare la prima posizione del pallino in ogni matrice. Di volta in volta le indicherò il numero di posizioni da ricordare.*

Riassumendo lei dovrà ricordare la prima posizione del pallino in ogni matrice e battere la mano sul tavolo ogni volta che il pallino cadrà all'interno di una cella grigia."

SET DA 2



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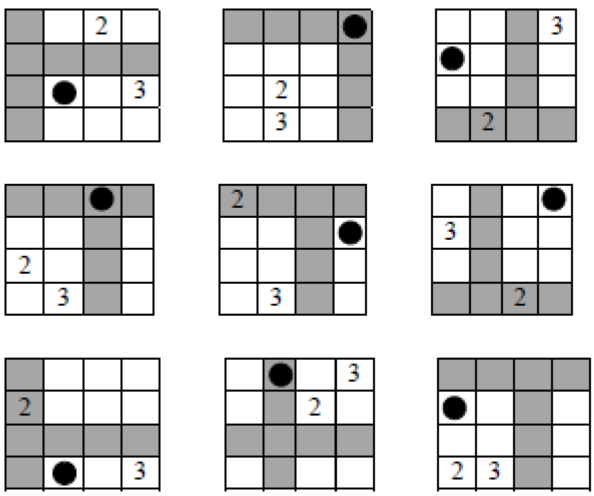

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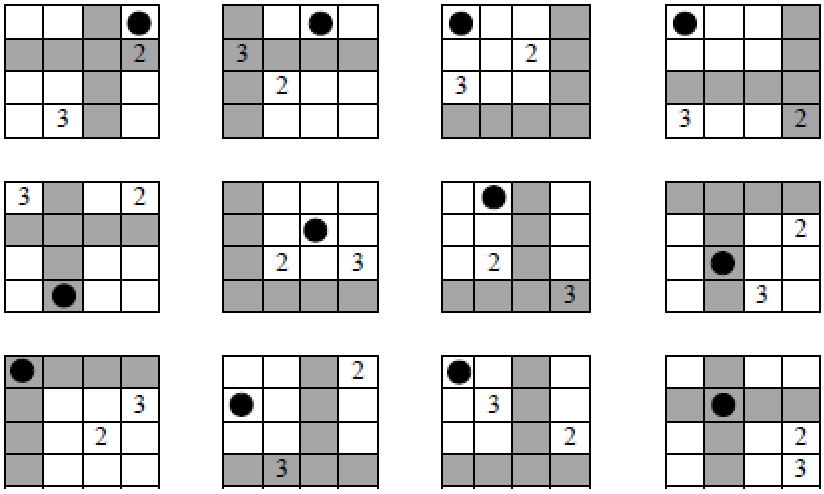

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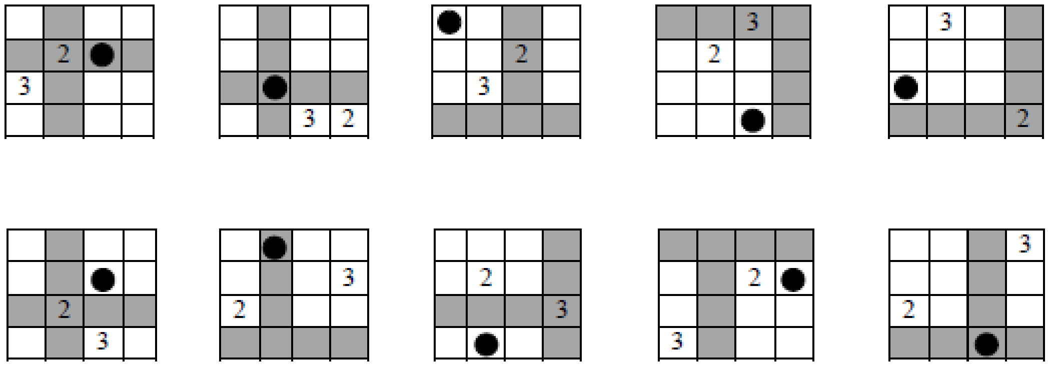


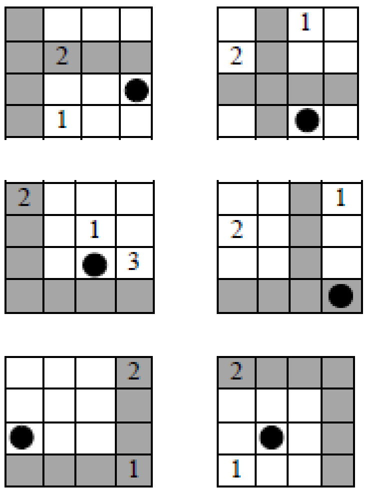
TERZA PARTE

Il compito del partecipante è quello di ricordare **l'ultima posizione del pallino in ogni matrice** (che corrisponde alla terza posizione ed è indicata con un pallino) e battere la mano sul tavolo quando il pallino cade in una cella grigia. Il partecipante viene avvisato che il numero di posizioni da ricordare durante la prova aumenterà progressivamente.

Le consegne per lo sperimentatore sono le stesse della parte precedente.

Consegne per il partecipante: *"Ora vedrà una serie di matrici all'interno delle quali ci sarà un pallino nero che si sposterà per 3 volte: il suo compito sarà quello di ricordare la posizione finale del pallino all'interno di ogni matrice. Alcune celle della matrice saranno di colore grigio: se il pallino cade all'interno di una di queste celle lei dovrà battere la mano sul tavolo. Il passaggio tra una matrice e la successiva sarà segnalato da una schermata grigia. Alla fine della presentazione* *apparirà sullo schermo una matrice bianca nella quale lei dovrà indicare l'ultima posizione del pallino in ogni matrice. Di volta in volta le indicherò il numero di posizioni da ricordare. Riassumendo lei dovrà ricordare l'ultima posizione del pallino per ogni matrice e battere la mano ogni volta che il pallino cadrà all'interno di una cella grigia."*

SET DA 2



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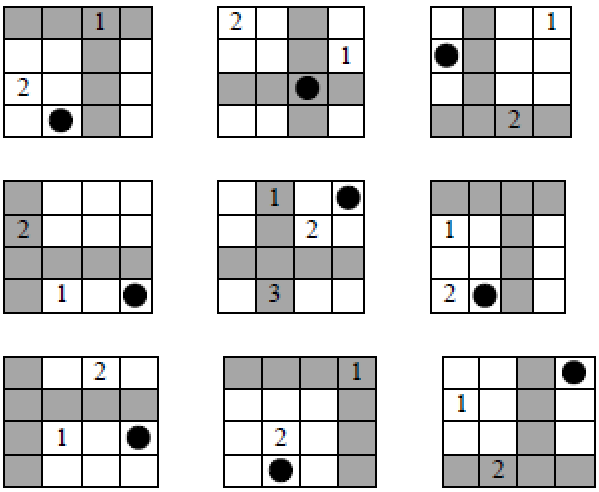

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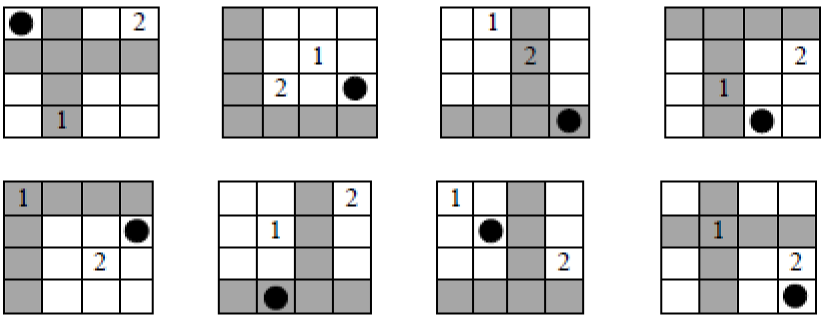

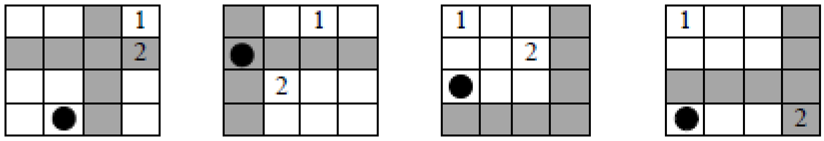

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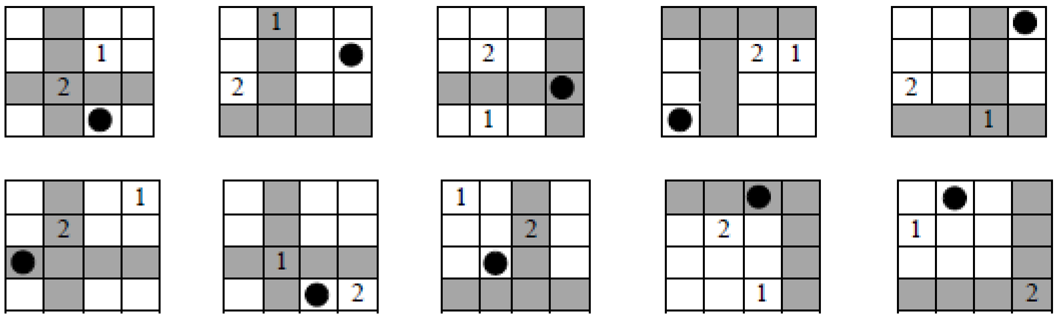


Secondo incontro

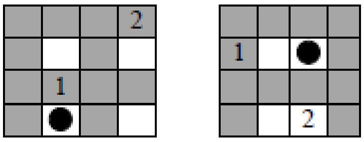
Il compito del partecipante è quello di ricordare **l'ultima posizione del pallino in ogni matrice** (che corrisponde alla terza posizione ed è indicata con un pallino) e battere la mano sul tavolo quando il pallino cade in una cella grigia. Il partecipante viene avvisato che il numero di posizioni da ricordare andrà da 2 a 5 e che lo sperimentatore gli dirà quando il numero di parole aumenterà.

Lo sperimentatore deve presentare i set annotando le posizioni ricordate dal partecipante ed eventuali errori di battuta.

Consegne per il partecipante: *"Ora vedrà una serie di matrici all'interno delle quali ci sarà un pallino nero che si sposterà per 3 volte: il suo compito sarà quello di ricordare l'ultima posizione del pallino all'interno di ogni matrice. Tuttavia a differenza della volta scorsa, in alcune matrici potrà esserci un maggior numero di celle grigie. In ogni caso il suo compito sarà quello di battere la mano sul tavolo ogni volta che vedrà il pallino all'interno di una cella grigia. Il passaggio da una matrice all'altra sarà segnalato da una schermata grigia. Il numero di posizioni da ricordare varierà da un minimo di due ad un massimo di 5, di volta in volta le indicherò il numero di posizioni da ricordare.*

Alla fine della presentazione apparirà sullo schermo una matrice bianca nella quale lei dovrà indicare l'ultima posizione del pallino all'interno di ogni matrice. Riassumendo lei dovrà ricordare *l'ultima posizione del pallino in ogni matrice e battere la mano ogni volta che il pallino sarà presentato all'interno di una cella grigia."*

SET DA 2 - COMPITO SECONDARIO MOLTO FREQUENTE



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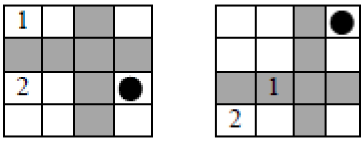

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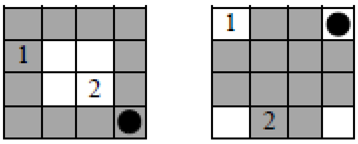

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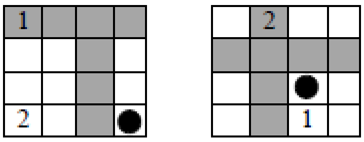

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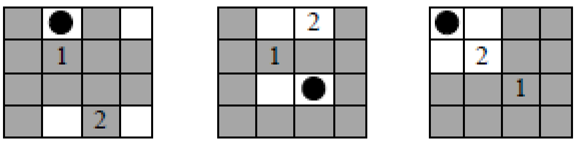

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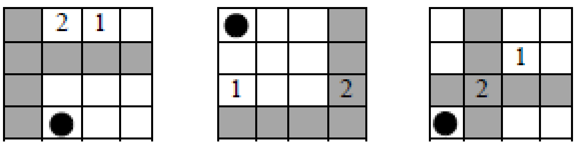

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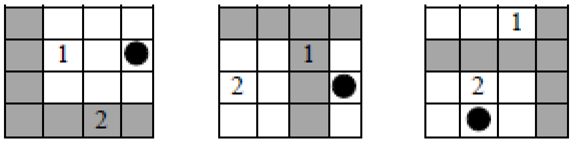
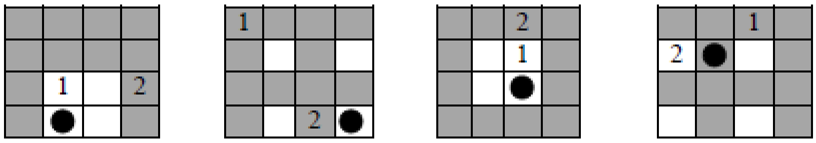


SET DA 4 - COMPITO SECONDARIO MOLTO FREQUENTE



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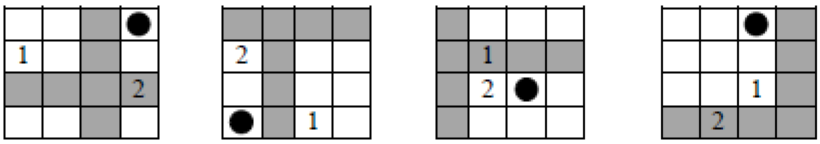

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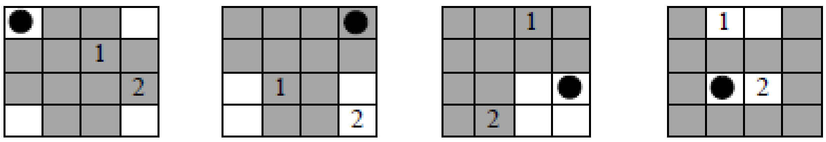

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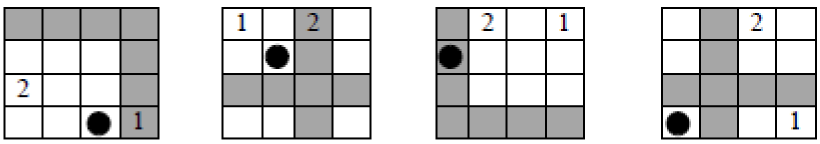

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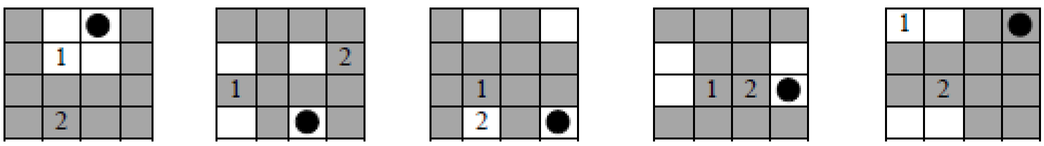
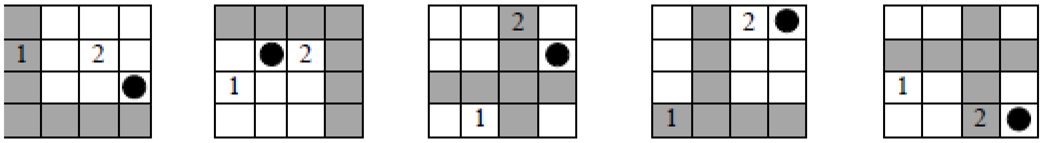
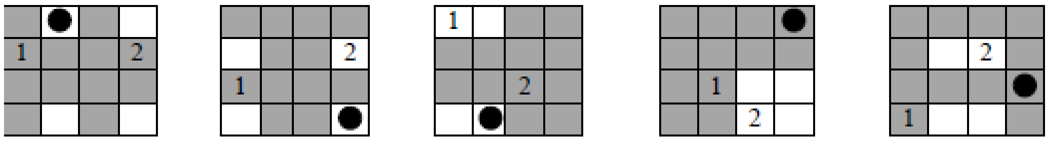


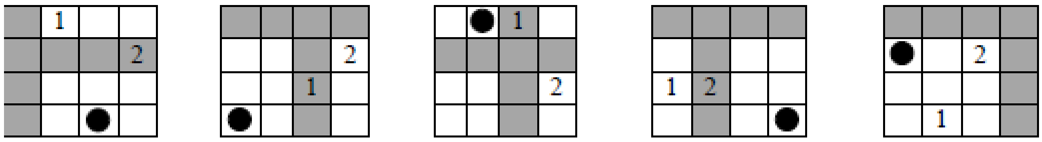
SET DA 5 - COMPITO SECONDARIO POCO FREQUENTE



SET DA 5 - COMPITO SECONDARIO MOLTO FREQUENTE



SET DA 5 - COMPITO SECONDARIO POCO FREQUENTE



Terzo incontro

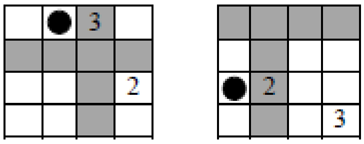
Il compito del partecipante è quello di ricordare la alternativamente l'ultima o la prima posizione del pallino all'interno di ciascuna matrice (la prima o la terza posizione) e battere la mano sul tavolo quando il pallino cade su una cella grigia. Il partecipante viene avvisato che il numero di posizioni da ricordare andrà da 2 a 5 e che lo sperimentatore gli dirà quando il numero di posizioni da ricordare aumenterà e se deve ricordare le prime o le ultime posizioni di ciascuna matrice.

Lo sperimentatore deve presentare i set annotando le posizioni ricordate dal partecipante ed eventuali errori di battuta.

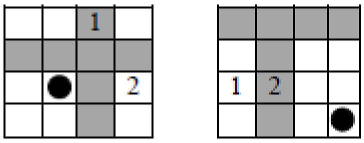
Consegne per il partecipante: "Anche questa volta vedrà una serie di matrici all'interno delle quali ci sarà un pallino nero che si sposterà per 3 volte: il suo compito sarà quello di ricordare alternativamente la prima o l'ultima posizione del pallino. Le indicherò di volta in volta quale posizione dovrà tenere a mente. Il passaggio da una matrice all'altra sarà segnalato da una schermata grigia. Il numero di posizioni da ricordare varierà da un minimo di due ad un massimo di 5, di volta in volta le indicherò il numero di posizioni da ricordare. Alcune celle della matrice saranno di colore grigio: se il pallino è all'interno di una di queste celle lei dovrà battere la mano sul tavolo. Alla fine della presentazione apparirà sullo schermo una matrice bianca nella quale lei dovrà indicare la prima o l'ultima posizione del pallino di ciascuna matrice.

Riassumendo lei dovrà ricordare o la prima o l’ultima posizione del pallino in ogni matrice e battere la mano ogni volta che il pallino sarà presentato all’interno di una cella grigia.”

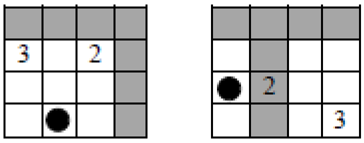
SET DA 2 - RICORDA PRIMA



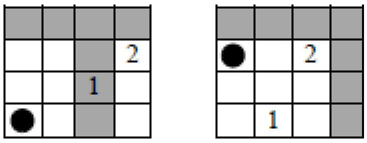
SET DA 2 - RICORDA L'ULTIMA



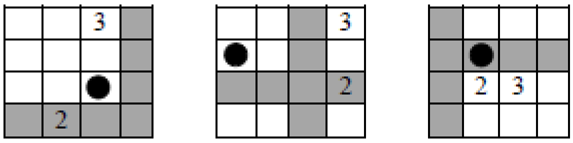
SET DA 2 - RICORDA PRIMA



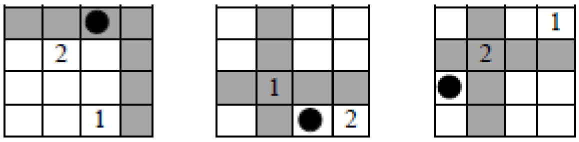
SET DA 2 - RICORDA L'ULTIMA



SET DA 3 - RICORDA PRIMA



SET DA 3 - RICORDA L'ULTIMA



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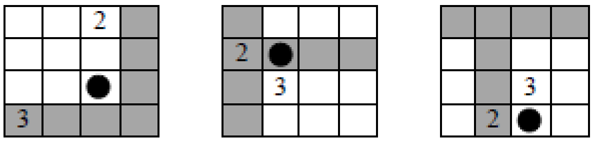
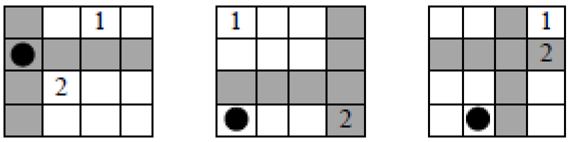
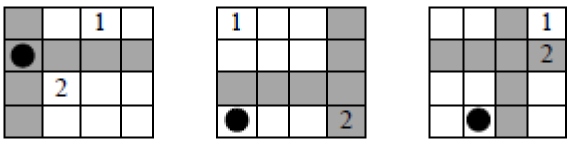


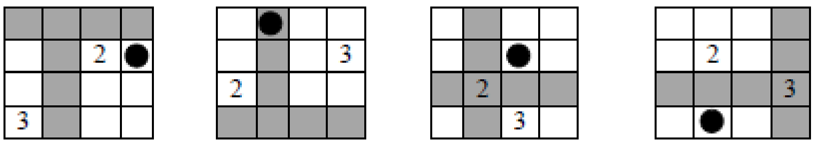
SET DA 3 - RICORDA L'ULTIMA



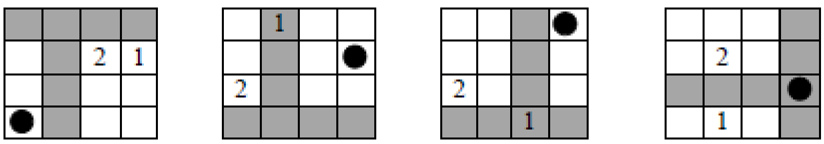
SET DA 3 - RICORDA L'ULTIMA



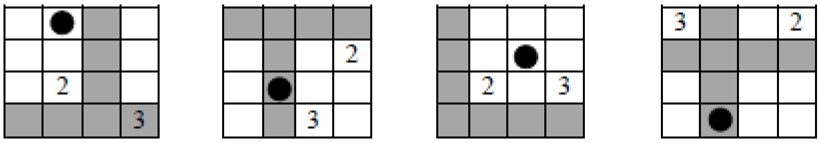
SET DA 4 - RICORDA PRIMA



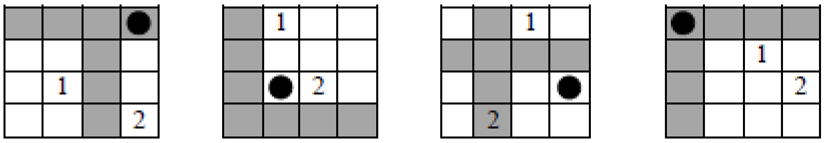
SET DA 4 - RICORDA L'ULTIMA



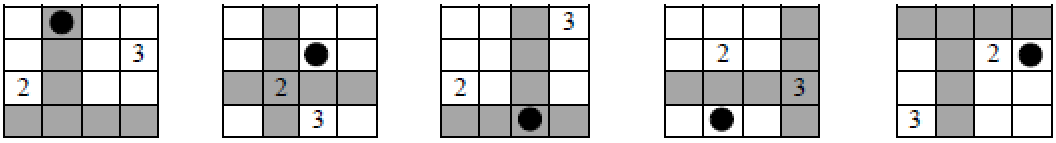
SET DA 4 - RICORDA PRIMA



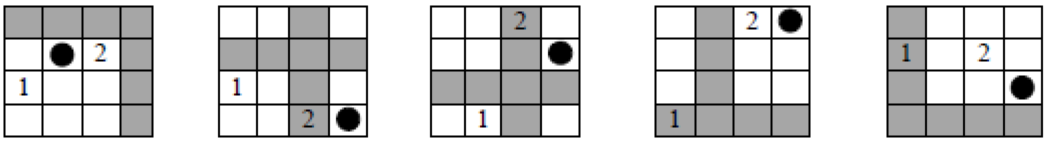
SET DA 4 - RICORDA L'ULTIMA



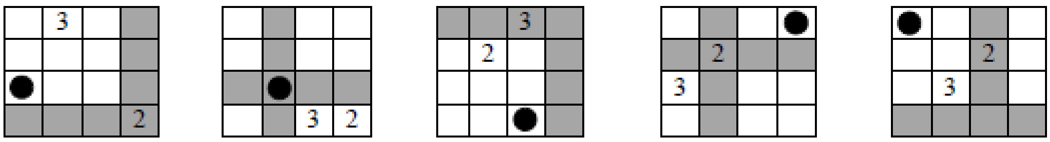
SET DA 5 - RICORDA PRIMA



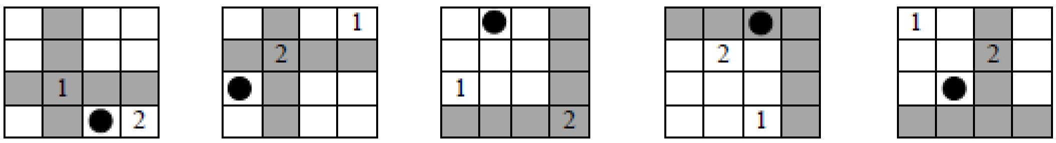
SET DA 5 - RICORDA L'ULTIMA



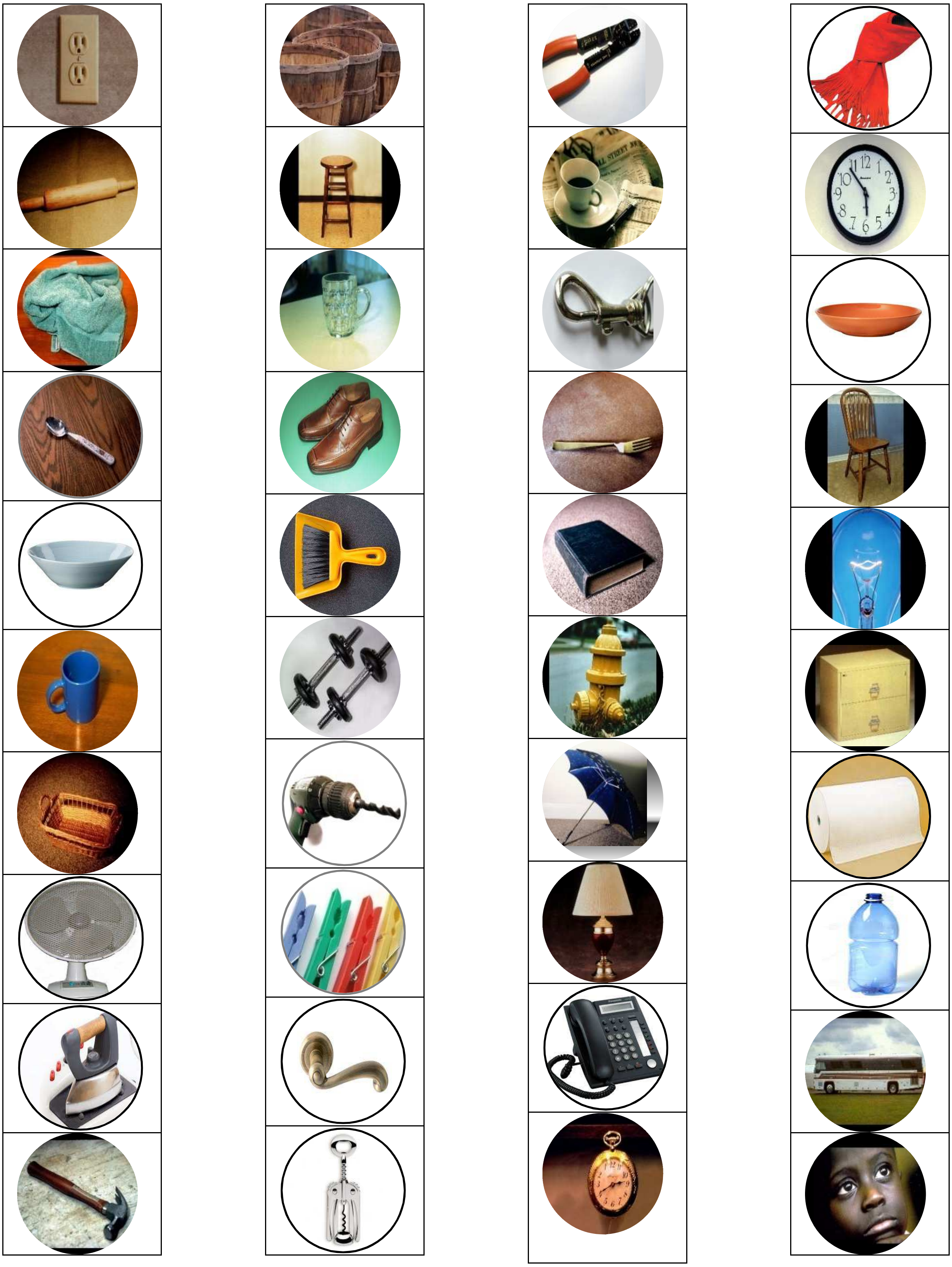
SET DA 5 - RICORDA PRIMA



SET DA 5 - RICORDA L'ULTIMA

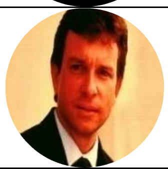


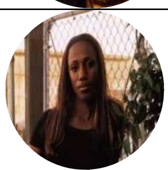
C. NEUTRAL AND POSITIVE STIMULI USED IN CRITERION TASK (STUDY 2 AND 3)

















100
100 EURO





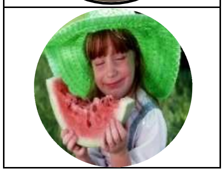













D. EPT TASK

EVERYDAY PROBLEMS TEST

FORMA A

ISTRUZIONI PER L'EVERYDAY PROBLEMS TEST

L'obiettivo di questa prova è quello di vedere quanto adeguatamente è in grado di leggere e comprendere informazioni che generalmente adulti e anziani incontrano nella quotidianità.

Queste informazioni sono relative a diverse tipologie di materiale, ad esempio foglietti illustrativi di farmaci, bollette telefoniche, ricette di cucina etc.

Nella parte superiore di ogni pagina troverà una tipologia di materiale (istruzioni, etichette etc); nella parte inferiore invece saranno presenti due quesiti relativi a questo materiale. Quello che deve fare è leggere i quesiti e farsi un'idea del tipo di informazione che dovrebbe reperire nel materiale, ricercare queste informazioni nel materiale e scrivere le risposte nelle apposite righe poste sotto ogni quesito.

Le riposte non devono essere scritte estesamente, è possibile rispondere con poche parole. Non ci sono penalizzazioni, quindi cerchi di rispondere a tutti i quesiti anche se non è sicuro. Non si focalizzi per troppo tempo su ogni quesito, le domande sono in tutto 14.

Giri la pagina e vediamo insieme un esempio.

Nella parte superiore della pagina è presente la ricetta per preparare i biscotti al latte. Leggi il primo quesito "Quale ingrediente è lavorato con lo zucchero?" e cerca la risposta nella ricetta.

BISCOTTI AL LATTE

Dosi consigliate per 12 biscotti.

500 gr. di farina 00	1 cucchiaino di miele
100 gr. di burro	1 pizzico di sale
1 bicchiere di latte	1 bustina di lievito

Amalgamare il burro con lo zucchero. Setacciare la farina. Lavorare il composto aggiungendo lentamente il latte. Infine aggiungere sale, miele e lievito. Lavorare fino ad ottenere un impasto liscio ed omogeneo. Stendere l'impasto su un tavolo ottenendo uno spessore di 2mm. Con le mani formare dei piccoli rettangoli. Cuocere in forno a 180° per 10-15 minuti.

A. Quale ingrediente è lavorato con lo zucchero?

__________________________________**BURRO**____________________________________

____

La risposta corretta alla domanda A è "burro". Quindi la parola "burro" è stata scritta sull'apposita linea.

B. Se volesse preparare solo 6 biscotti quanta farina dovrebbe utilizzare

____

____

La risposta corretta alla domanda B è "250 gr" in quanto la preparazione di 6 biscotti richiede la metà delle dosi indicate.

INIZIO DELLA PROVA

Tabella Nutrizionale Cereali

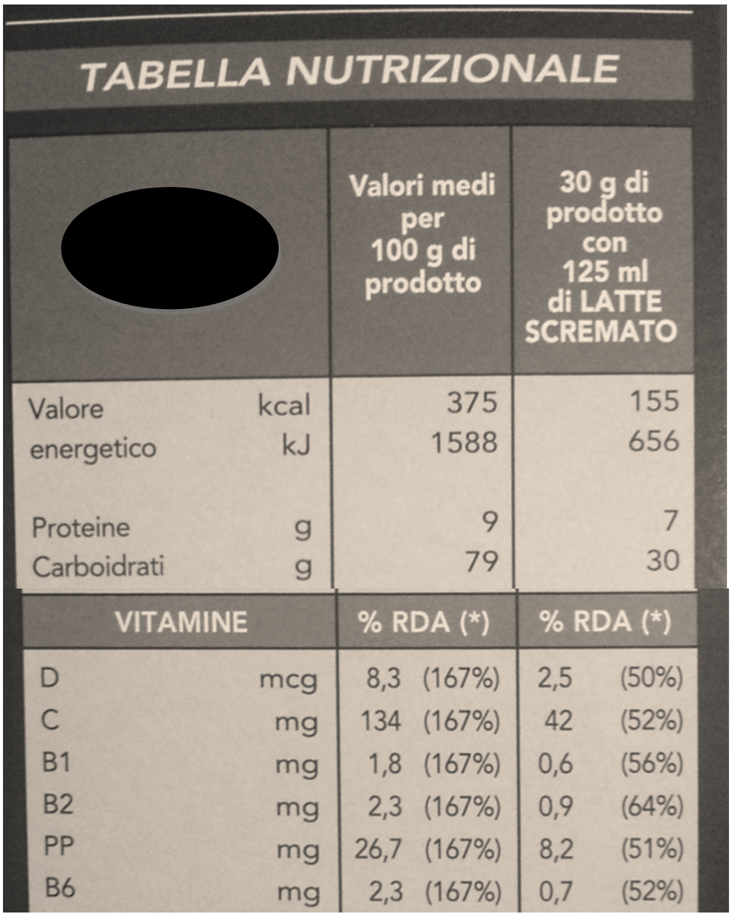


TABELLA NUTRIZIONALE

[redacted]		Valori medi per 100 g di prodotto	30 g di prodotto con 125 ml di LATTE SCREMATO
Valore energetico	kcal	375	155
	kJ	1588	656
Proteine	g	9	7
Carboidrati	g	79	30
VITAMINE		**% RDA (*)**	**% RDA (*)**
D	mcg	8,3 (167%)	2,5 (50%)
C	mg	134 (167%)	42 (52%)
B1	mg	1,8 (167%)	0,6 (56%)
B2	mg	2,3 (167%)	0,9 (64%)
PP	mg	26,7 (167%)	8,2 (51%)
B6	mg	2,3 (167%)	0,7 (52%)

1. Quale percentuale di Vitamina B2 è contenuta in una porzione di cereali con 125 ml di latte scremato?

---

2. Qual è il valore energetico (Kcal) di una porzione di cento grammi di prodotto?

Scheda Anamnestica

(Non Compilare)

HA O HA MAI AVUTO:	SI	NO
a. Disturbi neurologici		
b. Malattie del sistema immunitario		
c. Malattie del fegato (epatite, mononucleosi etc.)		
d. Ipertensione		
e. Problemi cardiaci		
f. Trasfusioni		
g. Emorragie		
h. Ipo/iperglicemia		
i. Problemi endocrinologici (ipo/ipertiroidismo, malattie surrenaliche etc.)		
l. Problemi gastrointestinali		
m. Problemi psicologici (ansia, depressione etc.)		
n. Problemi respiratori (asma, enfisema etc.)		
o. Allergie (se sì, quali?)		
p. Interventi chirurgici (se sì quali?)		
q. E' in stato di gravidanza?		

3. Se si sentisse spesso stanco e triste, su quale riga della scheda dovrebbe indicarlo?
   ____

4. Se avesse frequentemente bruciore di stomaco dopo i pasti, su quale riga della scheda dovrebbe indicarlo?

____

Dettaglio Bolletta Telefonica

CONTO	Numero Fattura	Data emissione fattura	Periodo di fatturazione
TELEFONICO	9703504970	07/03/2010	01/01/2010-28/02/2012

Il dettaglio della bolletta è fornito dal Gestore Telefonico Infotel. In esso troverà il costo delle chiamate locali e nazionali da lei effettuate. Qualora volesse usufruire della connessione ad Internet può disporre dell'abbonamento Smart-Tel.

Data	Ora	Minuti	Numero	Localita'	Costo	Tipologia di chiamata
13/01/2010	18:12	0:12:35	0455896XXX	Verona	0.20	Nazionale
13/01/2010	20:56	0:02:23	049774XXX	Padova	0.10	Locale
15/01/2010	22:19	0:14:14	0456290XXX	Verona	0.20	Nazionale
17/01/2010	18:24	0:29:00	0455896XXX	Verona	0.20	Nazionale
01/02/2010	18:37	0:12:02	0455525XXX	Verona	0.20	Nazionale

5. A quale numero telefonico è stato fatto il maggior numero di chiamate?

____

6. Qual è il nome della compagnia telefonica che fornisce il servizio telefonico locale?

____

Come diventare membro dell'Associazione Nazionale Terza Età Attiva (ANTEAS)

(Non Compilare)

INVIA OGGI IL TUO MODULO

L'ISCRIZIONE AD ANTEAS COSTA SOLO 25€

☐ 1 Anno a 25€ ☐ 3 Anni a 65€ ☐ 10 anni a 200€

Nome ____

Cognome ____

Indirizzo ____________________________ Provincia _______ CAP _______

Data di nascita ______/______/______

☐ Lavoro full-time ☐ Lavoro part-time ☐ Sono in pensione

Nome del Coniuge ____

Data di nascita del Coniuge ______/______/______

- Assegno o vaglia da intestare a NRP (non spedire denaro contante).
- Presentatemi un conto finale.
- Se hai lavorato nel campo dell'istruzione, segna qui per usufruire dell' agevolazione prevista dalla NRP.

Le quote di iscrizione non sono scaricabili dalle tasse. Le tasse di iscrizione annuali includono l'abbonamento di 5€ al bollettino dell'associazione. L'iscrizione include eventualmente il proprio coniuge. Il kit riservato ai membri dell'associazione sarà spedito entro 6 settimane dall'iscrizione.

7. Se decidesse di pagare una quota di iscrizione per il periodo 2013-2023, quanto dovrebbe versare?

____

8. Se fosse sposato e decidesse di aderire all'Associazione ANTEAS, quanto dovrebbe pagare il coniuge?

____

Istruzioni d'uso Lavatrice: Anomalie e Rimedi

Se la lavatrice non funziona, prima di telefonare all'assistenza, verificare se è possibile risolvere il problema aiutandosi con il seguente elenco:

Problema	Possibile causa/soluzione
Il ciclo di lavaggio non inizia	. L'oblò non è ben chiuso; . Il tasto ON/OFF non è stato Premuto; . Il rubinetto dell'acqua non è stato aperto; . È stato impostato l'avio ritardato.
La lavatrice non carica acqua	. Il tubo di alimentazione dell'acqua non è stato aperto; . Non c'è sufficiente pressione; . Il tasto AVVIO/PAUSA non è stato premuto.
La lavatrice perde acqua	. Il tubo di alimentazione dell'acqua non è collegato correttamente; . Il cassetto dei detersivi è intasato; . Il tubo di scarico non è collegato correttamente.

9. Se l'oblò non è ben chiuso che problema potrebbe presentare la lavatrice?

____

10. La lavatrice perde acqua; sia il tubo di alimentazione dell'acqua che il tubo di scarico sono collegati correttamente. Qual è la possibile causa del problema?

____

Norme del Codice della Strada

Art. 191 del Codice della Strada –

Comportamento dei conducenti nei confronti dei pedoni

Quando il traffico non è regolato da agenti o da semafori, i conducenti devono seguire delle precise regole:

1. I conducenti devono dare precedenza ai pedoni nelle seguenti situazioni:
   - Quando i pedoni si accingono ad attraversare o stanno transitando sugli attraversamenti pedonali.
   - Quando i conducenti, svoltando, si immettono in una strada al cui ingresso è presente un attraversamento pedonale e ai pedoni sia consentito il passaggio.
   - Quando su strade sprovviste di attraversamenti pedonali il pedone ha già iniziato l'attraversamento impegnando la carreggiata.
   - Quando una persona invalida con ridotte capacità motorie, o su carrozzella, o munita di bastone bianco, o accompagnata da cane guida, attraversa la carreggiata o si accinge ad attraversarla.
2. I conducenti devono comunque prevenire (*ad esempiomediante arresto del veicolo o segnalazione acustica etc*) situazioni di pericolo che possano derivare da comportamenti scorretti o maldestri di bambini o di anziani, quando sia ragionevole prevederli in relazione alla situazione di fatto.
3. Chiunque viola le disposizioni del presente articolo è soggetto alla sanzione amministrativa del pagamento di una somma da euro 150,00 a euro 599,00.

11. Se il conducente sta transitando in prossimità di una scuola e un bambino attraversa improvvisamente la strada, cosa deve fare?

---

12. Chi ha la precedenza se un ragazzo sui pattini ha iniziato ad attraversare e sta sopraggiungendo una macchina che ha appena svoltato?

Scontrino Alimentare

ALIMENTARI

SUPERMERCATO DI MARIO ROSSI
VIA VERDI, 23
P.IVA 047708722318
COD.FISC. RSMRB082P150E96X

	EURO
BUSTA INSALATA	2,10
2 x BISCOTTI	6,20
3 x DENTIFRICIO	9,00
ACQUA MINERALE 1l	1,50
TOT. PARZIALE	€ 18,8

TOTALE €18,8

13. Ha comprato due pacchi di biscotti, quanto costa un solo pacco?

14. Ha pagato con una banconota da 20 Euro, quanto resto ha ricevuto?

EVERYDAY PROBLEMS TEST

FORMA B

ISTRUZIONI PER L'EVERYDAY PROBLEMS TEST

L'obiettivo di questa prova è quello di vedere quanto adeguatamente è in grado di leggere e comprendere informazioni che generalmente adulti e anziani incontrano nella quotidianità.

Queste informazioni sono relative a diverse tipologie di materiale, ad esempio foglietti illustrativi di farmaci, bollette telefoniche, ricette di cucina etc.

Nella parte superiore di ogni pagina troverà una tipologia di materiale (istruzioni, etichette etc); nella parte inferiore invece saranno presenti due quesiti relativi a questo materiale. Quello che deve fare è leggere i quesiti e farsi un'idea del tipo di informazione che dovrebbe reperire nel materiale, ricercare queste informazioni nel materiale e scrivere le risposte nelle apposite righe poste sotto ogni quesito.

Le riposte non devono essere scritte estesamente, è possibile rispondere con poche parole. Non ci sono penalizzazioni, quindi cerchi di rispondere a tutti i quesiti anche se non è sicuro. Non si focalizzi per troppo tempo su ogni quesito, le domande sono in tutto 14.

Giri la pagina e vediamo insieme un esempio.

Nella parte superiore della pagina sono presenti le istruzioni per montare uno scaffale a tre ripiani. Leggi il primo quesito “Cosa bisogna fare per proteggersi le mani?” e cerca la risposta nelle istruzioni.

ISTRUZIONI PER ILMONTAGGIO:

SCAFFALE A TRE RIPIANI

MATERIALE NECESSARIO:

Viti, giravite, guanti da lavoro, tasselli di fissaggio a muro.

AVVERTENZA:
DURANTE IL MONTAGGIO USARE GUANTI DA LAVORO PER PROTEGGERE LE MANI.

MONTAGGIO:

4. Montare il primo piano ad un’altezza non superiore a 10 cm dal pavimento
5. Disporre il secondo ripiano a 20 cm di distanza dal primo. Porre il terzo, alla stessa distanza dal secondo.

CARICO:
Distribuire uniformemente il carico sui piani. Adagiare con cura i carichi sui piani evitando di lasciarli cadere in modo brusco.

A. Cosa bisogna fare per proteggersi le mani?
_________________**USARE GUANTI DA LAVORO**_________________

La risposta corretta alla domanda A è “indossare guanti da lavoro”. Quindi la frase “indossare guanti da lavoro” è stata scritta sull’apposita linea.

B. A quale distanza dal secondo bisogna porre il terzo ripiano?
____

La risposta corretta alla domanda B è “20 centimetri” in quanto nelle istruzioni il terzo ripiano va posto alla stessa distanza del secondo ripiano dal primo.

INIZIO DELLA PROVA

Preparazione Verdure Surgelate

ISTRUZIONI

1 busta di verdure surgelate

1 cucchiaio di olio extravergine di oliva*

50 ml di acqua

* Per insaporire il piatto aggiungere a Piacere pepe o prezzemolo.

2. Aggiungere un pizzico di sale e terminare la cottura per altri 3 minuti coprendo la padella con un coperchio.

IN MICROONDE:

1. Versare il contenuto della busta ancora surgelato in una pirofila di vetro e aggiungere 50 ml di acqua.

Secondo le istruzioni, cosa è necessario fare per insaporire il piatto?

1. Se cucinate in padella, per quanto tempo è necessario cuocere le verdure dopo aver aggiunto il sale?

Foglietto Illustrativo di un Farmaco

PERCHE' SI USA

Potete utilizzare KETOPROFENE in caso di dolori di varia origine e natura (mal di testa, mal di denti, nevralgie, dolori osteo-articolari e muscolari, dolori mestruali).

QUANDO NON DEVE ESSERE USATO

KETOPROFENE non deve essere usato in caso di ipersensibilità al principio attivo o ad altri farmaci analoghi (antinfiammatori, Acido Acetilsalicidico e derivati).

Nei bambini al di sotto dei 15 anni e nei neonati prematuri. In caso di ulcera peptica attiva, o precedenti anamnestici di emorragia gastro-intestinale, ulcerazione o perforazione. In gravidanza, accertata o presunta e durante l'allattamento.

In caso di eruzioni cutanee, rinite, asma; se soffrite di gastrite e disturbi digestivi cronici; se siete affetti da porfiria; in presenza di una riduzione del numero di globuli bianchi (leucopenia) o delle piastrine (piastrinopenia); in corso di trattamento con farmaci anticoagulanti ed in caso di insufficienza renale ed epatica.

In caso di severa insufficienza cardiaca.

COME USARE QUESTO MEDICINALE

Negli adulti e nei ragazzi sopra i 15 anni: 1 compressa in dose singola o ripetuta 2-3volte al giorno, nelle forme dolorose di maggiore intensità, da deglutire con un po' d'acqua, preferibilmente a stomaco pieno.

Utilizzate la dose minima efficace, in particolare nei pazienti anziani.

ATTENZIONE: NON SUPERATE LE DOSI INDICATE E NON IMPIEGATE IL PREPARATO PER PERIODI DI TEMPO PROLUGATI SENZA IL CONSIGLIO DEL MEDICO.

SOVRADOSAGGIO

In caso di ingestione/ barra assunzione accidentale di una dose eccessiva di KETOPROFENE, avvertite immediatamente il

2. Qual è la dose massima di compresse che un adulto può assumere in un giorno?

3. Il sig. Rossi soffre di dolori gastrici. Qual è il numero massimo di compresse che potrebbe assumere durante il giorno?

Tariffe Telefoniche

> Le chiamate effettuate a cavallo di due fasce orarie diverse mantengono le tariffe proprie di ciascuna fascia.

<table>
<tr><th></th><th>Fissi Nazionali&Internazionali</th><th>Verso cellulari</th></tr>
<tr><td>Dalle 8.00 alle 14.00</td><td rowspan="2">0,7 cent al minuto</td><td>15 cent al minuto</td></tr>
<tr><td>Dalle 14.00 alle 20.00</td><td rowspan="2">12 cent al minuto</td></tr>
<tr><td>Dalle 20.00 alle 8.00</td><td>ChiamaGratis</td></tr>
</table>

4. I suoi figli vivono nella stessa città fuori dall'Italia. Chiama sua figlia alle 11.30 e suo figlio alle 21.30. Entrambe le chiamate durano 5 minuti. Quale chiamata le costa di meno?

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5. Se chiama verso un cellulare alle 13.57 e la chiamata dura 7 minuti, qual è/sono sono la/ le tariffe applicabili?

Capi di Abbigliamento in Offerta

OFFERTA VALIDA PER TUTTO IL MESE DI MARZO SU SLIP E CALZE UOMO/DONNA		
Slip **Uomo/Donna** **2 Euro al pezzo**	Un pacco da 3 **5 Euro**	Un pacco da 6 **8 Euro**
Calze **Uomo/Donna** **3 Euro al pezzo**	Un pacco da 3 **8 Euro**	Un pacco da 6 **16 Euro** + **Buono sconto 2 Euro sulla prossima spesa**

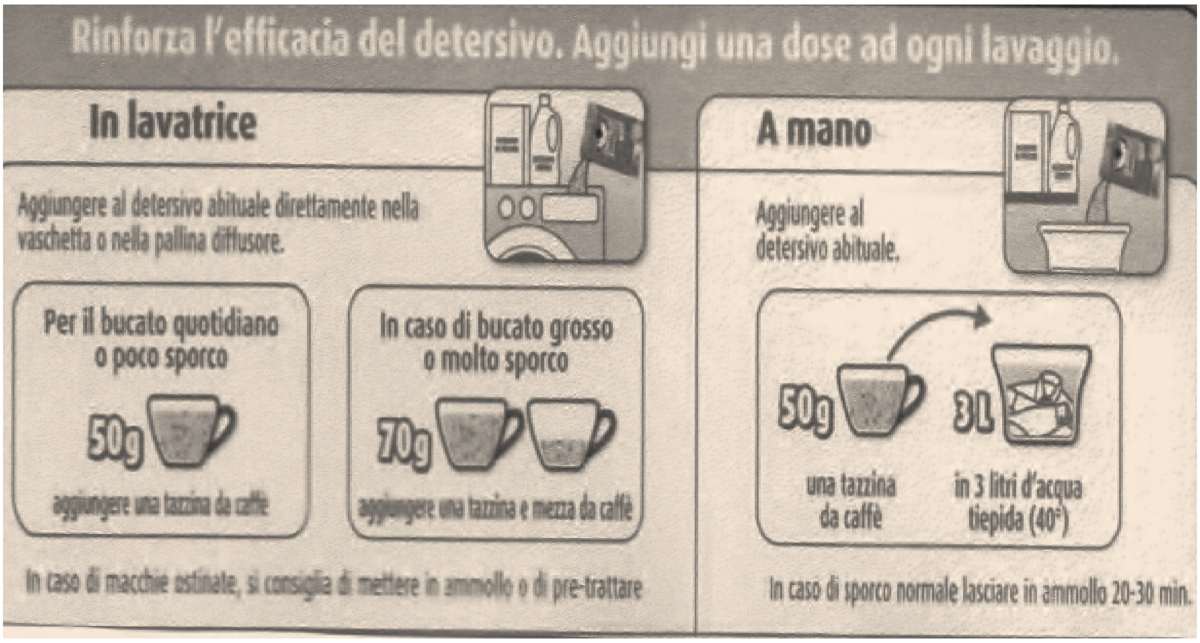
6. Decide di acquistare un pacco di slip da tre pezzi, anziché comprarli singolarmente, quanto risparmia?

___

7. Per ottenere un buono sconto del valore di 2 Euro, cosa dovrebbe acquistare?

___

Dosi Smacchiatore da Aggiungere al Detersivo



8. Per quale modalità di lavaggio è consigliato il pre-trattamento?

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9. In caso di sporco normale o quotidiano, quanto prodotto è necessario aggiungere al detersivo abituale?

Tariffe Taxi

ZONA	CORSA COMPRENSIVA DELLO SCATTO INIZIALE E PRIMI 2 Km	COSTO DI CIASCUN CHILOMETRO AGGIUNTIVO
1	**€ 5,50**	**€ 1,00**
2	**€ 5,50**	**€ 2,00**
3	**Tariffa unica - € 25,00**	

Nota: il prezzo del taxi è divisibile per il numero dei passeggeri.

SPIEGAZIONE TARIFFARIO:

1- Tutte le corse entro l'area urbana.
2- Tutte le corse entro l'area extraurbana, e tra i confini comunali e l'inizio dell'area extraurbana.
3- Viaggio di sola andata verso l'Aeroporto.

10. Se due persone dividessero un taxi per l'aeroporto, quanto dovrebbe pagare ciascuna persona?

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11. Viaggia da solo entro un'area extraurbana. Percorre, oltre ai primi due chilometri 10 chilometri, quanto dovrebbe pagare oltre ai 5,50 Euro di partenza?

____

Catalogo Premi con Raccolta Punti

Collezione Grandi Chef: crea la tua batteria di pentole!

Dal 1 Ottobre al 31 Gennaio

Per ogni 10€ di spesa*

riceverai 1 bollino. *Scontrino unico.

Scegli il tuo premio e barra la casella corrispondente.

LINEA ACCIAIO

Corpo in acciaio inossidabile 18/10, triplo fondo compatibile con

tutti i piani di cottura (compresa l'induzione) + coperchi in acciaio inossidabile 18/10. Lavabile in lavastoviglie.

Coperchio 22 cm 30 bollini ☐	Coperchio 24 cm 30 bollini ☐	Casseruola 1 manico 22 cm 40 bollini ☐
Casseruola semifonda 2 maniglie 24 cm 50 bollini ☐	Casseruola 2 maniglie 22 cm 60 bollini ☐	Pentola 2 maniglie 22 cm 70 bollini ☐

LINEA CERAMICA

Corpo in alluminio, rivestimento interno ceramico resistente a graffi e abrasioni, fondo serigrafato utilizzabile su tutte le fonti di calore (esclusa l'induzione). Lavabile in lavastoviglie.

Padella 24 cm 40 bollini +7,90€ ☐	Padella 28 cm 50 bollini ☐	Bistecchiera 26x26 cm 60 bollini + 9,90€ ☐

13. Se volesse in premio una padella in ceramica 24 cm, quanto denaro dovrebbe aggiungere ai bollini?

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14. Se lei avesse 90 bollini, quali premi le spettano senza aggiungere denaro?
