The Correlation of Dance Experience and Spatial Memory Abilities

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Abstract

Research has shown that practice and experience are determining factors in the development of expertise (Chase & Simon, 1973). It appears that years of practice correlate with memory ability in a given domain. Experts excel in domain-specific memory because they store and retain a large number of "chunks," or groups or patterns of information in long-term memory (Ferrari, Didierjean, & Marmeche, 2008). This improved memory ability seems to generalize for experts in many different domains, such as chess (Ferrari, Didierjean, & Marmeche, 2008) and perhaps dance. This study investigated the spatial and verbal memory of dancers and non-dancers using three memory tasks: the Corsi block-tapping task (spatial memory), a word span task (verbal memory), and a full-body version of the Corsi block-tapping task (dance-specific spatial memory). Participants included both dancers and non-dancers from the age group of 14 years and older. The researcher predicted that performance on both spatial memory tasks would be positively correlated with years of dance experience, such that the more experience an individual has in dance, the better the performance on the spatial memory tasks. The researcher also predicted that there would be no differences in verbal memory across the groups. The latter prediction was based on the assumption that dancers and non-dancers have had comparable verbal experience. Thus, this experiment examines the possible memory enhancement properties of dance.

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Introduction

The New York City Ballet corps waits backstage to be cued during their performance of Swan Lake. As the music begins, the ballerinas enter the stage and take their places in a basic semi-circle. Throughout the dance, the dancers move as one through an interwoven ever-changing pattern of formations, never missing a beat or a moment of synchrony. To the audience, the motions and changing spatial arrangements may appear seamlessly fluid. The dancers, however, have implemented a cognitive, spatial representation of the stage and are constantly moving both in the present and preparing for their next movement in the future. How are these dancers able to remember where to go next in the long sequence of formations? How are they able to locate themselves correctly among the 11 other dancers in a constantly moving environment? Perhaps these skills have been acquired over years of practice.

This project examines the spatial memory abilities of dancers and assesses the possibility that this skill is attained through deliberate practice. I will first consider the existing literature before discussing the methodology and design of my current experiment. I will explain the appropriate measures and procedure for data collection. Lastly, I will present the results and provide a formal discussion.

Review of the Literature

Brief history

Multiple Intelligences

It seems that some people are naturally drawn to certain activities, such as dance, music, or sports. Much research has been conducted regarding such skill-specific abilities. Why are young musical prodigies attracted to the piano at such an early age? Why are some children more inclined to run around kicking a ball while others enjoy drawing or reading? Empirically speaking, individual people may experience different types of intelligence (Gardner, 1983). Rather than assuming that "intelligence" has a strict and singular definition, Gardner (1983) suggests that people have specific genres of intelligence. For example, some people experience higher musical intelligence while others experience more proficient linguistic intelligence. Similarly, people high in bodily-kinesthetic intelligence (like dancers) seem more aware of bodily coordination and movement in space.

Gardner's theory suggests that people are drawn to certain activities because of their specific type of intelligence. For example, a young girl begins writing music and playing complicated Beethoven pieces because she has "musical intelligence." This suggests a causal relationship in that having a certain type of intelligence may *lead* one to pursue analogous activities. Thus, people may gain expertise in a field because they are predisposed (by means of their intelligence genre) to being good at it. On the other hand, one cannot disregard the necessity of practice. As a challenge to Gardner's theory, I propose that skills in any field may develop due to experience and practice rather than as a result of an innate ability. Similarly, I predict that the memory abilities of individuals of different intelligence types will differ depending on their area of expertise. For example, an expert pianist may have better memory for his specific craft—

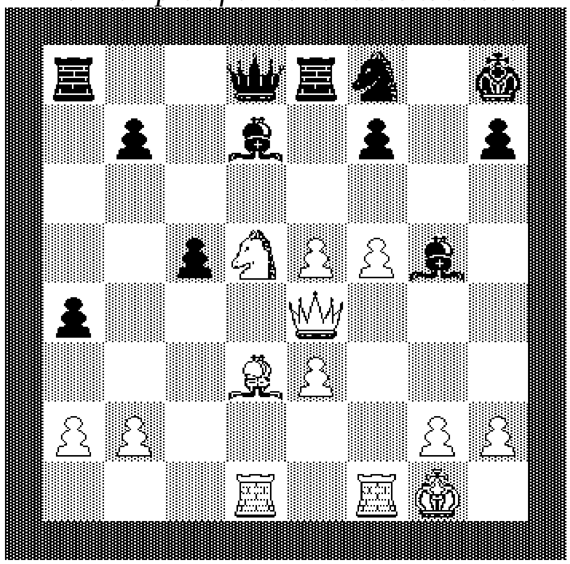
remembering scales, keys, chords, etc.—than a non-expert or non-musician. Along these lines, dancers may have better spatial memory (memory for positions and patterns in space) than non-dancers. I predict that people with dance experience will perform better at a spatial memory task than people with no experience. The more years of experience, the better the performance on the spatial memory tasks. As an alternative theory to Gardner's assertion that these spatial skills are innate for certain people, I propose that spatial skills may develop due to experience and practice of dance.

Acquisition of Expertise

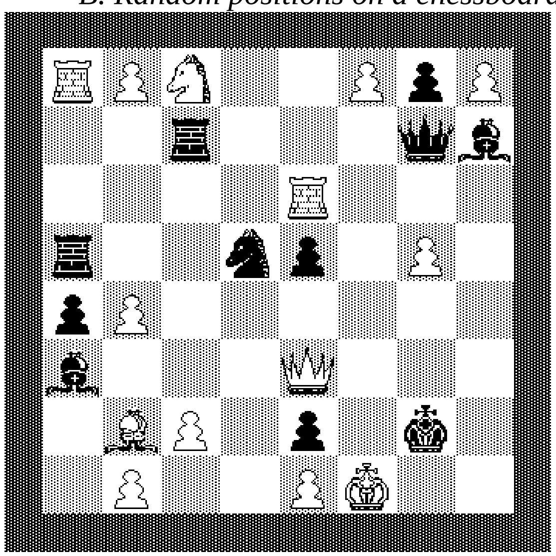
In most skill-acquisition activities, people progress from novice to mediocre to advanced after many years and hours of practice. As experience increases, it appears that so also does memory (Chase & Simon, 1973). Is this improvement in memory merely a function of growing older and becoming more cognitively aware, or is it more specific to the area of expertise? Chase and Simon's (1973) research on chess experts suggests that recall increases as a function of practice. The experimenters tested both novice and expert chess players' memory recall of chess pieces on a chessboard. Experts excelled at this ability, but only if the arrangement of pieces resembled those of an actual game. If the pieces were randomly placed, experts performed equally as well as novices (Chase & Simon, 1973). This finding suggests that the superior memory of experts is domain-specific. This study proposes to explore domain-specific memory in our study of dancers. See Figure 1.

Figure 1. Examples of chessboard placement. (Chase & Simon, 1973).

A. Example of a real chess situation.



B. Random positions on a chessboard.



Note: Image A represents an example of a chessboard arrangement that could be found in a real game of chess. Experts performed significantly better than non-experts at remembering piece-location when the chess pieces were located in a strategic, real arrangement such as this. Image B represents a randomly placed arrangement. In this situation, experts performed equally as well as novices.

Ferrari, Didierjean, and Marmeche (2008) further researched the acquisition of expertise in chess. Experts excel in domain-specific memory because they store and retain a large number of "chunks," or groups or patterns of information in long-term memory, which allows them to “recognize or recall chess situations more quickly and more accurately than do novices” (Ferrari et al., 2008, p. 1266). These chunks can either be perceptual (based off of color, basic position, or similarity to the pieces around them) or strategic (all related to each other in terms of a potential strategic play). Just like in a standard game of chess, not all possible plays have equal significance. Thus, these chunks also vary in terms of strategic value (McGregor & Howes, 2002, as cited in Ferrari et al., 2008). Ferrari and colleagues conducted a study that explored experts and novices’ detection of patterns (chunks) on a chessboard. Results suggested that experts detected developed (strategically meaningful) patterns more quickly than undeveloped (strategically un-meaningful) patterns, and experts also detected all types of patterns more quickly than novices.

Knowledge and expert performance are frequently correlated, but sometimes are completely unrelated (Ericsson & Lehmann, 1996, as cited in Williams, Ericsson, Ward, & Eccles, 2008). Sometimes people have many years of experience, but still do not perform at expert levels. For example, Ericsson (2004) conducted research that showed that years of experience and level of education do not always correlate with diagnostic performance in medical doctors. Thus, although doctors have many years of experience and education, some still do not perform at expert levels when tested for diagnostic performance. Similarly, when wine experts must taste and critique unnamed wine, they perform only slightly better than non-experts (Gawel, 1997; Valentin, Pichon, de Boisehebert, & Abdi, 2000). These examples demonstrate that expertise is not solely based on years of experience; it is vital to also consider actual performance ability. Thus, when testing for memory abilities in dancers, one must acknowledge both the years of practice and actual performance on the tasks.

Ericsson, Krampe, and Tesch-Romer (1993) explored the theory of deliberate practice, asserting that “practice rather than innate abilities is the main precursor to expertise irrespective of domain” (Ericsson, Krampe, and Tesch-Romer, 1993, as cited in Williams, Ericsson, Ward, & Eccles, 2008, p. S135). Deliberate practice is not the same as work or play. Rather, to deliberately practice, one must engage in a certain activity with the specific goal of improvement in mind. Ericsson and colleagues (1993) studied the development of musical expertise, concluding that the best musicians had at least 10 years and 7,410 hours of practice, whereas the good musicians and poor musicians had fewer years and hours of practice. These findings are consistent with the fields of chess and medical performance as well (Ericsson, 2004). Thus, expertise seems to develop through deliberate practice.

Expertise Within a Domain

There exists a difference between general knowledge of a domain and performance in that domain. For example, coaches and fanatics of a certain sport may have significant knowledge and experience, but cannot *perform* at the level of experts (Williams & Davids, 1995, as cited in Williams et al., 2008). Although coaches and extreme fans may be considered experts by means of years of experience studying a field, they have a different type of expertise from expert athletes within that field. Ericsson and Smith (1991) introduced the “expert performance approach” to understanding expertise. This approach can be divided into three steps. Williams and colleagues (2008) used this approach to examine expertise in sports. First, one must determine the nature of expertise within a certain domain. For example, what demonstrates expertise in basketball—the number of free throws? The number of blocks? In many sports, expertise cannot be determined by one factor—it involves a number of interrelated perceptual, cognitive, and motor skills (Williams et al., 2008). Researchers attest that expertise can thus be determined by focusing on "those aspects of performance where experts consistently outperform less expert performers" (Williams et al., 2008, p. S126). For dancers, this could mean a number of things. Is expertise determined by the number of turns one can do in a pirouette? Or the gracefulness of one's movement—who is the judge of that anyway?

The challenge for researchers is to determine which skills to assess and how to assess them within the lab. In order to examine the cognitive processes (memory strategies, reasoning, attention, etc.) being used by an individual while performing some activity in the real world (such as playing basketball), it is beneficial to examine these processes in a specific, repeatable way. Each participant in the study must complete the same measures in order for results to be directly comparable. This experiment focuses on quantitative (rather than qualitative) determinants of ability. Dancers often have to memorize long, complex series of movements to be performed with their entire bodies. Perhaps the ability to correctly memorize these spatial/movement patterns is what demonstrates expertise within the domain of dance. This experiment examines quantitative performance (% recall correct) on different memory tasks. Once the method is selected, researchers must determine the mechanisms used by experts. This is achieved in a variety of ways, including through verbal reports and movement. This experiment assesses the cognitive mechanism of memory by means of performance on memory tasks. Lastly, researchers explore how the skill is acquired. If spatial memory is superior for dancers, what exactly are the cognitive mechanisms that make it so?

Spatial Memory

Spatial memory is a specific type of memory that allows a person to remember the position of objects or patterns in space. The eyes are used primarily to encode spatial information, but sense of touch and spatial location of body parts also may contribute to encoding in some situations.

The sense of vision is a complex system that involves both sensation and perception. A person must first take in visual information through the eyes before perceiving it and processing it in the brain. In perceiving objects in space, people use visual information to process the object's location. This perception and processing involves different parts of the brain, including the dorsal visual stream. This area of the brain plays a crucial role in processing visual information that may be turned into action (Fiehler & Rosler, 2010). In contrast, work by Mishkin (1979) suggests that there is also a somatosensory (or sense-wide) pathway that can be observed across different senses that is involved in the process of objects and movements in space. This could perhaps be described as a general sense of feeling of where an object is located in space. Thus, it may not be only vision that plays a role in spatial understanding. This rings particularly important for blind people who may still have a spatial representation of an object, but it is not necessarily visual as it would be for a sighted person. Dancers may use both visual and somatosensory information when activating spatial memory.

When performing certain spatial movements, activation of different neural pathways may occur. For example, if a person plays the piano or a game of chess, different hand-eye neural pathways may become activated compared to if the person were playing a game of hop-scotch. With repeated practice, these neural pathways may become more defined, such as with dance experience. Perhaps repeated activation allows for better coordination in these specific movements. This could be one explanation for why dancers (and especially expert dancers) may have better spatial memory.

Aerobic Activity and Spatial Memory

Research shows that dance and aerobic movement have a number of physical and psychological benefits. Aerobic activity may improve spatial memory (Erickson et al., 2011).

Much research shows the physical and mental benefits of exercise. For older adults, being fit reaps the benefits of increased volume of the hippocampus and medial temporal lobes—which indicates improvements in spatial memory (Erickson et al., 2009; Honea et al., 2009). The size of the hippocampus shrinks by 1-2% each year in older adults, resulting in a higher risk for cognitive impairment, including memory loss (Jack et al., 2010; Raz et al., 2005). Erickson and colleagues demonstrated that a year's worth of aerobic exercise intervention was "effective at increasing hippocampal volume by 2% and offsetting the deterioration associated with aging." In the present study, we hope to extend the findings of Erickson et al. by examining a more specific type of aerobic exercise—dance.

As seen in the Erickson et al. study (2011), any type of aerobic activity may potentially provide benefits for spatial memory, due to increased hippocampal volume. However, much research also shows that dance specifically has a beneficial impact on memory and many other cognitive functions. Many people experience a number of benefits resulting from dance. Susan Sandel's work in dance and movement therapy has shown that dance has numerous physiological, psychological and sociological benefits for the elderly (Sandel, 1994), cancer survivors (Sandel, Judge, Landry, Faria, Ouellette & Majczak, 2005), and even schizophrenics (Sandel, 1982). In elderly people, dancing has aided procedural memory abilities for people with Alzheimer's Disease (AD) (Rösler, Seifritz, Kräuchi, Spoerl, Brokuslaus, Proserpi, Gendre & Savaskan, 2002).

In the current research, I assess the spatial memory abilities of dancers. I predict that dancers will have better spatial memory than non-dancers, and that expert dancers will have the best spatial memory of all, particularly in their area of expertise.

Dance and Memory

Some research shows that participation in dance over a period of time may improve the cognitive abilities of dementia patients. Hokkanen and colleagues (2008) conducted a Dance and Movement Therapy intervention for a group of elderly people suffering from dementia. Participants completed a 9-week program in which they participated in dance and movement classes. Researchers measured participants' performance on many cognitive tasks, including the Clock Drawing Test for spatial memory and a verbal memory task. Compared to a no-dance control group, participants who completed the 9-week dance program scored better on the spatial memory task, but not on the verbal memory task (Hokkanen et al., 2008). This provides interesting evidence to consider when examining the benefits of dance for people suffering from memory deficits and diseases. Perhaps dance specifically helps spatial memory rather than verbal memory. This could be because the art and practice of dance is specific to spatial memory, excluding the use of verbal memory.

Working Memory and Spatial Locations in Dancers

In studies of movement, visuo-spatial working memory is defined as a "…temporary storage of movements" (Cortese & Rossi-Arnaud, 2010, p. 266). Much evidence suggests that this working memory consists of at least two elements—one for appearance of the items/scene being viewed, and one for the spatial location and sequential order (Della Sala, Gray, Baddeley, Allamano, & Wilson, 1999; Logie, 1995; Pearson, 2001). By examining visuo-spatial memory in terms of its two components, researchers have been able to investigate how both visual information and spatial/sequential information work together. Logie (1995) defined each component in turn. The visual component, also called the visual cache, works as a "passive memory store that can temporarily hold information about static visual patterns" (Logie, 1995). The second component of visuo-spatial memory is referred to as the inner scribe, in that it "allow[s] the maintenance of information in the visual cache [and is] involved in holding information related to movement sequences" (Logie, 1995; Logie & Marchetti, 1991; Reisberg & Logie, 1993).

This model of working memory can be used to describe memory of movements and movement sequences. Research suggests that different types of movement can interfere with the performance of visuo-spatial working memory. For example, it seems that visuo-spatial memory ability is affected by the presence of movement distractions. These distractions include a variety of activities, such as spatial tapping of keys (Logie & Marchetti, 1991; Pearson, Logie, & Gilhooly, 1999), arm movements across an unseen matrix (Quinn, 1994; Quinn & Ralston, 1986) and eye movements (Pearson & Sahraie, 2003; Postle, Idzikowski, Della Sala, Logie, & Baddeley, 2006). A variety of research exists examining the effects of distractors on spatial memory. One specific example including professional and novice dancers suggests that memory span performance was negatively affected by an interfering motor task (Smyth & Pendleton, 1994).

Similarly, research suggests that people performing a hand movement memory task, the Kaufman Hand Movements Test (Kaufman & Kaufman, 1983), often encode movement sequences with verbal strategies (Frencham, Fox, & Maybery, 2003, 2004; Frencham, Maybery, & Fox, 2006). It appears that people often describe sequences or movement verbally in order to encode and remember. Especially for people with little experience in a spatial/movement field, it seems likely that a person may rely on verbal labels to help memorize the sequence. In these cases, the phonological loop is employed as well as the visuo-spatial sketchpad (Cortese & Rossi-Arnaud, 2010). On the other hand, experts may develop a more refined movement memory. Research shows that when expert ballerinas are asked to remember a sequence of dance movements, they are unaffected by visual or verbal distractions. However, when performing a memory task that also requires movement memory (like an arm movement task), memory for dance movements was impaired. Thus it appears that inexperienced people (non-dancers) do not have such a refined movement memory and must use verbal encoding strategies to remember spatial/movement sequences. As a person develops expertise, however, he or she may develop a special type of memory specific to movement that is unaffected by visual and verbal items (Cortese & Rossi-Arnaud, 2010).

Significance of This Study

The art of dance displays many physical and psychological benefits that can be seen across the lifespan. In elderly people, dance therapy has been shown to help with many cognitive detriments associated with age and memory. Dance helps Alzheimer's patients with procedural learning and also has helpful implications in the field of dementia (Hirsch, 1990). Across all ages, dance has therapeutic benefits in the autism and cancer survivor communities. Joanne Lara (2012) and Susan Sandel (2005) have both created successful dance programs for autistic people and cancer survivors. Both have had so much success as to suggest that dance really does make a difference. Lara's focus on autism therapy has provided much hope for the autism community (Lara, 2012) while Sandel's research has shown improved quality of life for cancer survivors (Sandel, 2005). These are just a few of the many examples of the cognitive benefits of dance.

The current project similarly has potential implications in the fields of dance and psychology. If the results support the hypothesis, it would suggest that dance begins having a positive effect on memory over the course of development, starting at a young age. It would also suggest that over a span of practice time, dance could improve memory. For people who struggle with memory processing, this could be a possible, partial solution to their problem. The implications of this project are substantial and it is important to research further into the benefits that dance may have for society.

I assessed the working memory of dancers and non-dancers using conceptual measures associated with the phonological loop and the visuo-spatial sketchpad (Baddeley & Hitch, 1974; Baddeley & Logie, 1999). To measure spatial memory, I employed a version of the Corsi Block Tapping Task, which requires participants to memorize and repeat certain patterns of "taps." (Corsi, 1972). I created a new version of the Corsi task that involves body movement (aka the "Barhorst Twister Task"). Instead of using the small blocks as a hand-eye task, as in the standard Corsi task, I used a much larger board with blocks that was placed on the ground for the participants to step on. This method was beneficial in studying the bodily spatial memory of dancers. In the full-body Corsi task, participants were asked to step in pre-determined patterns and, on some trials, in actual "dance patterns" that a typical dancer would know. This task differs from the regular Corsi task because it requires coordination of two limbs (both legs) rather than just one arm. It may be the case that to develop skills in the cognitive representation of multiple limbs, memory of their positions, and the execution of the memory, one must engage in an activity such as dance for a longer period of time. Thus the Barhorst Twister task may directly measure the type of coordination and memory acquired by dancers over the years. Through these data, I expect to extend the findings of Chase and Simon (1973) in that the dance "experts" will excel in memory abilities for their area of expertise. To measure verbal memory I used a simple word span task. See the methods section for more information.

I predicted that performance on a spatial memory task would be positively correlated with years of dance experience, such that the more experience a person has in dance, the better his or her spatial memory performance. I also predicted that expert dancers would perform significantly better than non-experts or people with no experience in the spatial memory sequences specific to their area of expertise. More specifically, I predicted that dancers would be better at both spatial memory tasks than people with no dance experience. It is possible that people with or without dance experience may perform equally well on the Corsi task, due to the frequency of common universal activities such as locating objects in space and pointing. However, I predict that dancers have a more advanced ability to remember locations and patterns in space due to repeated practice and exposure. When analyzing the data, I will use years of experience as a continuous variable that could range from zero to many years. This research may have important potential implications for the fields of expertise and dance. If I do indeed find a correlation between years of dance experience and better spatial memory performance, this could suggest that practicing dance may reap benefits of memory enhancement.

Method

Study Design

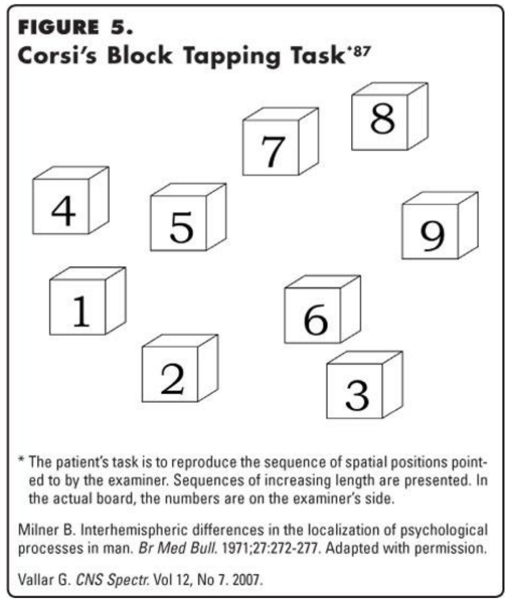
Working memory of dancers and non-dancers was assessed using conceptual measures associated with the phonological loop and the visuo-spatial sketchpad (Baddeley & Hitch, 1974; Baddeley & Logie, 1999, Baddeley, 2012). Each task is described in turn.

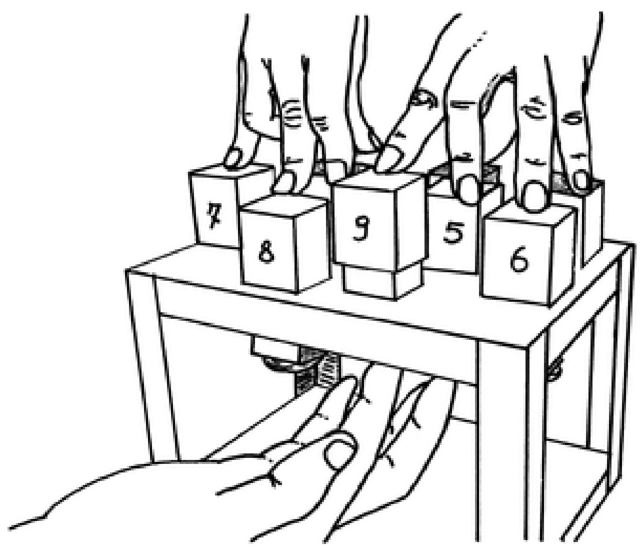
Corsi Block-Tapping Task

Spatial memory has been measured with many different tasks including dollhouse furniture arrangements (Cherry & Jones, 1999), chessboard positioning (Chase & Simon, 1973), the Corsi Block-Tapping task (Corsi, 1972), and more. The Corsi Block-Tapping task has been used for many years to measure visuospatial working memory. The Corsi task has many variations that can be applied to many different groups of people. Some research has been done on differing performance levels on the Corsi task for people in different stages of the developmental cycle (Berch et al., 1998) and for different genders (Ruggiero, Sergi, & Iachini, 2008). Other research has demonstrated that children with disabilities differ in their visuospatial learning abilities (Mammarella & Cornoldi, 2005). Also, certain people with high or low spatial ability perform differently on this task (Cornoldi & Mammarella, 2008).

The original task has been reworked many times, but it basically consists of a flat board with nine blocks placed randomly on the board. The experimenter taps out a certain sequence that the participant then copies. The experimenter continues with increasingly complex sequences until the participant is no longer able to tap them back correctly. For example, the task begins with one tap on one block, which is then repeated by the participant. The next sequence includes two taps, the next three, etc. See Figure 2 for a visual description of this task.

Figure 2. Corsi Block-Tapping Task. (Corsi, 1972)

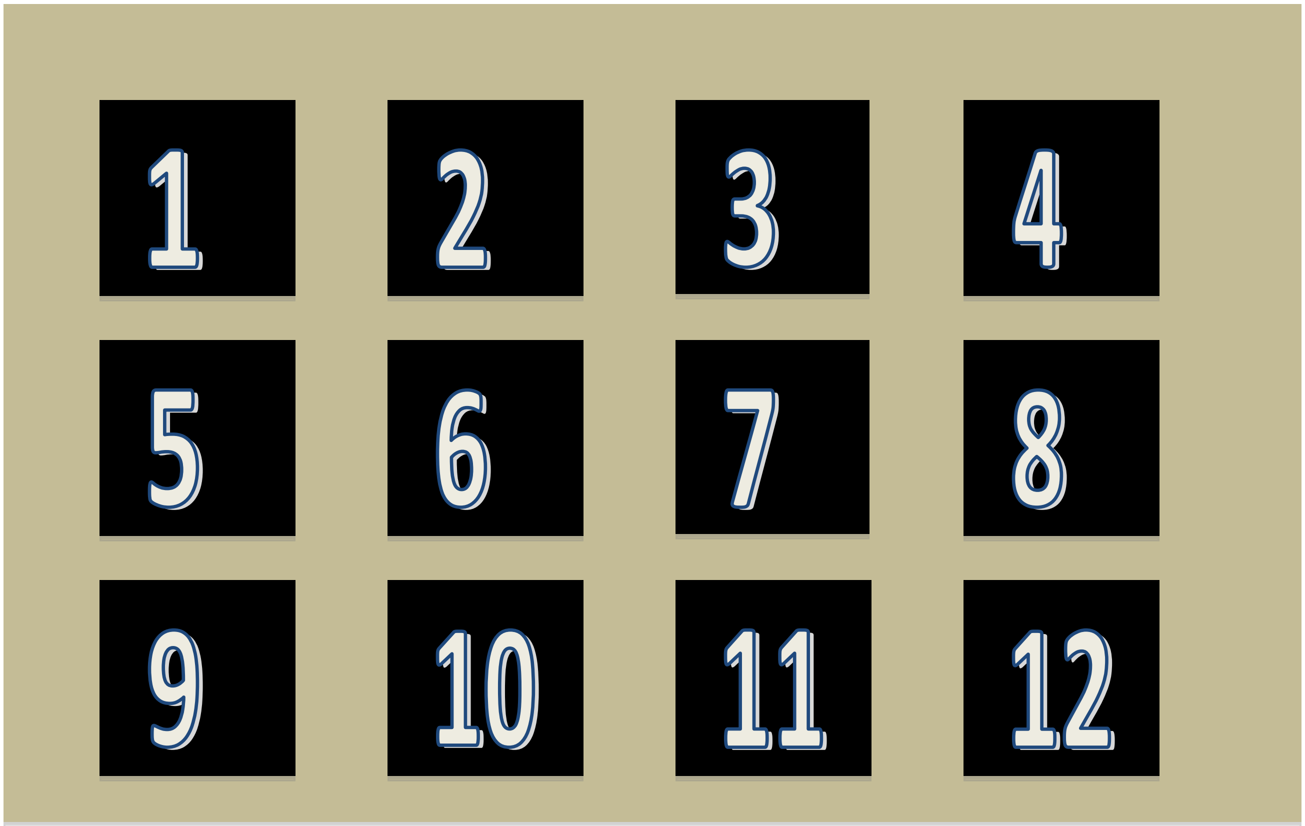




Note: The experimenter can see the numbers on his or her side of the blocks, but the participant is unable to see the numbers. In this example, the numbers were pushed upwards from underneath by the experimenter and then tapped again by the participant.

The Corsi Block Tapping Task, which requires participants to memorize and repeat certain patterns of "taps" (Corsi, 1972), was used to measure spatial memory. The task used a flat 8 ½ by 11 piece of fabric with 12 two inch by two inch black square pieces of fabric. The squares were sewn in three rows of four evenly spaced columns. The piece of fabric was covered by an equally sized piece of glass (see Figure 3). The fabric and glass rested on a table, with the experimenter and participant sitting on either side of the table. The experimenter conducted a sequence of 8 tapping patterns. The first pattern was the most basic, with just one tap on a certain square. The second pattern becomes more complex, with a pattern of two taps on two different squares. The third, fourth, fifth, sixth, seventh, and eighth patterns were increasingly complex, respectively. Each subsequent pattern excluded the same square order from the prior sequence. For example, if block 7 was tapped in the first sequence, the experimenter would next tap a sequence of 5, 12, then 2, 10, 4. Thus, practice effects were minimized. Each pattern was performed two times by the experimenter before allowing the participant to attempt to repeat the pattern back. The experimenter tapped out each sequence with .5 seconds of space between each tap. This was done for the purpose of consistency across participants and to ensure that there was no memory "blocking." Each experiment was also videotaped (with consent from participants) so that separate coders could also examine the task performance along with the experimenter. See Figure 3 for a visual representation of this task.

Figure 3. Modified Corsi Block-Tapping Task



Note: The board itself did not have numbers. The numbers are included here to help make sense of the sequences. See Table 1 for the specific sequences used.

Barhorst Twister Task

I created a new version of the Corsi task that involves body movement. Instead of using the small blocks as a hand-eye task, as in the standard Corsi task, I used a much larger board and squares that will be on the ground for the participants to step on. This method is beneficial in studying the bodily spatial memory of dancers and allows me to examine the potential difficulty of two-limb coordination. There may be a spatial memory difference regarding whether or not tasks are performed with one arm or with two legs. In the "Barhorst Twister Task," participants were asked to step in random patterns and, on some trials, in actual "dance patterns" that a typical dancer would know. Similar to the Corsi

Block-Tapping Task, sequences will begin with one step, then progress to two, three, four, five, six, seven, and eight. In order to be counted as a correct sequence, the participant must perform the sequence with the correct foot stepping on each block. For example, if the experimenter performs a certain sequence with right, left, right step patterns, the participant must also step with the right foot, then the left foot, then the right foot. Sequences 3, 4, and 5 mimic a natural dance step (box step, Charleston, grapevine, respectively). Through these data, I expect to extend the findings of Chase and Simon (1973) in that the dance "experts" will excel in memory abilities for their area of expertise. See Table 1 for a list of the sequences used with the appropriate feet patterns.

Figure 4. Barhorst Twister Task

Table 1. Tapping Sequences for Corsi and Barhorst Tasks

Corsi-B and BT-A Sequences

Green-Left foot
Orange-Right foot

Sequence 1: 1
Sequence 2: 7, 4
Sequence 3: 6, 5, 9 **(Box Step)**
Sequence 4: 11, 6, 7, 12 **(Charleston)**
Sequence 5: 5, 10, 7, 8, 4 **(Grapevine)**
Sequence 6: 6, 3, 8, 11, 6, 5
Sequence 7: 9, 1, 2, 7, 10, 3, 8
Sequence 8: 2, 4, 7, 9, 10, 3, 6, 1

Corsi-A and BT-B Sequences

Sequence 1: 11
Sequence 2: 8, 3
Sequence 3: 6, 5, 9 **(Box Step)**
Sequence 4: 11, 6, 7, 12 **(Charleston)**
Sequence 5: 5, 10, 7, 8, 4 **(Grapevine)**
Sequence 6: 9, 6, 3, 2, 7, 8
Sequence 7: 3, 6, 10, 8, 7, 6, 1
Sequence 8: 1, 7, 12, 11, 6, 2, 10, 9

Each sequence for each task was counterbalanced with the opposite sequence on the other task. Thus, for any given participant, Corsi A was always paired with Barhorst A, and Corsi B was always paired with Barhorst B. We organized the sequences this way so as to eliminate the difficulty confound. Thus, it cannot be argued that performance on a certain task was better because something about that task was fundamentally easier than the other task.

Word Span Task

To measure verbal memory I used a simple word span task. Participants heard a list of recorded words in progressively longer sequences. The first list had just one word, which was spoken twice. The second list had two words, the third had three words, etc. The lists were recorded on a GarageBand recording software file. The start of the spoken word began one second after the start of the last word for all sequences. See Table 2 for a list of the words used and their phonemes and Standard Frequency Index. See Table 3 for an ordered list of the words used in this experiment.

Table 2. List of words, phonemes, and Standard Frequency Index (SFI)

Word	**Phonemes**	**SFI**
Curtains	*6*	*48.7*
Engine	*5*	*42.09*
Weather	*4*	*58.11*
Branches	*7*	*57.8*
Coffee	*4*	*43.45*
Expert	*6*	*47.37*
Spider	*5*	*54.8*
Entrance	*8*	*46.61*
Pilot	*5*	*44.71*
Station	*6*	*57.8*
Necklace	*6*	*48.8*
Traffic	*6*	*51.05*
Lawyer	*5*	*57.15*
Novel	*5*	*45.14*
Bottle	*4*	*44.91*
Conflict	*8*	*45.35*
Pocket	*5*	*56.5*
Muscle	*5*	*53.63*
Robot	*5*	*48.9*
Pebbles	*6*	*49.6*
Disease	*5*	*51.26*
Button	*5*	*53.3*
Absence	*7*	*46.26*
Railroad	*6*	*54.36*
Pencil	*6*	*56.9*
Owner	*3*	*56.06*
Shovel	*5*	*49.6*
Passage	*5*	*56.19*
Canoes	*5*	*49.9*

Whistle	*5*	*53.3*
Tractor	*6*	*48.5*
Quarter	*5*	*56.59*
Candle	*6*	*53.2*
Driver	*5*	*51.12*
Needle	*5*	*55.0*
Contract	*8*	*54.27*

Note: The Standard Frequency Index for each word was determined by the Frequency Analysis of English Usage Lexicon (Francis & Kucera, 1982).

Table 3. Word Span List

1. Curtains (48.7)
2. Engine, weather (50.1)
3. Branches, coffee, expert (49.54)
4. Spider, entrance, pilot, station (50.98)
5. Necklace, traffic, lawyer, novel, bottle (49.41)
6. Conflict, pocket, muscle, robot, pebbles, disease (50.87)
7. Button, absence, railroad, pencil, owner, shovel, passage (53.24)
8. Canoes, whistle, tractor, quarter, candle, driver, needle, contract (52.81)

Note. In the recording, each word is spoken one second after the last word was began. The number in parentheses is the average frequency of usage in the English language. The average frequency for each list is between 48 and 54.

Population and Sample

I used a sample of non-dancers from the college age group (18 years and older) and dancers from Ballet Lubbock's pre-professional school company (ages 14-18) for the proposed experiment. Non-dancers were recruited from the standard introductory psychology subject pool. Introductory psychology students are required to gain a certain number of research credits by participating in experiments or writing research papers. As compensation for participating in this experiment, participants were awarded appropriate course credit (0.5 credits) for participating. In fall 2012, dancers were recruited from the

Texas Tech University dance department to participate in the experiment. Compensation consisted of being entered for a chance to win a pair of tickets to see *The Nutcracker* performed by Ballet Lubbock in 2012. Two participants from the dance department agreed to participate. In Spring 2013, dancers were recruited from Ballet Lubbock's pre-professional school. Participants were entered for a chance to win a $25 gift card to Barnes & Noble bookstore.

Procedure

I began the study by providing an informed consent form for the participants to read and sign (See Appendix A for the consent forms used for each group). Introductory psychology students and those over 18 years old gave consent to be videotaped or not. I then administered two cognitive tasks on memory. I employed the basic Corsi Block Tapping Task, described above, to measure spatial memory across all ages in both groups. See below for a copy of the verbal instructions:

> "This task involves memorizing a sequences of "taps" that I will first perform and then you will attempt to repeat. There will be a total of eight sequences that get progressively longer. For example, the first sequence will just have one tap on one square, the second will have two taps on two different squares, and so on all the way up to eight total taps. I will demonstrate each sequence two times before you will have the chance to repeat it back. We will be tapping the squares using pens."

In addition, I employed a full-body version of the Corsi Block Tapping Task that required participants to perform the memory task using their legs and feet. The structure of the task was similar to the coordination game of "Twister" in that participants were asked to step on certain blocks in different patterns. See below for a copy of the verbal instructions:

> "This task involves memorizing a sequences of steps that I will first perform and then you will attempt to repeat. There will be a total of eight sequences that get progressively longer. For example, the first sequence will just have one step on one square, the second will have two steps on two different squares, and so on all the way up to eight total steps. I will demonstrate each sequence two times before you will have the chance to repeat it back. In order for a sequence to be counted correct for you, you must step on the squares with the same feet as I do when I demonstrate. For example, if I step with my right foot on a square then my left foot on another square, you must also step with your right and left on the same squares. Please stand on the same side of the mat as me as I demonstrate so you can see exactly what I am doing."

To test for expertise, I employed certain sequences within the Barhorst Twister task that are actual "dance moves" (grapevine, box step, etc.). I also used a word-span task to measure verbal memory across all ages in both groups. Verbal instructions for the word span task can be viewed below:

> "This task involves memorizing a sequences of words. You will first hear myself on a recording saying each list twice and then you will attempt to repeat. There will be a total of eight lists that get progressively longer. For example, the first list will just have one word, the second will have two words, and so on all the way up to eight total words. Again, you will hear me recite each list two times before you will have

the chance to repeat it back. For the word list to be counted correct, you must repeat the words back in the same order as they are presented."

I presented each task in a counterbalanced manner, so that each task will occur first, second, or third at random an equal, number of times. At the end of the experiment, participants filled out a short survey on demographic information and years of involvement in any extracurricular activities. Within the survey, I asked specifically if the participant has had any experience with dance and length of time of involvement. See Appendix B for the extracurricular activity and demographic questionnaires.

Results

I began by calculating descriptive statistics for the primary variables in the study. The measures of memory appeared to be normally distributed. However, the standard deviations for the dance, sports, and musical instrument variables were as large or larger than the means, which suggested that those measures were not normally distributed. In this case, the accepted approach is to calculate nonparametric (i.e., rank-ordered) statistics. That is what I did in the present case. The correlations that I report used Spearman's rho, a nonparametric measure of statistical dependence between two variables.

The research literature allowed me to form directed hypotheses, primarily, that years of dance and hours of dance practice currently would be associated with higher scores on the Barhorst Twister task. For this reason, I calculated and report one-tailed p-values.

Table 4. Descriptive statistics for all measures

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
WS	50	3	6	4.30	.735
CS	50	4	7	6.06	.867
BT	50	3	7	5.14	1.125
BT-dance	50	1	3	2.52	.614
BT-random	50	1	4	2.62	.697
age	50	13	26	18.22	2.636
Yrs dance	50	0	23	5.70	6.072
Yrs Sports	50	.0	15.0	5.730	4.5053
Yrs Inst	50	0	13	2.68	3.235
hrs/wk now dance	50	0	23	4.30	6.855
hrs/wk now sports	50	0	25	1.80	4.957
hrs/wk now inst	50	.0	6.0	.240	.9543
Valid N (listwise)	50				

First, I looked at the correlations between Years of Dance, Years of Sports activity, and Years of Musical Instrument. The correlations showed a significant negative correlation between Years of Dance and Years of Sports (r=-.479), indicating that participants who danced generally did not play sports, and vice versa. There was a small positive correlation between Years of Dance and Years of Musical Instrument (r=.153).

Table 5. Correlations of Dance, Sports, and Instruments

Correlations

			Yrs dance	Yrs Sports	Yrs Inst
Spearman's rho	Yrs dance	Correlation Coefficient	1.000	-.479	.153
		Sig. (1-tailed)	.	.000	.144
		N	50	50	50
	Yrs Sports	Correlation Coefficient	-.479	1.000	-.206
		Sig. (1-tailed)	.000	.	.076
		N	50	50	50
	Yrs Inst	Correlation Coefficient	.153	-.206	1.000
		Sig. (1-tailed)	.144	.076	.
		N	50	50	50

In order to try to tease apart the effects of dance, sports, and musical instruments, I analyzed them one at a time. First, I selected those participants who had one or more years of dance. The correlations showed no significant associations of Years of Dance and Hours-Week-Now-Dance with performance on the Word Span task. This was consistent with my hypothesis. There was a marginal correlations between years of dance and performance on the Corsi span task (r=.263) and a marginal correlation between the Corsi task and the Hours-Week-Now-Dance measure (r=.222), suggesting that dance activities were only weakly connected to a general test of spatial memory. However, Years Dance was significantly associated with performance on the Barhorst Twister test (r=.267). Hours-

Week-Now-Dance was also significantly associated with performance on the Barhorst Twister task (r=.291). Years Dance was also strongly associated with Hours-Week-Now-Dance. This result suggests that Dance activities may amplify bodily spatial memory, which supports my primary hypothesis. To assess for expertise, I also examined individually those sequences on the Barhorst Twister task that included real dance steps (BT-dance) and those that included random patterns (BT-random). I found no correlation between years of dance and performance on the Barhorst Twister task dance steps (r=.167) or between Hours-Week-Now-Dance and performance on the Barhorst Twister task dance steps (r=.075). Interestingly, I found a positive correlation between years of dance and performance on the Barhorst Twister random steps (r=.286) and a significantly positive relationship between Hours-Week-Now-Dance and performance on the Barhorst Twister random steps (r=.390). This finding is contrary to my hypothesis in that I predicted that the more expertise in dance (years of practice), the greater the performance on the memory sequences specific to the field (the Barhorst Twister dance steps). Similarly, the current practice of dance has no relation to performance of the dance steps, but has a significant relation to performance of the random patterns. This also does not support my hypothesis.

Table 6. Correlations of Dance and Performance on Memory Tasks

Correlations

			Yrs dance	hrs/wk now dance
Spearman's rho	WS	Correlation Coefficient	.117	-.109
		Sig. (1-tailed)	.258	.273
		N	33	33
	CS	Correlation Coefficient	.263	.222
		Sig. (1-tailed)	.070	.107
		N	33	33
	BT	Correlation Coefficient	.267	.291
		Sig. (1-tailed)	.066	.050
		N	33	33
	BT-dance	Correlation Coefficient	.167	.075
		Sig. (1-tailed)	.176	.338
		N	33	33
	BT-random	Correlation Coefficient	.286	.390
		Sig. (1-tailed)	.053	.012
		N	33	33

Next, I selected those participants who had one or more years of sports experience. The correlations showed no significant associations between Years Sports and performance on the Word Span task (r=.022) or between Hours-Week-Now-Sports with performance on the Word Span task (r=-.163). This was consistent with my hypothesis. There was also only a marginal correlations between years of sports and performance on the Corsi span task (r=.213) and no association between Hours-Week-Now-Sports with performance on the Corsi span task (r=.028). These findings suggest that sports activities were not strongly connected to a general test of spatial memory. However, Years Sports was significantly associated with performance on the Barhorst Twister test (r=.289). On the contrary to the findings with dance, Hours-Week-Now-Sports was not associated with performance on the Barhorst Twister test (r=.125). This result suggests that Sports activities may amplify bodily spatial memory, similar to dance.

Table 7. Correlations of Sports and Performance on Memory Tasks

Correlations

			Yrs Sports	hrs/wk now sports
Spearman's rho	WS	Correlation Coefficient	.022	-.163
		Sig. (1-tailed)	.447	.161
		N	39	39
	CS	Correlation Coefficient	.213	.028
		Sig. (1-tailed)	.096	.433
		N	39	39
	BT	Correlation Coefficient	.289	.125
		Sig. (1-tailed)	.037	.224
		N	39	39
	BT-dance	Correlation Coefficient	.308	.111
		Sig. (1-tailed)	.028	.251
		N	39	39
	BT-random	Correlation Coefficient	.252	.098
		Sig. (1-tailed)	.061	.276
		N	39	39

Finally, I selected those participants who had one or more years of musical instrument. The correlations showed a marginal associations between years of instrument and the word span task (r=.263). There was no association, however, between Hours-Week-Now-Instrument and performance on the word span task (r=.027). There was no association between years of instrument and performance on the Corsi task (r=.197) or between Hours-Week-Now-Instrument and performance on the Corsi task (r=.152).

However, Years Instrument was associated with performance on the Barhorst Twister test (r=.315). Hours-Week-Now-Instrument was also strongly associated with performance on the Barhorst Twister task (r=.508). These results suggest that musical instrument activities amplify bodily spatial memory, similar to dance and sports.

Table 8. Correlations of Instruments and Performance on Memory Tasks

Correlations

			Yrs Inst	hrs/wk now inst
Spearman's rho	WS	Correlation Coefficient	.263	.027
		Sig. (1-tailed)	.080	.444
		N	30	30
	CS	Correlation Coefficient	.197	.152
		Sig. (1-tailed)	.148	.212
		N	30	30
	BT	Correlation Coefficient	.315	.508
		Sig. (1-tailed)	.045	.002
		N	30	30
	BT-dance	Correlation Coefficient	.503	.398
		Sig. (1-tailed)	.002	.015
		N	30	30
	BT-random	Correlation Coefficient	.152	.491
		Sig. (1-tailed)	.211	.003
		N	30	30

In summary, my three primary hypotheses were partially supported. There were no significant associations for dance and sports with the word span task and only a single marginal correlation with the Corsi task. However, dance showed significant associations with the Barhorst Twister task and Hours-Week-Now-Dance. This supports the claim that dance improves bodily spatial memory. This experiment was not designed to test the effects of experience in sports and with musical instruments. However, the analyses suggest that these activities also enhance bodily spatial memory, based on the significant correlations with Barhorst Twister.

Discussion

The negative correlation between years of dance and years of sports ($r=-.479$) can be explained in terms of practicality. The time demands of each of these activities increase over the years, such that athletes and dancers shift from practicing one or two hours per week to 15-20 hours. Thus, most individuals must choose one or the other because they cannot physically do both. It seems natural to assume also that as people become more dedicated to their activity, they begin to devote more time to it at the expense of other activities. As time commitment and involvement increase, people seem to choose either dance or sports, but not both.

The small positive correlation between years of dance and years of musical instrument ($r=.153$) is also noteworthy. Because dance and music are both considered within the realm of the performing arts, it seems natural to suggest that people who are drawn to one may be more likely to be drawn to the other. Dance and playing an instrument both involve music and expression, and thus have similar appeals.

Consistent with my prediction, I did not find a correlation between past or present practice of dance and performance on the word span task. There does not appear to be any direct relation between dancing and verbal memory, and so I did not predict that practicing dance would benefit verbal memory in any way. This proved consistent with my results, such that individuals with more dance experience performed equally as well as individuals with no dance experience.

Years of practice of dance marginally correlated with performance on the Corsi task, which is contrary to my hypothesis. I predicted that years of dance would be positively correlated with performance on the Corsi task, under the assumption that practice in dance is associated with increased spatial memory skills. I also found a marginal correlation between the current hours of practice per week now dance measure and performance on the Corsi task. This finding may suggest that dance activities are only weakly connected to a general test of spatial memory. Because the Corsi task is a general spatial memory test that involves hand-eye coordination, used regularly by most people, this task may not have tested the more specific spatial memory skills of a dancer.

Consistent with my hypothesis, years of dance was significantly associated with performance on the Barhorst Twister test (r=.267). Interestingly, the current hours of practice per week for dance associated even more strongly with performance on the Barhorst Twister Task (r=.291). This finding suggests that although more years of dance is associated with higher spatial memory performance, it matters more whether or not the individual currently practices dance. The years of dance measure was also strongly associated with Hours-Week-Now-Dance. This result suggests that dance activities may amplify bodily spatial memory, which supports my primary hypothesis.

I found similar results for sports. As in dance, neither years of practice in sports nor hours of current practice were associated with better performance on the verbal memory task. There does not appear to be any direct relation between playing sports and verbal memory, and so I did not predict that playing sports would benefit verbal memory in any way. The marginal correlation between years of sports and performance on the Corsi span task (r=.213) also suggests that the Corsi task may be a general test of spatial memory, and does not get at the spatial memory used in an activity such as dance or sports. There was no association between Hours-Week-Now-Sports and performance on the Corsi span task (r=.028), which amplifies an interesting difference between sports and dance. Whereas the current practice of dance showed one of the strongest positive correlations found in this experiment (r=.291), the current practice of sports showed one of the weakest (r=.028). These findings suggest that sports activities were not strongly connected to a general test of spatial memory.

Years of Sports was significantly associated with performance on the Barhorst Twister test (r=.289). This is similar to the correlation found for years of practice in dance. For both dance and sports, the more years of practice, the higher the performance on the Barhorst Twister task. On the contrary to the findings with dance, Hours-Week-Now-Sports was not associated with performance on the Barhorst Twister test (r=.125). This result suggests that sports activities may amplify bodily spatial memory, similar to dance. It appears that in order to reap the benefits of better spatial memory, it is more beneficial for dancers to be currently practicing dance than for athletes to be currently practicing sports.

I also found similar results for musical instruments. The correlations showed a marginal association between years of instrument and the word span task (r=.263). This was not consistent with my hypothesis, in that I predicted that there would be no difference across groups in performance on the word memory task. I found, however, that individuals with musical instrument experience performed better than people with dance or sports experience on the word span task. There was no association, however, between Hours-Week-Now-Instrument and performance on the word span task (r=.027). Opposite to the marginal association findings for dance and sports, there was no association between years of instrument and performance on the Corsi task (r=.197) or between Hours-Week-Now-Instrument and performance on the Corsi task (r=.152). This finding was consistent with my hypothesis in that I did not anticipate musical experience to be associated with spatial memory abilities.

However, Years Instrument was significantly associated with performance on the Barhorst Twister test (r=.315). Hours-Week-Now-Instrument was also strongly associated with performance on the Barhorst Twister task (r=.508). These findings add a unique component to my findings. People with years of musical experience and those who practice currently now perform significantly better on the Barhorst Twister task than those who have less or no music experience. These correlations are stronger than those for both dance and sports. These results suggest that musical instrument activities amplify bodily spatial memory, similar to dance and sports. One possible explanation for these results could be that these individuals have been/are involved with marching band, which requires a spatial representation of the field and one's location within the pattern. It could also be that playing a musical instrument in general demands awareness and memory of space. I did not include in my questionnaire questions specific to marching band, and this is one limitation to my study, especially given the unexpected results of musical instrument experience.

When assessing for expertise in the dancers, I did not find the anticipated effect. People with dance experience did not perform well on the dance steps of the Barhorst Twister task. On the contrary, they were more likely to perform well on the random patterns. This finding is opposite of my hypothesis, and should be reexamined in future research. One possibility is that the "dance steps" did not resemble the actual steps. It could also be that the dance steps were too easy and the expert dancers have never had to really think about what they were doing. This could explain the reason why they did not perform as well—perhaps they over thought the seemingly "easy" dance steps.

In summary, my three primary hypotheses were partially supported. There were no significant associations between dance or sports and the word span task and musical instruments had a marginal correlation with the word span task. The Corsi test did not appear to be an effective measurement of bodily spatial memory. Results on the Barhorst Twister task demonstrate the spatial memory benefits of dance, sports, and instruments.

This experiment is correlational, and thus all of the results demonstrate a correlational rather than a causal relationship.

Assumptions and Limitations

I used a college-aged sample of participants who had almost all participated in at least one of these activities. This may be a limitation because I did not have a group of participants who were not involved in any of these activities. Thus it is difficult to assert that my results are due to any of these individual activities themselves, or if they can simply be attributed to the fact that the majority of these students are/have been active and involved in something. I also did not inquire about participation in marching band, which may be a potential explanation for my results. I conducted the experiment for the Ballet Lubbock participants at the Ballet Lubbock studio, of which they are extremely familiar. Thus, it is possible that their better performance on some of the tasks could be attributed to context-dependency effects of doing dance-like activities at a dance studio. Because they are used to being spatially challenged and tested while at the studio, perhaps they were already predisposed to perform better on the task simply based on the location of the experiment. Lastly, this experiment was correlational and there was no manipulation of any type of variable. It is impossible to draw causal conclusions from this experiment. The data about dance/sports/instrument experience was collected through self-report in the survey, and thus may be imprecise and potentially inaccurate.

Future Directions

This research has important implications for future research in the field of field-specific and bodily memory. Results suggest that activities that involve memory of movement and patterns in space actually may lead to enhancement of that memory down the road. Future research should include, if possible, a clear group of participants who have not been involved in any of these activities. Future studies should also test the effectiveness of the Barhorst Twister task and its ability to accurately measure an individual's spatial memory abilities. This research provides the grounds for more evidence that demonstrates the cognitive benefits of dance, exercise, and bodily movement in general. It also demonstrates that years of practice may lead to memory enhancement.

Appendix A

Consent Form-A (Introductory Psychology Students)

What is this project studying?
This research project called "Spatial Memory" will help us learn how people use patterns to enhance memory.

What will I do if I participate?
You will be asked to perform three simple memory tasks involving words and hand and foot movements. You will be asked to stand and make stepping movements with your legs and feet in a variety of patterns. You will also be asked to answer several demographic questions. Your responses for the tasks will be videotaped.

How will I be compensated for participating?
You will receive 1/2 hour of research credit for your Introductory Psychology course.

Can I quit if I become uncomfortable?
Yes, absolutely. Dr. Taraban and the Protection Board do not think you will be uncomfortable. However, you can stop at any time. You can leave any time you wish. You will keep all the benefits of participating even if you stop. Participating is your choice.

How long will participation take?
We are asking for 1/2 hour of your time today.

How are you protecting my privacy?
Your responses will be created and stored without identifying information. After you complete the experiment, neither the experimenter nor anyone associated with this experiment will be able to associate your data with your identity. After the data are coded and analyzed, video recordings will be destroyed.

I have some questions about this study. Who can I ask?
Dr. Taraban in the Department of Psychology at Texas Tech University is running the experiment. If you have questions, you can call him at 742-3711 x247 or send an email to roman.taraban@ttu.edu. You can also mail your questions to the Human Research Protection Program, Office of the Vice President for Research, Texas Tech University, Lubbock, TX 79409.

_____ (check here) I confirm that I am at least 18 years old.
_____ (check here) I allow the experimenter to video record my response.

Signature ______________________________ Date _________________

Printed Name ________________________________

This consent form is not valid after August 31, 2013.

Consent Form-B (TTU Dance Department Participants-Fall 2012)

What is this project studying?
This research project called "Spatial Memory" will help us learn how people use patterns to enhance memory.

What will I do if I participate?
You will be asked to perform three simple memory tasks involving words and hand and foot movements. You will be asked to stand and make stepping movements with your legs and feet in a variety of patterns. You will also be asked to answer several demographic questions. Your responses for the tasks will be videotaped.

How will I be compensated for participating?
You will be entered in a drawing to win two tickets to "The Nutcracker." The drawing will take place on December 1, 2012. One out of every 12 participates will win tickets.

Can I quit if I become uncomfortable?
Yes, absolutely. Dr. Taraban and the Protection Board do not think you will be uncomfortable. However, you can stop at any time. You can leave any time you wish. You will keep all the benefits of participating even if you stop. Participating is your choice.

How long will participation take?
We are asking for 1/2 hour of your time today.

How are you protecting my privacy?
Your responses will be created and stored without identifying information. After you complete the experiment, neither the experimenter nor anyone associated with this experiment will be able to associate your data with your identity. After the data are coded and analyzed, video recordings will be destroyed.

I have some questions about this study. Who can I ask?
Dr. Taraban in the Department of Psychology at Texas Tech University is running the experiment. If you have questions, you can call him at 742-3711 x247 or send an email to roman.taraban@ttu.edu. You can also mail your questions to the Human Research Protection Program, Office of the Vice President for Research, Texas Tech University, Lubbock, TX 79409.

____ (check here) I confirm that I am at least 18 years old.
____ (check here) I allow the experimenter to video record my response.

Signature ______________________________ Date _________________

Printed Name ______________________________

This consent form is not valid after August 31, 2013.

Consent Form C (Ballet Lubbock 18+ Participants)

What is this project studying?
This research project called "Spatial Memory – Ballet Lubbock" will help us learn how people use patterns to enhance memory.

What will I do if I participate?
You will be asked to perform three simple memory tasks involving words and hand and foot movements. You will be asked to stand and make stepping movements with your legs and feet in a variety of patterns. You will also be asked to answer several demographic questions. Your vocal, hand, and foot responses for the tasks will be videotaped; however, your face will not appear in the videotapes.

How will I be compensated for participating?
You will be entered in a drawing to win a $20 gift card to Barnes & Noble bookstore to be drawn on April 30th. One out of every 10 participates will win tickets.

Can I quit if I become uncomfortable?
Yes, absolutely. Dr. Taraban and the Texas Tech Protection Board do not think you will be uncomfortable. However, you can stop at any time. You can leave any time you wish. You will keep all the benefits of participating even if you stop. Participating is your choice.

How long will participation take?
We are asking for ½ hour of your time.

How are you protecting my privacy?
Your responses will be created and stored without identifying information. After you complete the experiment, neither the experimenter nor anyone associated with this experiment will be able to associate your data with your identity. After the data are coded and analyzed, video recordings will be destroyed.

If I have some questions about this study, whom can I ask?
Dr. Taraban in the Department of Psychology at Texas Tech University is supervising the experiment. If you have questions, you can call him at 742-3711 x247 or send an email to roman.taraban@ttu.edu. You can also mail your questions to the Human Research Protection Program, Office of the Vice President for Research, Texas Tech University, Lubbock, TX 79409.

_____ (check here) I allow the experimenter to video record my responses.

Signature ______________________________ Date _________________

Printed Name ________________________________

This consent form is not valid after August 31, 2013.

Consent Form D (Letter to Parents and Parental Consent)

Letter to Parents

Dear parent(s),

Your daughter is being asked to participate in a psychology experiment for Texas Tech University called "Spatial Memory – Ballet Lubbock." Senior psychology student at Texas Tech and Ballet Lubbock teacher Erica Barhorst will be running the experiment at the Ballet Lubbock studio. Erica is being supervised by Dr. Roman Taraban, a professor in the Department of Psychology at Texas Tech University. Before doing the experiment with your child, Erica will ask your child if she is willing to participate. Below you will find additional details of the study. If you agree to allow your child to participate, please place check marks next to the questions at the end, if you agree, sign on the line provided, and return this form with your child to her next Ballet Lubbock dance class.

What is this project studying?
This research project will help us learn how participating in dance improves memory.

What will my daughter do if she participates?
She will be asked to perform three simple memory tasks involving words and hand and foot movements. She will be asked to stand and make stepping movements with her legs and feet in a variety of patterns. She will also be asked to answer several demographic questions. Her vocal, hand, and foot responses for the tasks will be videotaped; however, her face will not appear in the videotapes.

How will my daughter be compensated for participating?
She will be entered in a drawing to win a $20 gift card to Barnes & Noble bookstore to be drawn on April 1st. One out of every 10 participates will win tickets.

Can my daughter quit if she becomes uncomfortable?
Yes, absolutely. It is not likely that she will be uncomfortable. However, she can stop at any time. She can leave any time she wishes. She will keep all the benefits of participating even if she stops. Participating is her choice.

How long will participation take?
It will take about ½ hour of your daughter's time.

When will the experiment take place?
The experiment will take place on Saturdays during the month of February and March, after your daughter is finished with her Saturday morning ballet class.

How are you protecting my daughter's privacy?
Her responses will be created and stored without identifying information. After she completes the experiment, neither the experimenter nor anyone associated with this experiment will be able to associate her data with her identity. After the data are coded and analyzed, video recordings will be destroyed.

If I have some questions about this study, whom can I ask?
Dr. Taraban in the Department of Psychology at Texas Tech University is supervising the experiment. If you have questions, you can call him at 742-3711 x247 or send an email to roman.taraban@ttu.edu. You can also mail your questions to the Human Research Protection Program, Office of the Vice President for Research, Texas Tech University, Lubbock, TX 79409.

(Please see reverse)

If you agree:
Please check the two items below, as appropriate, sign and date this consent form, and return it to Erica Barhorst.

Thank you for your consideration,
Erica Barhorst

_____ (check here) I confirm that I am the legal guardian of my daughter.
_____ (check here) I allow the experimenter to video record my daughter's responses.

Signature of Parent or Guardian ________________________________

Printed Name __________________________________

Name of Child _______________________________________

Date __________________

This consent form is not valid after August 31, 2013.

(Remember, even if you do say, "Yes," now, you can change your mind later.)

Consent Form E (Assent Form-Minors)

Assent Form - Minors

I am here today because I am interested in learning more about dancers. I hope you can help me today. I am going to ask you to play some memory games with me. I will also ask you to imitate some dance steps. I will video record your answers to the memory games. I will also videotape your foot movements. The video recording will help me remember your responses. Because you volunteered to help, you are automatically eligible to win a $20 gift certificate to Barnes & Noble bookstore.

Helping me today is up to you. If you decide you don't want to do the activities I described, that is ok. If you start but want to quit, you can do that at any time. You will still be entered into the drawing for the gift certificate.

If you want to help me today, I am going to ask you to write your name on this line.

Name ____

Date ____

Appendix B

Extracurricular activities

1. Do you/have you ever played a sport? (Yes/No) _________

    If so, what sport? ______________

    If so, how many years did you participate? ___________

        About how many hours each week did you practice? ___________

    If so, do you still practice the sport now? _________

        About how many hours each week do you practice now?__________

    How much do you currently enjoy this sport? _________

    Not at all Extremely

    0 1 2 3 4 5

2. Do you/have you ever played an instrument? (Yes/No) ________

    If so, what instrument? __________

    If so, how many years did you play? ________

        About how many hours each week did you practice? ________

    If so, do you still play the instrument now? _______

        About how many hours each week do you practice now? ________

    How much do you enjoy playing this instrument? ________

    Not at all Extremely

    0 1 2 3 4 5

3. Do you/have you ever taken regular dance classes? (Yes/No) _______

    If so, what type of dance? __________

    If so, how many years did you take classes? _________

        About how many hours each week did you practice? _______

If so, do you still take dance classes now? ________

About how many hours each week do you practice? _______

How much do you enjoy taking these dance classes? _________

Not at all					Extremely
0	1	2	3	4	5

4. Are you/have you been a member of any type of club/honors society/academic team? (Please list all and years of involvement for each)
____
____
____
____

5. Currently, what is your favorite extracurricular activity?
____

How skilled are you in this activity now?

Not at all					Extremely
0	1	2	3	4	5

6. How easy do you find it to get around a new city?

Not at all					Extremely
0	1	2	3	4	5

7. With what frequency do you play video games?

Never					Every day
0	1	2	3	4	5

8. Do you exercise regularly?

If so, what type of exercise do you do? ____________________________________

If so, how many times per week do you exercise? _________________________

If so, how many hours per day do you exercise on average? _______________

Demographics Form

Age:

Gender:

Race:

Ethnicity:

Major:

Year in school:

Appendix C-IRB Approval Letters

TEXAS TECH UNIVERSITY
Vice President *for* Research

September 25, 2012

Roman Taraban
Psychology
Mail Stop: 2051

Regarding: 503598 Spatial Memory

Dr. Roman Taraban:

The Texas Tech University Protection of Human Subjects Committee has approved your proposal referenced above. The approval is effective from September 25, 2012 to August 31, 2013. This expiration date must appear on all of your consent documents.

We will remind you of the pending expiration approximately eight weeks before August 31, 2013 and to update information about the project. If you request an extension, the proposal on file and the information you provide will be routed for continuing review.

Sincerely,

Rosemary Cogan

Rosemary Cogan, Ph.D., ABPP
Protection of Human Subjects Committee

Box 41075 | Lubbock, Texas 79409-1075 | T 806.742.3905 | F 806.742.3947 | www.vpr.ttu.edu
An EEO/Affirmative Action Institution

TEXAS TECH UNIVERSITY
Vice President *for* Research

February 13, 2013

Roman Taraban
Psychology
Mail Stop: 2051

Regarding: 503823 Spatial Memory - Ballet Lubbock

Dr. Roman Taraban:

The Texas Tech University Protection of Human Subjects Committee has approved your proposal referenced above. The approval is effective from February 13, 2013 to January 31, 2014. This expiration date must appear on all of your consent documents.

We will remind you of the pending expiration approximately eight weeks before January 31, 2014 and to update information about the project. If you request an extension, the proposal on file and the information you provide will be routed for continuing review.

Sincerely,

Rosemary Cogan

Rosemary Cogan, Ph.D., ABPP
Protection of Human Subjects Committee

Box 41075 | Lubbock, Texas 79409-1075 | T 806.742.3905 | F 806.742.3947 | www.vpr.ttu.edu
An EEO/Affirmative Action Institution

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