The Effects of Noise and Sex on Children’s Performance on Recall and Spatial Tasks

The present study examined the effects of noise and sex as factors influencing children’s ability to perform recall and spatial tasks. The study consisted of 60 fifth- and sixth-grade students tested using the digit recall and block design subtests from the Wechsler Intelligence Scale for Children–Revised (WISC-R; Wechsler, 1974). The researcher randomly assigned boys and girls to 3 groups: an unstructured white noise group, a music group, and a silent control group. Children in each group completed the same WISC-R subtests. Children in the 2 experimental groups worked while exposed to unstructured white noise or music at 70 dB. The results of the study indicated no significant difference between boys and girls in performance on recall and spatial tasks in the presence of unstructured white noise or music. The present study did find significance between experimental conditions as children in the unstructured white noise group performed significantly better than children in the music group. However, neither experimental group performed significantly better than the control group. This study indicated that exposure to unstructured white noise increases children’s recall and spatial performance by improving concentration and organization ability.

Michael D. Jones
Lincoln Memorial University

Children must learn and develop their cognitive abilities in many different environments. These environments may contain elements that have an impact on children’s cognitive processes and overall learning. The existence of environmental distracters raises some interesting questions about how noise affects children’s cognitive abilities. If children are studying or trying to learn new material in proximity to a television, radio, or any noisy distraction, does this noise decrease their cognitive effectiveness or their ability to learn? There is also a question of sex and the effect of noise on children’s cognitive abilities. Do boys and girls have different reactions to noise?

In an attempt to answer the question of boy’s and girl’s reactions to noise, previous research has examined the relation between sex and the effects of noise on cognitive performance in college students and adults. The results of these studies indicate that sex is not a factor in performance under noisy conditions. In a study of 120 male and female Nigerian college students, Madu (1990) randomly assigned participants to a silent control group and three experimental noise groups consisting of exposure to 60, 80, and 100 dB of white noise. Participants then recalled words from a list of 30 words in either group. This experiment studied the effects of noise on sex and age and indicated no difference in the recall performance between men and women in noisy conditions. Srivastava (1988) discovered this same pattern in a study that focused on sex and the effects of adaptation to noise and performance. The results of this study indicated no significant differences between male and female adults classified as either adapted or not adapted to noise in their task performance. Gulian and Thomas (1986) examined the effects of noise and sex on mental arithmetic performance. In a between-subjects design, 72 men and women randomly assigned to 12 conditions consisting of noise and quiet performed arithmetic problems while given neutral, positive, and negative instructions. The results of this study indicated that noise impaired work rate, but not accuracy in both men and women in the noise conditions.

Noise can exist as unstructured white static noise or structured noise such as music. In an attempt to answer the question of noise effects on cognitive abilities, previous research has examined this factor in relation to noise and music and has revealed an interesting relation between unstructured white static...
noise and recall. Vitulli and McNeil (1990) explored college students’ short-term memory for numbers under unstructured white noise conditions. Sixteen male and 94 female undergraduates recalled a series of 25 random number sets in five different groups of white noise intensity. The results of this study indicated that higher background noise resulted in higher recall rates. Baker and Holding (1993) examined the effects of unstructured white noise and speech on cognitive task performance in a 2 x 2 x 5 (Sex x Time of Day x Noise Condition) between-subjects design. One hundred and sixty college men and women divided into 20 experimental blocks performed memory tasks while exposed to five levels of noise varying in intermittence and meaningfulness. The results of this experiment showed that noise increased recall performance. Smith, Whitney, Thomas, Perry, and Brockman (1997) examined the effects of caffeine and noise on mood, cognitive and memory performance, and cardiovascular functioning. They reported increased memory performance by participants exposed to noise and caffeine. The noise/caffeine group performed better than a noise/no caffeine group, although noise for both groups was significant compared to quiet and caffeine/no caffeine. Madu (1990) also reported increased recall with noise in the study concerning the effects of noise on sex and age. These past studies indicate that recall rate increases with unstructured white noise levels.

Additional research has shown a contradiction with the findings indicating that noise is associated with higher recall rates. Starnes and Loeb (1993) examined locus of control in memory recall in the presence of unstructured white noise. Fifty-four male and 72 female university students classified as either internal or external in locus of control for memory performed recall tasks using specific recall strategies in either an unstructured white noise or quiet condition. This study looked at both recall and memory strategy and found that unstructured white noise did not have a main effect on recall. A possible explanation for the contradictory results of this study compared to other studies concerning the effects of noise on memory is that this study employed specific memory strategies. Here the study placed more emphasis on how memory works instead of measuring basic recall accuracy. This contradiction also occurred in a study by Arnsten, Goldman, and Patricia (1998) that examined stress related to unstructured white noise and its effects on the cognitive functioning of monkeys. The results of this study showed that unstructured white noise stress impaired both cognitive functioning and working memory. The methodology of this study mainly concerned prefrontal cortical cognition and dopamine levels. This fact, in conjunction with the use of high noise levels of 105 dB, may explain the contradictory results of memory impairment relative to other studies.

Previous research has examined the effects of structured noise in the form of music on recall ability. Nittono (1997) conducted a within-subjects study concerning the effects of recall performance in the presence of pop music. Twenty-four undergraduate men and women recalled 20 sequences of nine digits while exposed to silence, forward pop/classical music, or backward pop/classical music, respectively. The results of this study found that the introduction of music during a recall task resulted in lower recall rates. Furnham and Bradley (1997) also looked at the detracting effects of pop music in a within-subjects design. Twenty participants classified as introverts or extroverts completed memory and reading comprehension tests in either a quiet control group or a music experimental group. The results of this study associated lower recall rates with instrumental music.

Past research concerning the relation between noise and spatial ability included a study by Vause (1998) that examined spatial processing in adverse auditory environments. The results of this study indicated that masking noise reduces spatial ability. Wilson and Brown (1997) examined the influence of Mozart’s music on spatial task performance in 22 undergraduate men and women. This within-subjects study consisted of participants randomly assigned to one of three groups consisting of Mozart’s music, relaxation music, and silence, respectively. Participants completed pencil and maze tasks after a 10-min listening period. The results indicated no significant increase in spatial ability associated with music. However, in a within-subject study by Rideout, Dougherty, and Wernert (1998), 32 male and female adults performed paper folding and cutting tasks in three groups consisting of a 10-min preexposure session of relaxation, Mozart’s sonata, or Mozart-like Yanni music. The results of this study showed that spatial ability improved with music.

Past research has produced two patterns of results concerning the effect of noise and sex on performance on recall and spatial tasks. The first is that there is no relation between sex and cognitive performance in the presence of noise. The second is that unstructured white noise seems to increase recall performance, whereas structured noise like music decreases recall. Past research has also shown conflicting results concerning the effects of noise on recall ability. Because previous research has focused on adults, researchers do not know the relation of noise and sex on recall and spatial ability in children. Children’s
cognitive development differs from that of adults. Therefore, unstructured and structured noise may have a more profound impact on children’s cognitive functioning and learning.

The present study looked for a relation between the sex of children and their ability to perform recall and spatial tasks in the presence of noise. Previous research has focused mainly on adults and the effects of noise on recall and spatial ability (Baker & Holding, 1993; Furnham & Bradley, 1997; Gulian & Thomas, 1986; Madu, 1990; Nittono, 1997; Rideout et al., 1998; Smith et al., 1997; Srivastava, 1988; Starnes & Loeb, 1993; Vause, 1998; Vitulli & McNeil, 1990; Wilson & Brown, 1997). In addition, past research has shown contradictory results regarding the effects of noise on cognitive abilities (Arnsten et al., 1998; Rideout et al., 1998; Starnes & Loeb, 1993). Thus, the present study also explored the question of whether there is a difference in the effects of unstructured and structured noise on the cognitive abilities of children.

**Method**

**Participants**

Participation in the present study depended on children’s level of cognitive development. It was a goal of this study to recognize cognitive differences between adults and children. Therefore, only children who displayed a concrete operational stage of cognitive development participated in the experiment. Children between the ages of 7 and 11 typically exhibit a concrete level of thinking. Sixty fifth- and sixth-grade students from four intact elementary school classes in the southwestern Virginia area participated in the experiment. Each child included in this study participated only if the parents gave written consent and the teacher verbally consented. In addition, each child participated only if he/she verbally agreed to participate. A total of 28 boys and 32 girls who met these consent considerations participated in the present study. The ages of these children ranged from 9–11.

**Instrumentation**

The present study used two subtests from the Wechsler Intelligence Scale for Children–Revised (WISC-R; Wechsler, 1974). The WISC-R was selected because it is a standardized test with demonstrated validity and reliability that is normal for the age group included in this study. The subtests used from this inventory included the block design subtest to assess spatial ability and the digit recall subtest to assess recall memory. The block design subtest of the WISC-R consisted of nine blocks, each of which had two sides colored red, two sides colored white, and two sides colored half red and half white. These blocks can be arranged to form various geometric patterns. The test required that each child complete nine patterns. Each pattern had a specific time limit, and if the child failed two designs in a row, the test ended. The digit recall subtest of the WISC-R consisted of a series of numbers read by the test administrator to the child. The test required the child to accurately recite each series of numbers back to the test administrator. The series included seven forward-number series and seven backward-number series, each of which progressed in difficulty. If the child inaccurately recited two series in a row, the test ended. Each test provided a number score of the child’s performance with high scores indicating better performance.

**Procedures**

The present study used a between-subjects design. This type of design prevented a lengthy experimental period and eliminated any learning effects. A larger number of participants allowed for each child to be tested only once, which lessened the distraction on both the child’s learning and the school’s time.

The researcher randomly assigned children to either the control group or one of two experimental groups. Although there were unequal numbers of boys and girls, the researcher attempted to ensure that these numbers were reasonably equal in each group.

The same test administrator tested each child individually under a teacher’s supervision. The silent control group consisted of 10 boys and 11 girls assessed using the WISC-R digit recall and block design subtests in a quiet room. The experimental groups consisted of children assessed using the same digit recall and block design subtests of the WISC-R in the presence of noise. The first experimental group included 9 boys and 11 girls assessed in the presence of unstructured white noise registered at 70 dB. The second experimental group included 9 boys and 10 girls assessed in the presence of structured noise in the form of pop music (the Britney Spears song “Baby One More Time” repeated on a continual loop) registered at 70 dB. The researcher selected this particular vocalist because of the qualities of a female vocalist that are attractive to both boys and girls, and the artist’s popularity with the experiment’s target age group.

During the experiment each child sat with the test administrator at a table in an empty classroom that provided an environment free of distraction and offered appropriate supervision. An Emerson cassette
recorder and compact disc player (model no. PD6607) sat on the table 24 in. (61 cm) in front of the child’s work area. A Radio Shack digital sound meter (model no. 33-2055) ensured that unstructured white noise and music produced by playing recordings on the CD player registered 70 dB relative to the child’s position. Each child, regardless of group, received information as to why the CD player was on the table. Children in each group received instructions to perform as well as they could on the WISC-R subtests despite the presence or absence of noise or music from the CD player. The researcher informed each child that he/she was participating in a college research project, and each child received a description of the tasks he/she would be performing. The researcher asked each child if he/she had any questions about the tasks or the research project before proceeding with the experiment. Each child performed the block design subtest first and the digit recall subtest second. The test administrator presented and conducted each WISC-R subtest according to the WISC-R test manual. The researcher recorded each child’s score on an individualized score sheet, and a subject participation number insured children’s confidentiality. After testing, the researcher told each child that he/she had performed very well and thanked each child for his/her participation. As a reward and compensation for the child’s effort, each child whose parents had consented received a candy bar.

Results

Combined Spatial and Recall Performance Between Groups

The alpha level used for all statistical tests was .05. Analysis of the combined performance scores of recall and spatial tasks for noise groups yielded significance, $F(2, 55) = 4.33, p = .018$. Tukey’s HSD test indicated that the significant difference (see Figure 1) occurred between the two experimental groups with the music group showing lower performance ($M = 34.50$) than the white noise group ($M = 43.00$). The control group ($M = 38.00$) was not significantly different from either of the experimental groups. These combined scores also reflect better general intellectual functioning in the unstructured white noise group (Ogdon, 1986).

Spatial Performance Between Groups

The discovery of significance in the combined scores of the experimental groups suggested a similar trend in the individual subtest scores (see Figure 2). Analysis of spatial performance showed significant difference between the groups of silence ($M = 27.20$), white noise ($M = 31.90$), and music ($M = 24.84$), $F(2, 55) = 3.68, p = .03$. Subsequent Tukey’s tests indicated that the spatial scores for the noise group were significantly ($p < .05$) higher than the spatial scores for the music group.

Recall Performance Between Groups

The discovery of significance between groups for combined score and spatial score prompted analysis of the recall performance between groups. Although children’s recall performance in the unstructured
Performance Differences Between Boys and Girls

Boys and girls did not differ in their performance on the WISC-R subtests; boys (M = 38.55), girls (M = 38.56), F(1, 56) = 0.007, p = .932. To explore the possibility of reaction differences to noise between boys and girls, the researcher conducted an analysis of these two experimental groups. This analysis indicated that the performance of boys (M = 39.29) and girls (M = 38.28) did not differ, F(1, 36) = 0.095, p = .759.

Discussion

The results of the present study indicated that unstructured white noise produced significantly higher combined scores and spatial ability scores than did music. No significant difference existed between the two experimental groups and the control group. A similar, albeit marginally significant, trend was shown for recall performance. The scores of boys and girls did not differ.

The lack of any sex differences is consistent with previous research with adults (Gulian & Thomas, 1988; Madu, 1990; Srivastava, 1988). Therefore, we can tentatively conclude that in both children and adults, sex has no influence on the ability to recall information or perform spatial tasks in the presence of noise.

The results of this experiment support previous research concerning the effects of noise and performance on recall and spatial tasks. The significant difference between the noise and music groups indicates that children exposed to music experience a decreased ability to recall information and to perform spatial tasks. However, in agreement with previous research (Baker & Holding, 1993; Madu, 1990; Smith et al., 1997; Vitulli & McNeil, 1990), exposure to unstructured white noise increases children’s performance on recall and spatial tasks. In the present experiment, this increase in recall and spatial ability in the presence of unstructured white noise is relative only to the decrease in performance in the music group. This decrease in spatial ability in the presence of music supports the research findings of Vause (1998) and Wilson and Brown (1997). This pattern of increased performance associated with noise has occurred in previous research, but to date there is no explanation of why it occurs. Baker and Holding (1993) suggested that complex interactions between variables outside the experimental condition resulted in random increases and decreases in performance ability in the presence of noise. However, because several studies (Baker & Holding, 1993; Madu, 1990; Smith et al., 1997; Vitulli & McNeil, 1990) have reported this increase in performance, explanations regarding the random influence of outside interactions may not be tenable. Perhaps unstructured white noise has a calming effect, relative to music, that facilitates concentration and organization. This hypothesis requires further research.

References


