The Benefits of Music Instruction on Processing Speed, Verbal Fluency, and Cognitive Control in Aging

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Abstract
The purpose of this research was to examine the effects of active music instruction in piano compared with music listening instruction on executive function in healthy older adults (ages 60-85). Seventy adults were matched by age, education, and estimated intelligence in two 16-week training groups: group piano instruction (GPI) and music listening instruction (MLI). Participants completed a battery of cognitive assessments pre- and post-instruction to examine processing speed, verbal fluency, planning, and cognitive control. Forty-six participants (24 in GPI, 22 in MLI) completed the study. Results of a series of repeated measures ANOVAs reveal no significant group differences on measures of executive function as both groups demonstrated an increase in scores. To further examine the effects of training on specific cognitive abilities, separate analyses of paired t-tests for each independent group indicate significantly enhanced processing speed, verbal fluency, and cognitive control for GPI participants. These results suggest the importance of active music making in community music programs.

Older adults represent a large target group for increased participation in music education initiatives. Adults are interested in developing musical skills with opportunities for aesthetic experiences, group socialization, and cognitive maintenance (Jutras, 2006). While many studies detail the effects of music instruction on cognitive abilities in young children, few examine the effects of musical training on cognitive abilities in older adults. Can music-making offer cognitive benefits to older adults? The purpose of this research is to examine the effects of active versus passive music instruction on cognitive abilities in older adults and to evaluate specific cognitive transfer stemming from musical training programs.

Successful aging has been described as, “one’s potential to arrive at a level of physical, social, and psychological well-being in old age that is pleasing to both self and others” (Gibson, 1995, p.279). One common barrier to successful aging is decreased performance in cognitive abilities, such as executive function and working memory tasks due to age-related cognitive decline (Salthouse, 1994; Wecker, Kramer, Hallam, & Delis, 2005). Specifically, aging has been associated with decreased processing speed, limited working memory capacity, and decreased performance on inhibitory tasks. Decreases in processing speed have been attributed to cognitive slowing (Salthouse, 1996). In addition, control processes may account for limited working memory capacity as research has suggested that older adults have difficulty ignoring irrelevant information.

Many cognitive interventions, designed to mitigate age-related deficits, demonstrated only short-term success with little potential for transfer or fail to be replicated outside a laboratory setting (Lustig, Shah, Seidler, & Reuter-Lorenz, 2009). Previous research suggested older adults choose to use alternative strategies or ignore recently learned encoding strategies, resulting in the inability to generalize training outcomes (Scoggin, Storandt, & Lott, 1985). Several studies attempted to account for encoding difficulty by modifying memory strategies and providing active rehearsal sessions. Results of one such study indicated rehearsal of free recall strategies with instruction beneficial to learning categorization of word lists; however, without instruction, there is no significant application of trained strategies (Schmitt, Murphy, & Sanders, 1981). PET results confirmed that older adults did not lack the neural resources for mnemonic usage; however, some adults found strategies difficult to associate or chose to use their own strategies due to familiarity or perceived effectiveness (Nyberg et al., 2003). Educational opportunities often provided opportunities for individuals to build upon their own learning strategies through a progressively difficult curriculum. Research suggested that educational opportunities had the potential to protect against cognitive decline (Ghisletta, Bickel, & Lovden, 2006). A key challenge was to discover enjoyable cognitive interventions that transfer beyond the domain of training to everyday situations. The current study evaluated music instruction as a perspective cognitive intervention and the role of such training on cognition in an aging sample.

Music is a multimodal, complex stimulus known to affect various cognitive processing systems. Music listening could improve verbal fluency and reduce tension in older adults (Hirokawa, 2004;

Thompson, Moulin, Hayre, & Jones, 2005). In addition to verbal fluency, there were considerable linkages between music and language with regard to syntax and semantics as shown by research in harmonic structure (Koelsch, 2005). Furthermore, musical training has been correlated with perception of pitch contour in language (Schon, Magne, & Besson, 2004). Although there were limitations associated with research in music listening, such as inconsistencies regarding musical stimuli and comparisons of differential musical expertise, this research offered insight into the mechanisms that supported music perception and the beneficial effects of music listening (Seung, Kyong, Woo, Lee, & Lee, 2005).

Music instruction benefited executive, spatial, temporal, and verbal memory functions in many populations, indicating transfer capabilities. Musical training was correlated with higher verbal memory performance among college students and young children (Chan, Ho, & Cheung, 1998; Ho, Cheung, & Chan, 2003). Four-year-old children receiving ten minutes of piano instruction up to twice a week performed better on spatial-temporal task performance assessments than children receiving computer training (Rauscher, Levine, Shaw, & Wright, 1997). After eight months of piano instruction, kindergartners displayed greater improvements in spatial abilities than the control group (Rauscher & Zupan, 2000). Six-year-olds scored significantly higher on a Short-Term Memory subtest of the Stanford-Binet Intelligence Battery after receiving thirty weeks of music instruction (Bilharz, Bruhn, & Olson, 2000). Preliminary research has shown a multimodal intervention, individualized piano instruction (IPI), has the ability to significantly enhance some working memory and executive processes such as attention and concentration, working memory, and planning and strategy learning in older adults (Bugos, Perlstein, McCrae, Brophy, & Bedenbaugh, 2007). The purpose of this research was to further examine the effects of active music making in group piano instruction (GPI) and music listening instruction (MLI) on processing speed, verbal fluency, planning, and cognitive control. I hypothesized that group piano instruction (GPI) would enhance processing speed, verbal fluency, planning, and cognitive control compared to matched controls receiving music listening instruction (MLI).

Methods

Participants

Seventy community dwellers participated in the study. Participants were recruited through advertisements in the paper, radio, community organizations, and the area councils on aging. Criteria for study enrollment consisted of being between the ages of 60-85, native English speakers, no history of colorblindness, no prior history of neurological impairment such as stroke or dementia, no difficulty with the movement of their hands, less than three years of prior musical training, and not currently engaged in music reading or musical performance. All potential participants completed a short telephone interview, *Telephone Interview for Cognitive Status* (TICS) (Brandt, Spencer, & Folstein, 1988), to screen for Alzheimer's disease. Potential participants were required to score a minimum of 30 on the TICS to participate. Participants were also screened for depression with the *Beck Depression Inventory* (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961; cut off score of <11) and *Geriatric Depression Scale* (GDS; Yesavage, Brink, Rose, & Adey, 1983; cut-off score of > 10/30). Written informed consent was obtained from all participants prior to study enrollment.

Description of Measures

Advanced Measures of Music Audiation (AMMA) (Gordon, 1989) was a measure of music aptitude that yielded tonal and rhythmic composite scores based on 30 paired-melodic phrases. Participants must determine if the phrases were the same, tonally different, or rhythmically different. The AMMA was chosen for its reliability (r = .81) and content validity.

Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999) contained four short subtests used to estimate full-scale IQ, verbal IQ, and performance IQ. These subtests include Vocabulary and Similarities subtests to estimate verbal IQ (VIQ) and Block Design and Matrix Reasoning subtests to estimate performance IQ (PIQ).

Repeated Measures

Paced Serial Addition Task (PASAT) (Gronwall, 1977) was a measure of processing speed consisting of four trials, each trial with a faster presentation rate. Participants listened to a sequence of single digit numbers and reported the sum of the previous two numbers. The addition of the last number heard on the recording and the new number presented combined with the progressively difficult trials allowed for examination of information processing in simple arithmetic calculations. The 100-item PASAT was used as it was more appropriate and less aversive than the 200-item instrument. The four trials consisted of 25 items each with an inter-stimulus interval (ISI) of 2.4 seconds, 2 seconds, 1.6 seconds, and 1.2 seconds respectively. The PASAT was chosen for its consistency and was used in many clinical trials (Polman & Rudick, 2010). The PASAT's split half reliability was .9 (Spreen & Strauss, 1998).

Trails Test Card A and B (TMT) (Reitan & Wolfson, 1985) was a measure of planning, sequencing, visuomotor speed, and mental flexibility. Card A required participants to draw a line connecting numeric stimuli in sequential order, while Card B required the switching between connecting of numeric and alphabetical stimuli in sequential order (1, A, 2, B, etc.). TMT scores reflected the time to complete the card (in seconds) and the number of errors made on the task. This task was chosen to examine cognitive flexibility in the visual domain. Construct validity for the TMT was established by correlations (.36-.93) with an object-finding task and a hidden pattern task (Ehrenstein, Heister, & Cohen, 1982). Reported reliability coefficients for the TMT were .94 for Part A and .90 for Part B (Spreen & Strauss, 1998).

Cued Color Word Stroop Test (Golden, 1978) measured cognitive control (interference) and reaction speed. The computerized Cued Color Word Stroop previously utilized in other studies with both clinical and healthy populations was employed (Perlstein, Larson, Dotson, & Kelly, 2005). The task comprised of the same three colors and color-words (Red, Blue, and Green) used in the standard card Stroop (Golden, 1978). Each trial began with a 750 millisecond visual instructional cue (Color or Word) followed by a 1000 millisecond delay, and finally by a visual stimulus presented for up to 2500 milliseconds, which was terminated by the participant's response. Participants were asked to decide between the color and word of the visually presented stimulus depending upon instructions of the cue. For the color condition, participants were asked to respond to the ink color of the word presented. For the word condition, participants were instructed to respond to the name of the word written on the screen. The task comprised of a total of 360 trials presented in four blocks of 90 trials. The order of the blocks consisted of mixed, color, mixed, word. Stimuli were pseudorandomized. Visual stimuli were presented in the center of a black screen visual display, and delivered on an Apple Macintosh MacBook Pro computer using E-Prime 2.0 software (Schneider, Eschmann, & Zuccolotto, 2002). Participants received instructions to respond as quickly and accurately as possible.

Delius-Kaplan Executive Function Measure (D-KEFS) Verbal Fluency subtest (D-KEFS; Delius, Kaplan, & Kramer, 2001) was administered to examine letter fluency, category fluency, and category switching. To minimize practice effects, usage of two forms of the assessment was necessary, one for pre-testing, and one for post-testing. In the letter fluency condition, each 60-second trial consisted of naming as many words that begin the letters F, A, S (pre-testing trials) or B, H, R (post-testing trials). Words could not be names of people, places, or numbers. In the category condition, participants named as many words belonging to a specific category such as items of clothing and girls' names in 60 seconds. In the category switching condition, participants must switch between providing a name of a piece of fruit and item of furniture. Reliability coefficients for the D-KEFs *Verbal Fluency* subtest were as follows: letter fluency (.88), category fluency (.82), and category switching (.51) (Delis, Kaplan, & Kramer, 2001).

Procedure

Participants were matched for age, education, and intelligence as measured by the *Wechsler Abbreviated Scale of Intelligence* (WASI) (Wechsler, 1999) in two training groups: music listening instruction (MLI) and group piano instruction (GPI). Music aptitude was measured by the Advanced Measures of Music Audiation (AMMA) (Gordon, 1989). Participants completed a battery of cognitive assessments pre- and post-music instruction. All testing was conducted individually in a quiet testing room at a local senior center by a trained research assistant. Participants were compensated for their time in testing.

Participants were assigned to one of the two 16-week treatments: *Group Piano Instruction* (GPI) or *Music Listening Instruction* (MLI). GPI is a basic piano course that included finger dexterity exercises, scales, basic music theory, and standard piano literature from the Alfred Adult All-in-One Course (Palmer, Manus, & Lethco, 1995). Classes met once a week for 45 minutes followed by 15 minutes of social activities. Individuals learned to perform individually and accompany other members of the group. Social activities ranged from playing the autograph game, which included requesting the autograph of participants with selected experiences, to discussing their favorite memories. Participants were required to practice the piano for 30 minutes daily and log all practice sessions. GPI served as an experimental task that utilized fine motor bimanual coordination.

MLI was a music appreciation course that incorporated both world music and music of the classical vernacular, based upon *Music Listening Today* (Hoffer, 2002). Classes met once a week for 45 minutes followed by 15 minutes of social activities. Each lesson reinforced prior lessons and promoted the learning of new musical elements and terms. Participants completed weekly assignments based upon course readings and class discussion of musical styles. A CD-ROM accompanied the text and participants used computers at a local senior center or at home to view diagrams of formal elements while listening to recorded musical examples. Participants were required to listen to the CDs for 30 minutes daily and log listening experiences. MLI served as a control task as it did not involve bimanual coordination or musical performance and contained an attentional component similar to that of the Group Piano Instruction.

Results

Forty-six participants (24 in GPI and 22 in MLI) completed the study. Attrition was due to personal illness or family illness, a need to return to the workforce, or a lack of commitment to practice. Descriptive statistics for demographic variables are provided in Table 1. Results of an independent samples *t*-test on age $t(44) = .8$, $p = .40$, years of education $t(44) = -.3$, $p = .80$, intelligence, $t(44) = -.7$, $p = .50$, music aptitude (tonal) $t(44) = .6$, $p = .50$, and music aptitude (rhythm) $t(44) = -.2$, $p = .80$, indicated no significant group differences ($p > .05$).

Table 1
Demographic Data

	GPI ($N = 24$)	MLI ($N = 22$)
Male/Female	5/19	5/17
Age	69.3 (7.0)	67.7 (6.3)
Education (in years)	14.1 (2.9)	14.4 (2.6)
VIQ	103.6 (9.8)	106.9 (9.9)
PIQ	105.3 (17.6)	106.9 (14.8)
FSIQ	104.8 (14.0)	107.6 (11.2)
AMMA Tonal	13.0 (3.7)	12.3 (4.5)
AMMA Rhythm	12.5 (3.5)	12.7 (4.0)

The effects of musical instruction on the four cognitive domains were assessed by Group (GPI, MLI) x Time (pre-testing, post-testing). The assessed domains were verbal fluency, planning, processing speed and cognitive control. For these data, repeated measures ANOVAs were preferred over a MANOVA because the same participants were tested before and after instruction, and a repeated measures option was not available for MANOVA in SPSS. Each ANOVA tests individual hypotheses for a main effect of time and a Group x Time interaction. Eight hypotheses were evaluated at the level of $p < .05$, to be adjusted for multiple comparisons using the Benjamini and Hochberg correction (Keselman, Cribbie, & Holland, 2002). All Group x Time interaction hypotheses were non-significant. Significant main effects of time were found for processing speed ($p < .019$), verbal fluency ($p < .006$), and cognitive control ($p < .013$). *Post-hoc* analyses evaluated the hypotheses that performance of each group improved after musical instruction. Each accepted main effect of time yielded two within group comparisons. Paired *t*-tests for each individual group were evaluated at the level of $p < .05$, adjusted for multiple comparisons with the Benjamini and Hochberg correction. Significantly enhanced performance on measures of verbal fluency ($p < .017$), cognitive control ($p < .008$), and processing speed ($p < .025$) was found for the GPI group, but not the MLI group.

Verbal Fluency Results

Results of a Group (GPI, MLI) x Time (pre- and post-test) Repeated Measures ANOVA conducted on a composite score reflecting number correct on letter fluency, category fluency, and category switching conditions of the D-KEFS indicated no significant interaction, $F(1,45) = .2$, $p = .69$. There was a main effect for time, $F(1, 45) = 12.9$, $p < .006$. Since the pattern of results suggested improvement by both, I further examined the extent of the enhancement for each individual group. For the D-KEFS Verbal Fluency subtest, a paired *t*-test was conducted for each individual group for the total correct across letter fluency trials, category fluency trials, and category switching conditions. Results of a paired *t*-test for the total correct across conditions was $t(21) = -2.3$, $p < .041$ for the MLI group, and $t(24) = -2.8$, $p < .017$ for the GPI group. Since I applied the Benjamini and Hochberg correction, the detection rate for significance was ($p < .03$). Thus, the results indicated significantly enhanced performance by the GPI group, but not the MLI group (see Table 2).

Processing Speed Data

Results of Group (GPI, MLI) x Time (pre-test, post-test) ANOVA on the total number correct for the PASAT indicated no significant interaction effect, $F(1, 45) = 1.5$, $p = .23$. A main effect of time was found, $F(1, 45) = 6.6$, $p < .019$. The pattern of results showed that both groups demonstrated increases in correct scores; however, it was necessary to further analyze increases in scores for each independent group.

A paired *t*-test was conducted for each individual group to examine differences between pre- and post-test processing speed performance on the *Paced Auditory Serial Addition Task* (PASAT). Results revealed no significant differences in performance for the Music Listening Group in the total number correct. Results of a paired *t*-test on PASAT performance for the Group Piano Instruction (GPI) group indicated significantly enhanced performance on the total number correct across all PASAT trials, $t(24) = -2.6$, $p < .025$.

Table 2
Results of Total Correct Responses (CR) and Error Rates (ER) Across Trials

	Music Listening Instruction (N=22)				Group Piano Instruction (N=24)			
	Pre-Test Mean (*sd*)	Post-Test Mean (*sd*)	*t*	*p*	Pre-Test Mean (*sd*)	Post-Test Mean (*sd*)	*t*	*p*
PASAT (CR)	49.0 (18.0)	51.3 (21.9)	-0.9	.090	50.6 (17.5)	57.2 (15.6)	-2.6	.025*
D-KEFS (CR)	83. 7 (16.1)	88.6 (15.9)	-2.3	.041	84.6 (16.6)	90.6 (16.9)	-2.8	.017*
Stroop (ER)	34.1 (27.0)	28.1 (27.9)	1.2	.250	43.1 (26.9)	30.3 (23.9)	3.1	.008*

* Statistically significant.
Note: The Benjamini Hochberg (BH) correction applied to the D-KEFS hypothesis for MLI required a $p < .033$ to be considered significant.

To examine task compliance and the effect of working memory on the PASAT, I calculated the total number of consecutive correct responses, dyad scores. Research suggested that older adults with working memory difficulties often provided the sum of two numbers and skipped a number to compensate for task difficulty (Gonzalez et al., 2006). Gonzalez and others (2006) found correlations between the total number correct on the PASAT and total dyad scores in healthy populations; however, this association diminished as stimulus presentation occurred more rapidly and placed higher demand upon working memory. Mean dyad scores for the MLI group were 25.1 (*sd* = 19.1, skeweness =.34, kurtosis = -1.28) at pre-testing, and 29.8 (*sd* = 23.3, skewness = .47, kurtosis = -.89) at post-testing. Mean dyad scores for the GPI group were 25.9 (*sd* = 19.8, skewness = .28, kurtosis = -1.17) at pre-testing, and 31.9 (*sd* = 19.4 skewness = .08, kurtosis = -.09) at post-testing. Both groups complied with task requirements.

Cognitive Control Results

Results of a Group x Time ANOVA on cued Color Word Stroop performance indicated no significant differences in error rates across conditions, $F(1, 42) = 1.14$, $p = .29$. A main effect of time was found, $F(1, 42) = 8.45$, $p < .013$. Results of a paired *t*-test for the GPI group indicated a significant reduction in error rates, $t(22) = 3.11$, $p < .008$. No significant difference in mean errors was found between pre- and post-test performance for the MLI group, $t(20) = 1.18$, $p = .250$.

Planning Results

MLI participants completed Card A at pre-testing in an average of 37.4 seconds (±13.8) and 36.4 seconds (±10.7) at post-testing. The GPI group completed Card A at pre-testing in an average of 37.1 seconds (±11.9) and post-testing 38.2 seconds (±12.4). A Group (GPI, MLI) x Time (Pre-test, Post-test) ANOVA on Trail Making Test Card B scores showed no significant group differences, $F(1,45) = 1.6$, $p = .21$. There was no main effect of time, $F(1,45) = .75$, $p = .39$.

Discussion

The goal of this research was to examine the effects of group piano instruction on processing speed, verbal fluency, planning, and cognitive control in older adults. Results showed no significant differences in performance on the cognitive measures between GPI and MLI groups. The pattern of results suggested that both training regiments could positively impact cognitive abilities. This result was quite surprising since I initially hypothesized that active participation in piano instruction would place higher demands upon cognitive abilities and attentional resources. However, the music listening program also required focused attention and challenged participants with a fast-paced curriculum.

Another focus of this research was to better understand how musical training maps to specific cognitive abilities. I could confidently report results of the Paced Auditory Serial Addition Task (PASAT), which showed significant performance enhancements for the GPI group in processing speed performance. Research has suggested that instrumental practice, particularly related to piano practice, engages multiple brain areas by requiring temporal and sequential control of finger movements (Krings et al., 1999). Bimanual coordination and perceptual representation of those movements is required to gain fluency and dexterity. Once fluency is achieved attention is shifted to other musical challenges. Practice requirements are essential to learning an instrument, reinforce transferability and manifest training-dependent reorganization (Pantev, Lappe, & Hergolz, 2009). Likewise, as one is engaging in musical performance, planning and strategizing become a natural part of a multi-task process.

Results suggested that piano instruction enhances verbal fluency performance. These results are consistent with prior research examining the effects of violin instruction on verbal fluency performance (Chan, Ho, & Cheung, 1998; Ho, Cheung, & Chan, 2003). I speculate that auditory chunking strategies reflected in sequences and repetitions inherent to musical training may have contributed to these results.

Results of this research suggested that group piano instruction could assist with cognitive control, part of executive functioning. This finding is consistent with previous data collected on the effects of piano instruction on executive function (Bugos et al., 2007). These data are also consistent with results of research examining mismatch negativity (MMN) in two groups of non-musicians in which one group was trained to perform a sequence on the piano and the other received ear-training instruction (Pantev et al., 2009). Results indicated greater enhancement of musical representations in the auditory cortex for the piano group compared to those who received auditory training (ear-training). Integration of sensorimotor and auditory systems contributes to cortical organizational changes in the auditory cortex.

In addition, age-related cognitive decline related to executive function has been associated with decreases in the structural integrity of white matter in the splenium of the corpus callosum (Voineskos et al., 2010). Imaging data revealed that musicians demonstrate enlargements in the corpus callosum (Schlaug, Jancke, Huang, Staiger, & Steinmetz, 1995; Schmithorst & Wilke, 2002). Most research examining differences in musicians and non-musicians included musicians who began training prior to age seven, the critical period. While there is evidence for a greater degree of neuroplasticity during the critical period, older adults have been shown to exhibit neuroplastic changes in the brain associated with learning (Lovden, Backman, Lindenberger, Schaefer, & Schmiedek, 2010). Research on musicians with significant expertise suggested that musical training could activate multiple brain regions including the parietal and prefrontal cortex (Bangert, Reuter-Lorenz, Walsh, Schachter, & Seidler, 2010). Activation in these regions is also associated with working memory and executive processes (Collette & Van der Linden, 2002).

Limitations and Potential Explanations

No significant enhancements were noted on the Trail Making Test (TMT) for both the GPI and MLI groups. Results of a previous study examining the effects of piano instruction on executive function reveal significant enhancements on the TMT following six months of training (Bugos et al., 2007). While I hypothesized differences in planning abilities resulting from instruction, perhaps the training length was too short to demonstrate effects on the TMT. Further research is necessary to determine the appropriate length of training and the type of training that provides the greatest potential for cognitive transfer.

Intervention research traditionally used a relatively large sample size. This research involved a small sample size. A larger sample size may be necessary to generalize results. Another potential limitation is the quantity and quality of practice. Thirty minutes of practice per day or three hours of practice were required per week. All practice sessions were logged by participants and practice logs validated each week by the course instructor. Some participants practiced more than 30 minutes on occasions. One participant was dismissed from study participation due to a lack of compliance with practice requirements. Repetitions and duration of practice sessions were recorded by participants; however, a recording of practice sessions and practice strategy training may better assist in quality assurance.

Conclusions

Group piano instruction and music listening instruction can enhance cognitive abilities in processing speed, verbal fluency, and cognitive control. A novel and progressively difficult curriculum that facilitates focused attention and concentration with complex bimanual coordination may successfully contribute to preserving cognitive abilities in aging. While simple coordination exercises are performed automatically, complex motor tasks typically require additional focused attention and executive control for older adults (Bangert et al., 2010; Wishart, Lee, Murdoch, & Hodges, 2000). Musical training contains many essential components of a successful cognitive training program such as task novelty, bimanual coordination, and progressive difficulty.

Implications for Music Educators

Music instruction is a naturally enjoyable and sustainable focus of lifelong learning. While this research provides support for the effects of music instruction on cognitive abilities, it is important to note that music instruction also provides many expressive and aesthetic benefits. Additional group-based learning opportunities should be provided to encourage musical participation for adults in community ensembles, intergenerational groups, and small ensembles. Music educators should be prepared to advocate for providing programmatic support for lifelong learning endeavors. These formal and informal programs should require active participation among participants and allow for re-entry points regardless of prior experience.

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CHINESE ABSTRACT
中文摘要

學習音樂對於老年人大腦思維速度、語言流利程度和認知控制能力的益處

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本研究的目的是爲了比較鋼琴課與音樂欣賞課對於健康老年人(60 歲-85 歲)機體功能的作用。70 位老年人參與了研究，研究者根據參與者的年齡、教育程度和預估智能高低進行匹配比較。研究過程持續了 16 周，參與者分別接受集體鋼琴課和音樂欣賞課，并在接受音樂課之前和 16 周的音樂指導結束後分別完成了對大腦思維速度、語言流利程度、計劃和認知控制能力的測試。46 名參與者（24 名鋼琴課，22 名音樂欣賞課）完成了所有的課程與測試。研究者進行了重複的 ANOVA 統計，結果顯示兩組參與者的機體功能測試分數都在試驗結束後有所提高，沒有顯著區別。爲了進一步證實認知能力訓練的效果，研究者對於匹配後的參與者的分數進行了 *t*-test 統計。結果證實了接受鋼琴訓練的參與者比接受音樂欣賞課的參與者在思維速度、語言流利程度、認知控制方面有顯著的提高。研究結果顯示了主動的音樂學習課程在社區音樂課程中的重要性。