Effect of Dancing on a Visuospatial Working Memory Task and Mood

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Abstract

The cognitive advantages of dance have been researched for many years. However, the amplitude of mechanisms on the brain-dancing intersection still needs to be understood. One of them is the influence of dancing on visuospatial working memory. The direct link to causality between the two is still unclear. Exercise is an activity that is ubiquitously known to uplift mood. With dancing being both an aerobic exercise and a social activity, its prowess to be a better mood enhancer is juxtaposed with a more traditional exercise routine. In this pretest/posttest study, Zumba dancers (n=23) are compared to a control group of exercisers using gym equipment (n=23) to determine which group scored better in a visuospatial working memory (VSWM) test and how each group scored on a 6-point self-assessed mood scale. Results from the VSWM task showed a significant interaction effect between the study and control groups. The non-dancers decreased in mean scores posttest compared to pretest; whereas the dancers had no significant difference in mean scores at pretest and posttest measures. The mood scale outcome showed that the dancers reported significantly higher scores than the control group during the pretest and posttest. This study advocates the potential of social dancing as a health-promotive measure towards improving cognitive health as it relates to highly positive emotions. Further investigation into the direct visuospatial link to dance suggests a more controlled experimental design and more advanced instruments to assume a more comprehensive understanding of the construct are required.

Keywords: Zumba, dance, visuospatial working memory, working memory task, exercise, mood, between-subjects design

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Introduction

Dance has been a primitive form of art and self-expression across multiple species since before recorded history. As ancient as the beginning of species, it is a common practice used as a form of recreation, customary observances, and a mating ritual prerequisite to reproduction in some species. It is regarded as a full-body experience with possible metaphysical implications and a reputation for having many health benefits. There has been a growing body of research studies dedicated to understanding the influence of dance on physiological wellness and its benefit on cognitive health. One is the renowned field of dance psychology, the study of dance from a psychological perspective (Lovatt, 2018, p.14). In recent studies, Teixeira-Machado et al. (2019) concluded that dancing relates to improved structural and functional changes in the brain, evidently demonstrating improved neuroplasticity. A further study by Noguera et al. (2020) showed that dancing modulates executive brain functions in salsa dancers against non-dancers, which can suggestively delay neurodegenerative decline. And a recent controlled randomized study on middle-aged participants showed a significant improvement in working memory scores in a dancing group after an 8-month-long Latin dance intervention, compared to a control group receiving only health education (Aguiñaga et al., 2022).

Exercise and dancing have been known to be an activity linked to positive emotions. An enhanced mood and decreased stress levels are one of the most consistent cognitive and behavioral effects of a single exercise session (Basso & Suzuki, 2016). Various studies linked dance activities to igniting chemical reactions beneficial to the brain. One of many is the increased nitric oxide, serotonin, estrogen hormones, and HDL cholesterol levels while decreasing dopamine, serum glucose, serum triglycerides, and LDL cholesterol benefits (Lopez-Nieves et al., 2022). Furthermore, significant changes to the brain's chemical reactions elicited by dance cause the release of endorphins like serotonin and dopamine, the "feel-good" hormones (Wargo, 2021, p.39). All of which relate to physical health and psychological advantage. In addition, dance movement therapy effectively improves motor function and cognitive deficits in neurodegenerative diseases like Parkinson's disease and mild cognitive impairment (Wang et al., 2022.). In line with these recent research paradigms, dancing has been a subject of interest with potential claims to cognitive health and can potentially counter the onset of neurodegeneration.

Visuospatial Working Memory and Dance

Visual and spatial working memory (VSWM) is the ability to temporarily store and mentally manipulate visual information (McAfoose & Baune, 2009). Unbeknownst to most, it is a common task that is part of our daily functioning, involving orientating in space and navigating oneself into an environment. Common functions are recognizing a pattern, making sense of where things in the environment are, and using these details to one's advantage. It can be simple things like knowing where your locker is when preparing to get off work in the locker room or even recalling where you placed your mobile phone after putting it away for dinner. In dancing, for example, one can emulate a step by associating a movement with a symbol, like forming a figure 8 or assuming a square route while moving their feet. It has been a research of interest as to dancers correlate with spatial memory abilities. In a study on children, dance is concluded to improve the topological map of the body by enhancing the motor domain when dancers outperformed non-dancers in divergent thinking task (Palmiero et al., 2019). This relates to the definition of VSWM that one makes good use of the environment to solve a problem.

Dancing is an active task that uses conscious awareness of space and body movements. One must learn to mimic a series of body movements in space and synchronize it with the beat of the music. Relatedly, recent findings suggested that positive emotional induction with the use of music boosted visuospatial working memory performance (Ribeiro et al., 2022). Using various dance kinesthetics with varying beats and choreography in a dance class could prime the intervention group to score better in a simple visuospatial task post-intervention. A meta-analysis by Yuan et al. (2022) concluded that dance activity interventions significantly improve global cognition, memory, visuospatial function, cognitive flexibility, attention, and balance in older adults with mild cognitive impairment. A cross-sectional study by Guo et al., (2016) concluded that physical exercise improves visuospatial working memory in older adults compared to sedentary individuals. In dancing, very few studies still support the claim of dance intervention to VSWM. Moreover, the immediate effect of dancing on VSWM is not yet studied. In fact, in the aforementioned analysis by Yuan et al. (2022), there were only six studies investigating VSWM that showed significant results.

A recent study by Berente et al. (2022) concluded that deficits in visuospatial working memory is one of the early markers of cognitive decline. Neurological symptoms of neurodegenerative diseases first appear after middle age (Katsuno et al., 2018). Thus, the public needs to be aware of the key preventative measures for better cognitive health. According to the World Health Organization (2022), 1 in 6 people will be 60 years or over by 2030, with persons aged 80 or older expected to triple between 2020 and 2050 to reach 426 million. From a preventive health perspective, if widely implemented, dancing could be a practical alternative to counteract the early signs of cognitive degeneration. If this study yields significant results, it may support the narrative that one can turn to the primitive art of dance to strengthen one's brain. And eventually, it may be a more effective and enjoyable alternative to delay neurodegeneration and promote neuroplasticity. To investigate these claims, this study employs the popular dance exercise Zumba as the intervention in the study group. With its qualities of being a leisure, a workout, and a social event, it is paralleled against another more conventional form of exercise. This paper interchangeably uses VSWM and visuospatial working memory or visual and spatial working memory.

Dancing as a Social Activity

One of the revered qualities of dancing is it is often connotative with social gatherings. Across cultures, a cultural celebration is always incorporated with dancing. This is supported by a recent study by Basso et al. (2021) which found that the natural affinity to dance transcends across human cultures because it produces neurochemical reactions, which enable connectivity inside the brain and among the participants' brains in the dance act. This activation and human connection produce a pleasurable experience. Consequently, dancing has the advantage of catering not just to the neuropsychological and physiological state but also has a community aspect, making it more of a social experience. Using dance as an avenue for recreation with the added benefit of exercise also plays a role in one’s affective state. A study by Zajenkowski et al. (2015) concluded that recreational dancers reported an increase in energetic arousal and hedonic tone, with a decrease in tense arousal after a dance exercise compared to competitive dancers. This supports the assumption that recreational dancing’s feel-good effect makes it not just an activity but also a part of their lifestyle, which possesses more longevity if incorporated into one’s daily life. For instance, it was also known that consistent Zumba participation is mediated by patrons who find it enjoyable, with physiological gains regarded as a secondary benefit (Yamasaki et al., 2021). The interpersonal aspect of dancing as a group could be an asset if it is a highly satisfying activity compared to another form of individual exercise. Therefore, this study investigates the immediate interaction between dance, mood, and visuospatial working memory, considering the handful of research linking dance to cognitive health. The Zumba group is speculated to have an advantage over the non-choreographic exercise group.

Methodology

To measure the effects of dancing on visuospatial working memory and mood, a quasi-experimental between-subjects pretest/posttest design is employed in this study. The design was chosen primarily due to the practical advantages that fit this research project given the limited time and resources of the researcher.

Participants

The participants (N=46) train at Stavanger, Norway. There were two groups: a study group (n=23) who went into a Zumba dance class; and a control group (n=23) who did their regular strength training using weights and exercise machines. They were recruited using convenience sampling. The control group was sampled at one fitness center, while the dancing group was taken at several locations: three fitness centers and a sports hall. Most of the questionnaire-answering was taken at noontime. However, four participants from the control group and five from the Zumba group were taken late in the afternoon, not later than 6:00 p.m. Data collection commenced on March 3, 2023, and ended on March 28, 2023.

Altogether, 55 participants completed the experiment. Nine men from the control group had to be excluded from the data because of gender disparity due to the scarcity of male Zumba participants. This resulted in the entire study group being homogenously female. The imbalance in gender distribution between groups posed a threat to the validity of this study, considering the modulating role of age and gender on VSWM (Castilla et al., 2022) and the plausible gender-specific differences in memory and exercise response (Loprinzi & Frith, 2018). The excluded male participants were then replaced with females accordingly. Thus, the population of this study is entirely female.

Control Group

The control group (n=23) trained at one training center. They were approached to participate in the study right before they were going to start their exercise session. They were informed of the pretest/posttest premise of the study and were asked to meet with the researcher right after they were done. The tests were usually taken between 10:00 a.m. and 4:00 p.m. on seven different days. The group's ages ranged from adolescents to retired individuals. Eleven people from the control group (49%) were 18-30 years old. There were four people (17%) from the age of 31-40 years old; three (13%) of them aged 51-60 years old, the other three (13%) were under the age of 18 (teenagers); one participant (4%) is between 41-50 years old; and one (4%) between 71-80 years old. They were approached to participate in the study inside the locker room before exercising, where there were fewer stimuli and a bench to sit on. On the variable of exercise frequency, nine (39%) of the respondents indicated that they exercise 3-4 times a week; seven (30%) of them train 1-2 times a week; four (17%) of them do so more than five times a week; while three (13%) of them exercise less than once a week – meaning not on a weekly basis.

Study Group

The intervention group (n=23) were individuals who deliberately booked a Zumba class on five different classes. They were approached to participate in the dance hall/studio before the dance intervention started. Eleven respondents were taken from a Zumba marathon charity event in a sports hall, while the other 12 were taken from a class on five occasions in three different centers; wherein a member of the facility can book an attendance on classes at designated time and centers lead by a trained Zumba instructor. Booking a class is done independently via an app. Those who went to the charity event are mostly regular attendees at Zumba classes at the fitness center. They were recruited to come to the event after hearing about it from the Zumba instructors after a session at the gym. The Zumba marathon is led by the same instructors affiliated with the fitness center where the other half of the study is held.

Nine of the dancers (39%) belonged to ages 31-40 years old. There were five people (22%) from ages 51-60 years old; four participants (17%) between 41-50 years old; two (2%) of them were between 18-30 years old; one (4%) under 18 (adolescent); (4%) one had an age range between 61-70 years old; and one (4%) within 71-80 years old. Most of the study group are regular dance class attendees. Nine of the respondents (39%) indicated that they take dance exercises 1-2 times a week; six (26%) of them regularly dance 3-4 times a week; four (17%) of them dance more than five times a week; while another four (17%) of them dance less than once a week – meaning not every week.

Materials

Zumba is the dance exercise being used as the medium of intervention to the study group. Visuospatial working memory is assessed using a modified spatial span task. Mood is assessed on a mood barometer scale. The study relies on a paper-based answering method.

Zumba

Zumba is a popular aerobic exercise with Latin-inspired choreography and music that has gained notoriety in the past decade. Its purported benefits include improved quality of life, response inhibition, and visuospatial working memory after a 6-month Zumba dance intervention reported in a study by Stonnington et al. (2019). Dances vary from salsa, merengue, cha-cha, samba, reggaeton, bachata, jive, calypso and flamenco to name a few. However, other forms of dance cultures have also been incorporated into the growing discipline, like belly dancing and African beats. The music is upbeat with Latin and pop songs, and a regular class usually lasts an hour. The steps vary in difficulty and agility. Similar to most group-based exercises, a session starts with a warm-up exercise with a slow-moderate tempo and then gradually increases the cardiovascular demand as the session progresses. From the fifteenth to the forty-fifth minute is a high-intensity level dancing. Toward the end, a cool-down exercise uses mellow beats and more subtle choreography.

Lastly, stretching is done at the end to culminate the affair. The premise of Zumba is that one should enjoy dancing to the beat of the music, not put too much pressure on oneself on how well choreography is executed and recognize that each one has their individual and unique dancing flair. Hence, its inclusivity welcomes everyone regardless of dancing capabilities.

According to different studies, a reduction in body parameters, improvement in respiratory functions (Ljubojevic et al., 2023), improvement in health-related quality of life, dimensions like vitality, physical role, and mental health (Barranco-Ruiz et al., 2020), and improved performance in visuospatial working memory and response inhibition (Stonnington et al., 2019) were observed after a Zumba intervention. With its ubiquity, this form of exercise has been catapulted into a popular habit. Consequently, giving the program more longevity and making it an easier habit to acquire.

Five different trained and experienced Zumba instructors taught the study group participants. Each had their discography of different music and choreography to different genres of Latin music but stayed true to the premises of Zumba dancing. However, several steps were observed to be common between different instructors' dance repertoires. Eleven data were gathered from a one-and-a-half Zumba marathon fundraiser led by different instructors. The same instructors also led the other 12 other data in a one-instructor regular class. Observably, there is an atmosphere of familiarity among the attendants. Many have been acquainted as regular dance participants, while others train with friends. Zumba dancers also had a notable diversity in age, ethnicity, and physical fitness level. Dance exercise has been shown to have a beneficial effect on health and cognition.

Visual and Spatial Working Memory Task

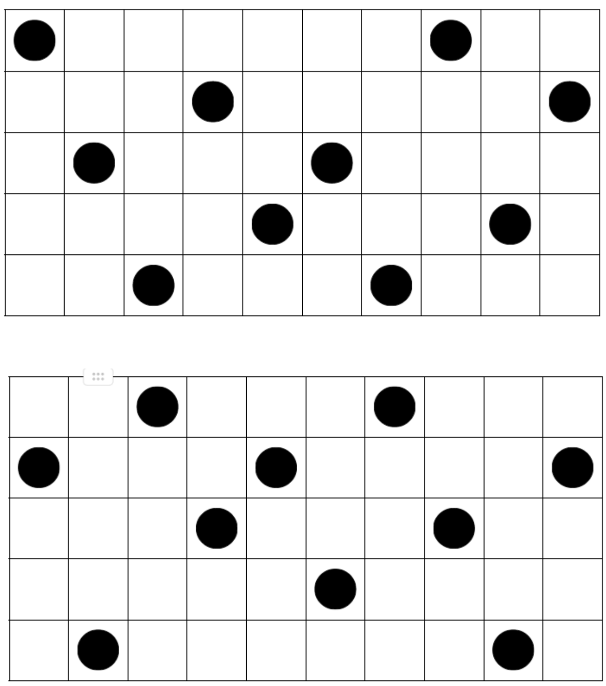
A simultaneous presentation of a five-by-ten dot matrix grid was used to assess the VSWM of the respondents. A dot test is one of the primary tests to assess visuospatial capability. It is used as one of the diagnostic measures for working memory assessment like the standardized Automated Working Memory Assessment. (Packiam Alloway, 2012). It is also used as one of the tests to assess VSWM abilities in diagnosing cognitive decline, comparable to finding the direct link of age on visuospatial memory in adults (Mammarella et al., 2013). It has also been tested as a reliable measure. After being used in a study with control group and a schizophrenic group, moderate test-retest reliability was considered on the dot test on a paper-based answering, making it a valuable tool for repeated measures designs (Bollini et al., 2000). Different versions of the test are predominantly used to assess VSWM. A similar version is used in developmental psychology, specifically in the assessment of children's visuospatial skills (Boerma & Blom, 2020). A similar yet more juvenile version using animal figures deemed as a valid and reliable instrument for the online computerized and self-reliant measurement of visuospatial working memory (Van de Weijer-Bergsma et al., 2015).

In lieu of limited resources, a modified version is employed with dots placed at random placements designed by the researcher. The dots are carefully placed to promote image ambiguity. Ten dots were filled in the grid and each correct placement is scored, ending with a 10-item scale. Individual scores were calculated according to the number of correct placements. A pilot test comprising a four-by-ten matrix was done initially with a 30-second processing time, but it showed a ceiling effect on the dependent variable. Additional items were added to counteract the effect. Hence, the five-by-ten dot matrix task with a 20-second working memory concentration time. A paper-and-pen-based answering is observed in the entire study, printed on an A4-white sheet, and portrait orientation. Questionnaires were printed in black and white color. Despite the onset of digital versions, Bailey et al. (2018) found that paper-based tests demonstrated increased reliability compared to computerized versions of spatial tests. The simultaneous dot matrix task is exposed to each respondent for 20 seconds while the researcher timed the processing using an Apple iPhone

Pro11 clock timer. The time interval rationale is based on the findings that working memory has a short duration of approximately 30 seconds maximum (Lawson et al., 2015). Assuming that respondents can have the 10-second remainder of the maximum time to retain the dot pattern and enough to answer the empty matrix grid. A study using similar methods was assumed to have higher test-retest reliability for the performance of subjects at a similar task after a 10-second delay (Bollini et al., 2000). The simultaneous exposure of the task is opted for based on a study by Lecerf & De Ribaupierre, (2005) where a presentation on a six-by-six matrix has led subjects to be superior in recalling patterns in simultaneous exposure over sequential presentations.

Figure 1

Example of the 5x10 Dotted Grid Used for the Visuospatial Working Memory Tas



Note: Scores were based on correct dot placements. Counterbalancing was observed at pretest and posttest measures.

Mood Scale

An essential subjective assessment of the affective state is also assessed in the study. A mood scale is a quintessential tool that evaluates personal feelings momentarily. The appraisal was needed to compare the difference in mood brought by dancing compared to strength training, and if there is a significant difference between groups. A six-point mood scale is employed, ranging from very happy (coded as 1), slightly happy (coded as 2), neutral (coded as 3), slightly sad (coded as 4), sad (coded as 5), to stressed/angry (coded as 6). This is a modified version of the five-point anger scale. The inclusion of a neutral scale was added with the possibility of extending the variance of positive to negative emotions. Since exercise is known to be associated with positive emotions evidently even after a single session (Basso & Suzuki, 2017), the mood scale used is modified to extend the deviation from positive to negative emotions. The presentation of the mood question is asked before the working memory task and on the same sheet of paper as the demographic question about age, gender, frequency of exercise, or music exposure (for the control group post-test). Six emoji figures in vertical placement were created in colored print. A short description is written beside the emoticon figures. A recent study by Toepoel et al., (2019) stated that in this emoji-using generation, survey question respondents evaluated the emoji design most positively among eight other different designs. It is a practical tool also especially when asking questions in a limited amount of time. A recent study by Ligeza et al. (2023) reported an improvement in self-reported mood after a single aerobic exercise session on both depressed and non-depressed subjects. With dance being also an aerobic exercise, the investigation of its superiority against a non-aerobic group is highlighted.

Figure 2

Mood Scale Used in the study

Note: The 6-point-mood scale used in the study with super happy=1, stressed/angry=6.

Procedure

First, the respondents were approached to participate in a study investigating the effects of different exercise modalities on cognition. The affiliation of the researcher was communicated as well, that is for a BA in psychology research paper. Then, they were informed of the scope of information needed for the study and that it would take not more than five minutes to answer. Those who voluntarily agreed proceeded with the next which was the presentation of the informed consent *(see Appendix A for a copy).* After reading the consent, they started filling in the questionnaire. Information about age, gender, frequency of physical exercise habits, and the current mood was asked. The independent variables were categorized as follows – gender: male or female; age: under 18 years old, 18-30 years old, 31-40, 41-50, 51-60, 61-70, 71-80, and over 80 years of age; frequency of exercise: less than once a week, 1-2 times a week, 3-5 times a week, and more than five times a week. A mood scale is also to be answered before exposure to exercise. The mood ranges from super happy, slightly happy, neutral, slightly sad, sad, and stressed/angry. All these queries were on one page to answer. A copy of the entire questionnaire can be seen in the Appendix section *(see Appendices)*. Proceedingly, participants were to answer the VSWM task which required them to concentrate on remembering the placements of the dots in a 5x10 matrix grid *(see Figure 1)*. They were given 20 seconds to try to concentrate as the researcher stood on the side, with a timer using the iPhone 11 pro clock app. Soon after, they were tasked to try to replicate the placements as much as they could remember on the blank grid on the next page. There was another filler sheet between the VSWM task figure and the answer sheet grid to obscure the visibility of the dotted pattern upon answering. After this, they moved on with their exercises which took at least an hour. They were informed to meet again later for another test.

Upon posttest, a follow-up question about the respondent's current mood was re-evaluated, an. In addition, they were to perform the same VSWM 5x10 grid dot-pattern task. The material is counterbalanced; thus, they were presented with a different pattern of dot placements. This is done to prevent practice effect – a research phenomenon that could falsely increase post-test scores. Some respondents were surprised to be reacquainted with the questionnaire, while a few of them anticipated the posttest. Some noticed that it was not the same pattern. There was no time limit as to how long they spent answering the tasks, but most were done after a few minutes. The answering of the questionnaire did not last more than five minutes. Some expressed frustration after experiencing that the memory faded quickly while answering. While some others took it very lightly and complacently accepted their utmost effort. When answering the mood posttest, there were about 3 respondents who verbalized that they should assume a better mood than they had pretest. They were then consciously advised to answer based on their subjective experience at the moment. One of the particular posttest commentaries was that the respondents felt tired after the exercise, mostly the control group. Although there were a couple of dancers who expressed the same sentiments.

The testing location is performed in a natural, uncontrolled environment. Some answered the test in the locker room, while others in the dance studio for a majority of the study group. Nonetheless, respondents answered the posttest in the same environment where they took the pretest. On the supplementary question about listening to music while doing their exercise that was required from the control group posttest, 14 of the respondents affirmed that they listened to music while strength training. They listened to music using their headphones. Eight of them said that they did not listen to any music, while one did not answer. However, it is worth mentioning that music was constantly playing in the fitness center regardless and despite the discreet volume, one could hear music through speakers situated at various corners of the location.

Ethics Statement

The researcher had gained permission from the administration of the local gym to be able to conduct this study. Consent was also given from the organizers of the Zumba marathon event where some data of the study was gathered from. The University of Stavanger approved this study involving human participants. Each one of them was approached and informed about the nature of the study, the amount of time needed to answer, the number of measures, and the kind of personal information it required. It was on a voluntary basis. Those who initially answered the pretest, but thought differently during the posttest, were retracted from the study and initially withdrawn. Informed consent is presented to them about the nature of the study questions. Their information was stated to be kept safe, and anonymity was observed. No personal questions were asked other than gender, age, and training frequency. Although, they were required to write their first names on a post-it note attached temporarily to the questionnaires for the purpose of identifying individual pretests from posttest sheets that belonged to the same person. The paper was later removed and destroyed, and they were also informed that their names would not transpire in data publishing. After the intervention, some participants expressed feeling tired due to the physical impact of the exercise. Some verbalized dissatisfaction with their performance on the VSWM task. No compensation is given to the respondents.

Results

To compare the effect of Zumba dancing on visuospatial working memory between the study group and the control group, data analysis is done using *IBM SPSS Statistics 28*. Of the 55 participants who completed the pretest/posttest study, nine males were excluded from the control group due to compromised gender demographics between the study and control groups.

Descriptive Statistics

Final statistical analysis using an all-female demographic (study group n=23; control group n=23) showed that 47.8% of the control group were between 18-30 years old (*M*=2.7, *SD*=1.5), and a majority of 39.1% exercised 3-4x per week (*M*=2.5, *SD*=.9). In comparison, the study group majority had 39.1% between ages 31-40 years old (*M*=3.7, *SD*=1.4), and 39.1% danced 1-2x per week (*M*=2.4, *SD*=1.0). In the 10-point scale visuospatial working memory task, the control group pretest mean was *M*=5.40 (*SD*=2.6) and *M*=4.00 (*SD*=1.8) posttest. The study group scored *M*=4.70 (*SD*=2.1) pretest and *M*=4.74 (*SD*=2.2) posttest. On the mood scale of 1 to 6 (1=very happy, 6=stressed/angry), 69.6% of the control group were slightly happy (*M*=2.2, *SD*=.7) pretest and 56.5% were slightly happy posttest (*M*=1.8, *SD*=.7). Of the study group, 47.8% were very happy (*M*=1.7, *SD*=.8) pretest and 78.3% were very happy (*M*=1.2, *SD*=.4) posttest. In addition to the measures of scores in VSWM and mood, the non-dancing control group had to indicate their exposure to music while exercising, which was 61%.

Normality Testing

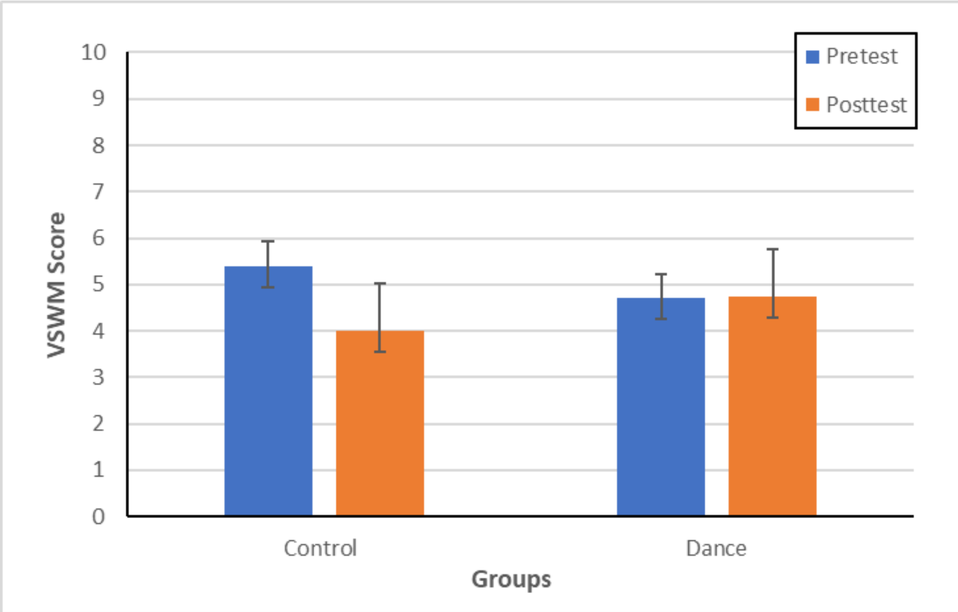
To assess the distribution of the dependent variables, a test of normality and variance on the pre/posttest moods and VSWM scores was done for each group. Shapiro-Wilk test showed a normal distribution on the VSWM pretest and posttest scores for both groups: the control group pretest was W(23)=0.96, p=.53, and was W(23)=0.93, p=.09 posttest; the study group VSWM scored W(23)=0.92, p=.08 pretest, and W(23)=0.95, p=.33 posttest. However, the mood scale yielded significant results for both groups. The control group had W(23)=0.75, p=<0.001 pretest and W(23)=0.79, p=<0.001 posttest. The study group had W(23)=0.77, p= <0.001 pretest and W(23)=0.51, p= <0.001 posttest.

VSWM Scores

To investigate the effect of the intervention on VSWM task scores, a repeated measures ANOVA is calculated within and between subjects. A statistically significant interaction effect is present between the study group and the control groups' pre/posttest scores on the VSWM task (F(1,00) = 4.484, p =.040, η^2=.092). To assess the difference in the VSWM scores within groups, a paired sample t-test was analyzed. The result showed that the mean posttest scores of the control group (*M*=1.43*, SD=2.45, 95% CI* =0.38-2.49) were significantly lower than the pretest (*t=2.81, df= 22, p=* .010). The effect size was medium, with a Cohen's d of 0.57 after Hedges correction. On the contrary, the study group (*M=-.43, SD=2.29, 95% CI* = -1.03-0.95) had no significant differences in pretest and posttest scores on the VSWM task (*t=-.09, df= 22, p=* .93).

Figure 3

Group Pretest and Posttest Scores on the Visuospatial Working Memory Task



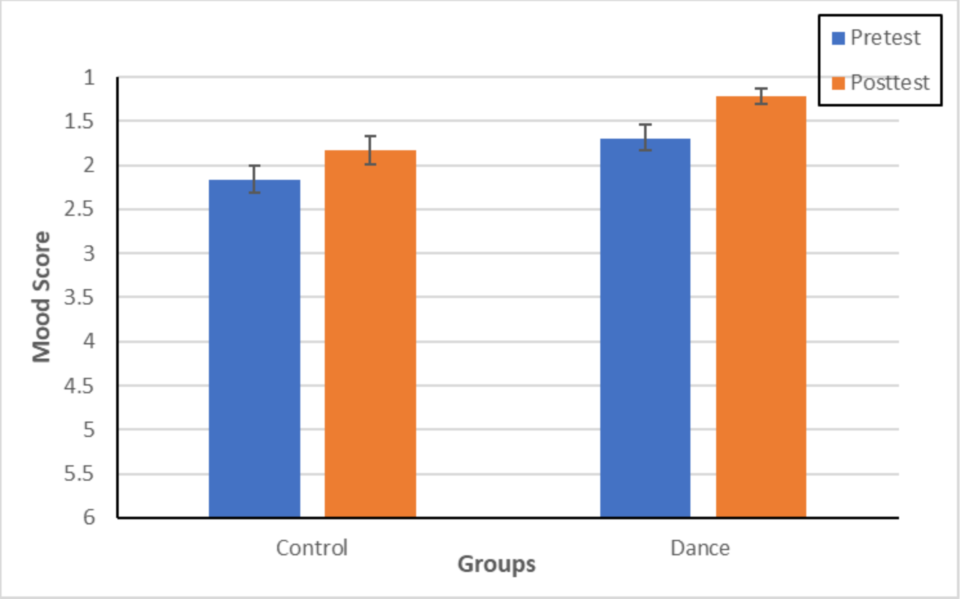
Note: Performance scores by the control group and dance (study) group on the 10-point visuospatial working memory task. Error bars show standard errors.

Mood Score

To test the difference in scores within each group, a nonparametric Wilcoxon signed rank test was ran in each group population. This test indicated that the posttest mood assessment in the control group was statistically and significantly lower than the pretest mood with a medium effect size (Z= -2.309, p<.021, r= -0.34). Comparingly, the study group had no statistically significant difference in pretest and posttest mood (Z= -.151, p<.880).

Figure 4

Group Pretest and Posttest Scores on the Mood Scale



Note: Scores are based on the pretest and posttest self-report on a 6-point mood scale where 1= very happy and 6= stressed/angry. Error bars show standard errors.

Discussion

This study aimed to investigate the immediate effect of dancing (Zumba) on cognition, primarily visuospatial working memory, and mood. Currently, there are limited amounts of significant studies supporting the direct effects of dancing on visuospatial working memory. Relatively, the results of the present study had statistically insignificant data supporting the hypothesis that dancing promotes visuospatial superiority compared to gym equipment exercise. Although the study group had not outperformed the control group in the VSWM task, they were able to preserve a better score trajectory than the control group. The control group had a higher pretest mean (M=5.40, SD=2.6) than the study group (M=4.70, SD=2.1), yet the control group means depreciated posttest (M=4.00, SD=1.8) while the study group did not (M=4.74, SD=2.2). The result is supported by a statistically significant lower control group score posttest (M=1.43, $SD=2.45$, $95\%\ CI$ =0.38-2.49) and a consistent study group task score ($M=-.43$, $SD=2.29$, $95\%\ CI$ = -1.03-0.95).

As for the mood scale, the study group reported consistently high subjective mood (very happy) both pretest and posttest. The control group, however, had a more different pretest/posttest trajectory (Z= -2.309, p<.021) and scored lower (from very happy to slightly happy posttest) than their counterparts (Z= -.151, p<.880). Nonetheless, both groups reported positive moods at pretest and posttest collectively. This pattern of results is consistent with the previous literature on the uncertain modulating role of dancing on spatial memory (Noguera et al., 2020). Whereas past research using Zumba indicated otherwise, with an improved visuospatial working memory post-intervention (Stonnington et al., 2019). Compared to this, the latter was assessed after a 6-month randomized controlled study. More experimental control could have been beneficial to avoid type II errors. However, it is worth noting that given the limited resources of the researcher, this could be a potential alteration to consider in future studies.

The exposure of the control group to music is also a factor to consider in the VSWM results. It was 61% of the control group was directly listening to music on their headphones while exercising. This could have affected the results. The music could have contaminated the control group since the intervention also involved music. Also, even if the others in the control group did not intend to listen to music while exercising, there was some music in the fitness center. The rhythmic element of the music could have potentially activated the visuospatial areas of the brain as it did to the study group.

On the mood scale, despite high positive mood scores in both groups at pretest and posttest measures, the dancers outscored the non-dancers on both occasions. The high scores of both groups are consistent with Basso & Suzuki's (2016) findings on the positive effects of a single exercise on mood. The amplified response from the study group can be attributed to the fact that there is a social aspect to Zumba classes. Being placed in an environment set for fun with upbeat music in the background and familiar faces (for regular attendees) puts legitimate grounds for one to have a good mood. Since most of the control group is exercising independently, a social aspect is probably the missing factor for the control group to be on par with the dancers. This coincides with the findings of Basso et al., (2021) and Yamasaki et al. (2021), which showed that neurochemical brain activity and the enjoyment gained from social dancing being the motivational factor in consistent dance activity participation. However, there is also a point in arguing if people inclined to dance have a naturally cheerful disposition than those who do not. Or if it is vice versa where the dancing makes one happier. This argument could be a potential question for future research on dance and mood.

Limitations and Implications

Aside from the above-mentioned limitations and implications, there are a few other constraints of this study that could be addressed for future research. One of them is the exposure of the control group to music is a factor to consider in the VSWM results. It was 61% of the control group that was directly listening to music on their headphones while exercising. And even if the others in the control group did not intend to listen to music while exercising, there was music playing constantly in the fitness center. Relating to the findings by Ribeiro et al. (2022) that positive emotions through music could cause VSWM advancements, it is possible that the active and passive exposure to music could have contaminated the control group's performance on the working memory task. And since the present research cannot directly link VSWM improvement to either music or dance alone, there is an open plausibility that the rhythmic element of the music could have potentially activated the visuospatial areas of the brain like it did the study group. Not having the control group listen to music is considered relevant for future studies.

Another potential limitation of this study is the VSWM tool used. A paper-based answering could have distracted the participants since they need to pay extra attention to other things related to writing their answers like flipping the next page and holding the paper in place or opening the lid of a pen. The impracticalities of a manual task could have provided a mental distraction for those who could have scored better. A digitalized answering method could have been a better iteration for future similar studies. In a similar vein, considering a different VSWM task could also be interesting to use, like the Corsi block tapping test. Although Bailey et al. (2018) supported paper-based testing's reliability on spatial tests, the convenience of administering a digital questionnaire has more capabilities to do multiple tests in a short span of time. Studies with significant results by Guo et al. (2016) and Stonnington et al., (2019) employed computerized questionnaires and ran a number of tests not accessible to public domain. Although arguably, having multiple tests could fatigue the respondents and might discourage participation.

A more contained and quieter environment could have also helped the scores on the VSWM task, for instance, uncontrollable sudden events like noise must be kept to a minimum for future study. Having the participants answer in a quiet and separate room with little stimuli could promote more concentration. Some participants, particularly those in the control group, expressed feelings of tiredness posttest which may have affected their posttest scores both in the VSWM task and the mood scale. Some of the participants came from work, some of them trained too much, while others felt frustrated from their perceived performance in the task.

Another major limitation in this study is the lack of experimental control. Using randomization and having control of the intervention study could have been an alternative suggestion. Adding more comparison groups could also be a major study suggestion conducted at a larger level. Full control of the participants and their environment may have reduced inevitable environmental disruptions. Additionally, a longitudinal approach, i.e. – longer study duration, may be employed to better assess the trajectory of control versus study groups. In comparison, Stonnington et al. (2019) and Aguiñaga et al. (2022) both conducted their randomized controlled study for a minimum of six months. On the other hand, Guo et al. (2016) employed a cross-sectional approach but had kept selective inclusion criteria. Thus, if immediate effect of the construct is to be explored, the control of the intervention and environment is of primary concern for future research.

Finally, the age difference between groups and the small number of participants representative of different age groups made it statistically ineffective to run analyses based on age. It would be useful to extend the current results by adopting a larger and more diverse population. Stratifying the respondents in age, gender, and dance exercise frequency could be explorative of the different correlational effects of dance and VSWM based on different factors.

Despite these challenges and limitations, this research is one of the few studies to investigate the immediate effects of dance on VSWM. Based on the results, there is no significant link between the two. Although this study did not fully support the dance towards neuroplasticity narrative, it still showed a consistent result of VSWM at pretest and posttest measures, nonetheless not a negative outcome. On the contrary, the mood scores provided significant evidence that dance does give a highly positive experience to those who chose to engage in it. Hopefully, this study could encourage future investigation into the association of dance and visuospatial working memory for more cognitive health improvement research.

Conclusion

This study is one of the few attempts to measure and compare the immediate effects of dancing on mood and visuospatial working memory. Findings showed that dancing elicits a highly positive mood, both at pretest and posttest, even more than non-dancers. This result exhibits the initial cognitive benefits of social dancing as it contrives a favorable atmosphere among the performers. Contrary to what was presumed, the dance group did not have an improvement in the visuospatial working memory task posttest, while the control group's score decreased. Although this study did not have significant claims linking VSWM to dance, it has attempted to make small progress on understanding the construct using fundamental resources. A more experimental-contained environment is strongly suggested to be able to discriminate factors belonging to the study group and the control group.

This study implies that dancing is an exercise to be reverted to when desirous of having a full-body experience and a socially engaging activity. It is a practical recreational activity with potentially impactful benefits, which have yet to be fully studied and/ or proven. Nonetheless, it is an engaging gateway activity to promote physical and psychological wellness. Its continuous potential claims to neuroplasticity are still there to explore. Future research on this study should assume more experimental control with a larger study population, stratified sampling regarding age and dance practice, and more sophisticated instruments to measure VSWM more accurately. Eventually, a study methodology requiring longer-duration experiments like a follow-up measure could potentially aid in determining long terms benefits.

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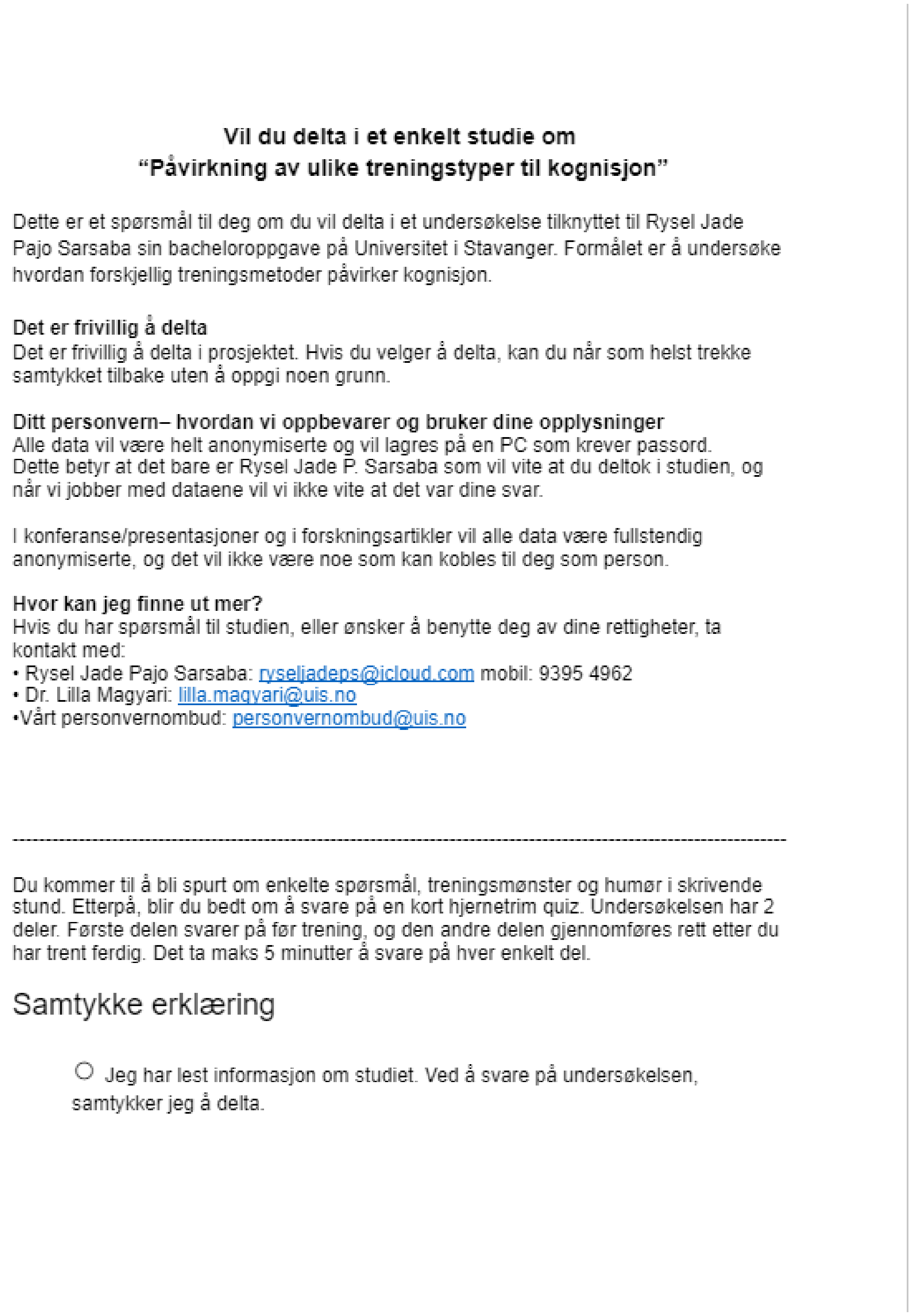
Appendices

Appendix A

Informed Consent Attached to the First Page of the Questionnaires



Vil du delta i et enkelt studie om
"Påvirkning av ulike treningstyper til kognisjon"

Dette er et spørsmål til deg om du vil delta i et undersøkelse tilknyttet til Rysel Jade Pajo Sarsaba sin bacheloroppgave på Universitet i Stavanger. Formålet er å undersøke hvordan forskjellig treningsmetoder påvirker kognisjon.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn.

Ditt personvern– hvordan vi oppbevarer og bruker dine opplysninger
Alle data vil være helt anonymiserte og vil lagres på en PC som krever passord. Dette betyr at det bare er Rysel Jade P. Sarsaba som vil vite at du deltok i studien, og når vi jobber med dataene vil vi ikke vite at det var dine svar.

I konferanse/presentasjoner og i forskningsartikler vil alle data være fullstendig anonymiserte, og det vil ikke være noe som kan kobles til deg som person.

Hvor kan jeg finne ut mer?
Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:
• Rysel Jade Pajo Sarsaba: ryseljadeps@icloud.com mobil: 9395 4962
• Dr. Lilla Magyari: lilla.magyari@uis.no
•Vårt personvernombud: personvernombud@uis.no

Du kommer til å bli spurt om enkelte spørsmål, treningsmønster og humør i skrivende stund. Etterpå, blir du bedt om å svare på en kort hjernetrim quiz. Undersøkelsen har 2 deler. Første delen svarer på før trening, og den andre delen gjennomføres rett etter du har trent ferdig. Det ta maks 5 minutter å svare på hver enkelt del.

Samtykke erklæring

○ Jeg har lest informasjon om studiet. Ved å svare på undersøkelsen, samtykker jeg å delta.

Appendix B

Example of Questionnaire for the Study Group : Pretest

Dans-gruppe: *Pre-test*

Vennligst kryss av tilsvarende:

Kjønn:

- ○ Mann
- ○ Kvinne
- ○ Ønske ikke oppgi

Hvor ofte går du på dansetrening?

- ○ mindre enn 1 gang per uke
- ○ 1-2 ganger per uke
- ○ 3-4 ganger per uke
- ○ 5 ganger eller mer per uke

Alder:

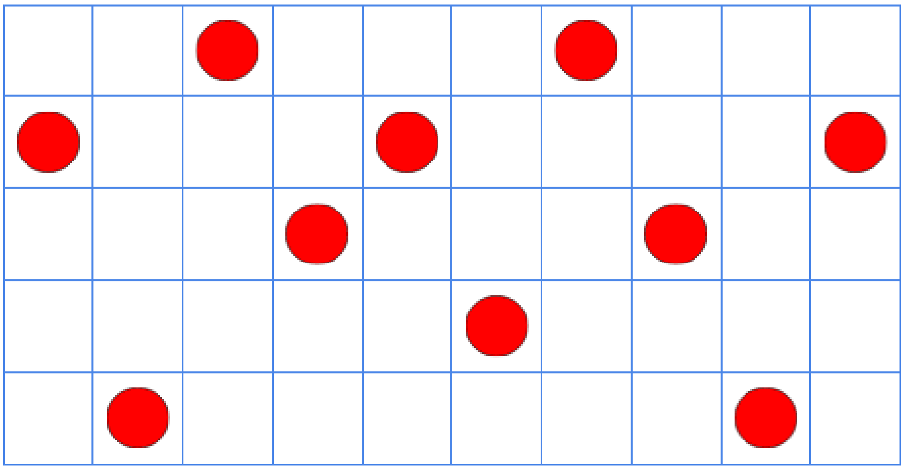
- ○ 18-30 år
- ○ 31-40 år
- ○ 41-50 år
- ○ 51-60 år
- ○ 61-70 år
- ○ 71-80 år
- ○ 80+ år

Hvordan føler du deg i skrivende stund?

- ○ Kunne ikke vært bedre (super happy)
- ○ Helt fint (slightly happy)
- ○ Neutral- Greit.Kan ikke klage
- ○ Litt lei (slightly sad)
- ○ Lei (sad)
- ○ Ikke bra i det hele tatt (stressed/angry)

Hjernetrim:

Nå få du tildelt et ark med mønster.
Du få nå 30 sekund for å prøve å **huske figuren**. Etterpå så skal du prøve å plassere de prikkene i riktig plass på neste siden. Arrangøren holde tiden mens du konsentrere deg med huskeoppgaven.



Note: This appeared in black and white on the disseminated questionnaires.

Besvarelsesarkt:

Så mye du klarer, vennligst plassere de prikkene på riktig plass. Du kan gjerne bruke et kryss (❌), runding (⭕), eller sjekk (✔) etter preferanse. Det viktigste er å prøve å fylle på tilsvarende plassering ut fra visste oppgaven.

Note: This appeared in black and white on the disseminated questionnaires.

Appendix C

Example of Questionnaire for the Study Group : Posttest

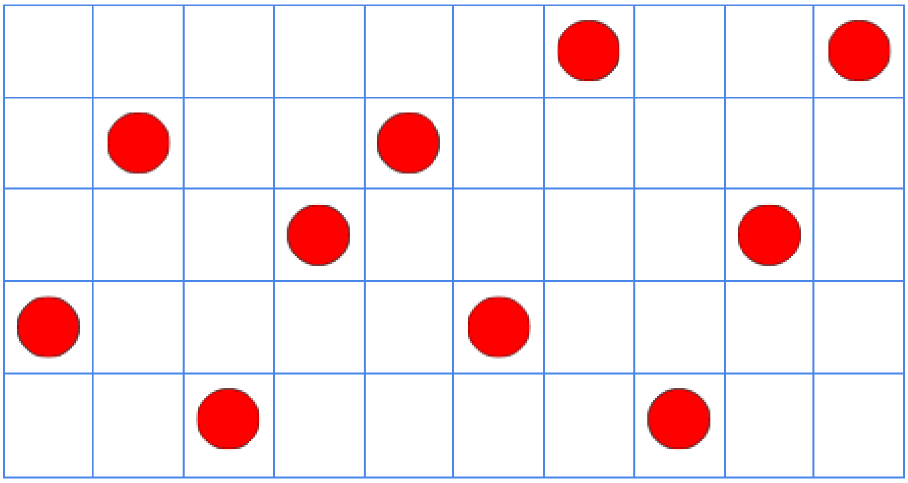
Del 2: *Post-test (dans)*

Hvordan føler du deg i skrivende stund?
Vennligst krysse tilsvarende.

- ○ Kunne ikke vært bedre (super happy)
- ○ Helt fint (slightly happy)
- ○ Neutral- Greit.Kan ikke klage
- ○ Litt lei (slightly sad)
- ○ Lei (sad)
- ○ Ikke bra i det hele tatt (stressed/angry)

Hjernetrim: igjen ✌

Nå skal du få en liknende oppgaver som sist. **Prøv nå igjen å huske mønsteret**. Du få 30 sekund for å huske dette. Så skal du prøve å plassere prikkene på riktig plass på neste siden. Arrangøren holde tiden mens du konsentrere deg med huskeoppgaven.



Note: This appeared in black and white on the disseminated questionnaires.

Besvarelsesarkt:

Så mye du klarer, vennligst plassere de prikkene på riktig plass. Du kan gjerne bruke et kryss (❌), runding (⭕), eller sjekk (✔) etter preferanse. Det viktigste er å prøve å fylle på tilsvarende plassering ut fra visste oppgaven.

Tusen takk for din tid og god samarbeid! 🙂

Note: This appeared in black and white on the disseminated questionnaires.

Appendix D

Example of Questionnaire for the Control Group: Pretest

Pre-test

Vennligst kryss av tilsvarende:

Kjønn:

- ○ Mann
- ○ Kvinne
- ○ Ønske ikke oppgi

Hvor ofte går du på trening?

- ○ mindre enn 1 gang per uke
- ○ 1-2 ganger per uke
- ○ 3-4 ganger per uke
- ○ 5 ganger eller mer per uke

Alder:

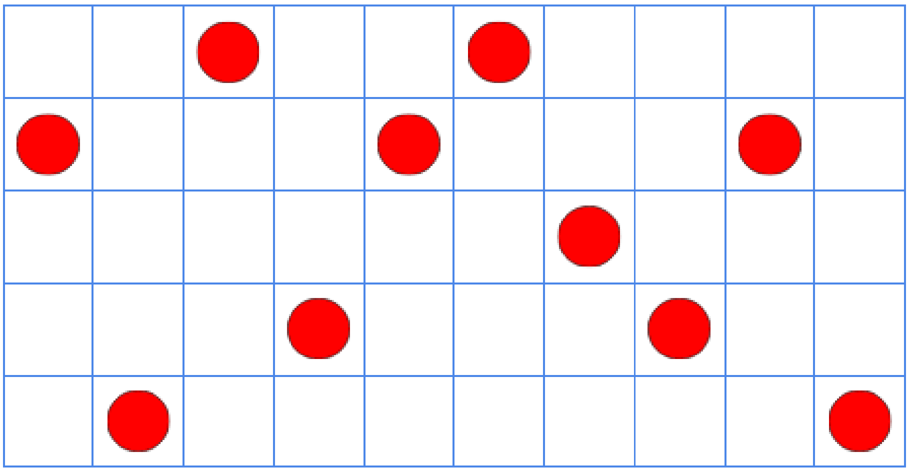
- ○ 18-30 år
- ○ 31-40 år
- ○ 41-50 år
- ○ 51-60 år
- ○ 61-70 år
- ○ 71-80 år
- ○ 80+ år

Hvordan føler du deg i skrivende stund?

- ○ Kunne ikke vært bedre (super happy)
- ○ Helt fint (slightly happy)
- ○ Neutral- Greit.Kan ikke klage
- ○ Litt lei (slightly sad)
- ○ Lei (sad)
- ○ Ikke bra! (stressed/angry)

Hjernetrim:

Nå få du tildelt et ark med mønster.
Du få nå 20 sekund for å prøve å **huske figuren**. Etterpå så skal du prøve å plassere de prikkene i riktig plass på neste siden. Arrangøren holde tiden mens du konsentrere deg med huskeoppgaven.



Note: This appeared in black and white on the disseminated questionnaires.

Besvarelsesarkt:

Så mye du klarer, vennligst plassere de prikkene på riktig plass. Du kan gjerne bruke et kryss (❌), runding (⭕), eller sjekk (✔) etter preferanse. Det viktigste er å prøve å fylle på tilsvarende plassering ut fra visste oppgaven.

Note: This appeared in black and white on the disseminated questionnaires.

Appendix E

Example of Questionnaire for the Control Group: Posttest

Del 2: *Post-test*

Hvordan føler du deg i skrivende stund?
Vennligst krysse tilsvarende.

○ Kunne ikke vært bedre (super happy)

○ Helt fint (slightly happy)

○ Neutral- Greit.Kan ikke klage

○ Litt lei (slightly sad)

○ Lei (sad)

○ Ikke bra i det hele tatt (stressed/angry)

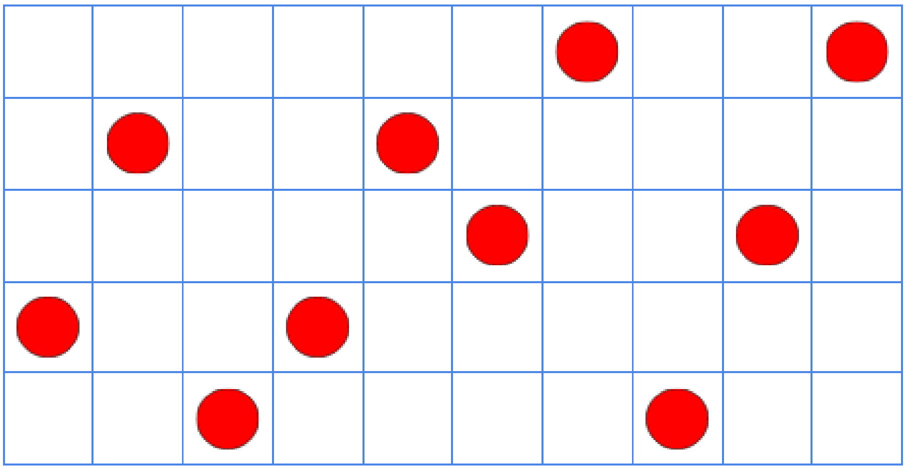
Hørte du på musikk mens du trent?

- ☐ Ja
- ☐ Nei

Del 2: *Post-test*

Hjernetrim: igjen ✌

Nå skal du få en liknende oppgaver som sist. **Prøv nå igjen å huske mønsteret**. Du få 20 sekund for å huske dette. Så skal du prøve å plassere prikkene på riktig plass på neste siden. Arrangøren holde tiden mens du konsentrere deg med huskeoppgaven.



Note: This appeared in black and white on the disseminated questionnaires.

Besvarelsesarkt:

Så mye du klarer, vennligst plassere de prikkene på riktig plass. Du kan gjerne bruke et kryss (✕), runding (○), eller sjekk (✓) etter preferanse. Det viktigste er å prøve å fylle på tilsvarende plassering ut fra visste oppgaven.

Tusen takk for din tid og god samarbeid! 🙂

Note: This appeared in black and white on the disseminated questionnaires.