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AUTHOR Birch, Leann Lipps
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ABSTRACT

This study was designed to investigate whether age differences in timesharing performance would be found if the baseline performance of younger and older children was experimentally equated. Two groups of twelve 8-year-olds and one group of twelve 13-year-olds participated. Each subject performed a compensatory tracking task and an auditory matching task, first alone and then timeshared. The 8- and 13-year-old baseline groups performed baseline trials on each task prior to timesharing trials. Each 8-year-old in the training group was randomly paired with a 13-year-old and given sufficient single task practice before timesharing to equate the 8- and 13-year-old pair members' baselines on both tasks. Results showed trained 8-year-olds to be indistinguishable from 13-year-olds in timesharing, whereas the 8-year-old baseline group showed significantly greater decrements in timesharing and higher baseline scores on both tasks. These data provide support for the hypothesis that timeshared performance is directly related to level of baseline performance and indicate that once baseline differences are experimentally equated, no age differences in performance remain to be attributed to developmental differences in attentional processes. (MS)

Baseline Differences, Attention, and Age Differences in Timesharing Performance

Leann Lipps Birch

University of Illinois

Child Development Lab

Running Head: Baseline Differences

Abstract

Two groups of 12 8-year-olds and one group of 12 13-year-olds participated in an experiment designed to determine whether age differences found when two tasks are timeshared can be accounted for in terms of age differences in single task baseline performance. Each subject performed a compensatory tracking task and an auditory matching task, first alone and then timeshared. The 8 and 13-year-old baseline groups performed baseline trials on each task prior to timesharing trials. Each training group 8-year-old was randomly paired with a 13-year-old and given sufficient single task practice before timesharing to equate the 8 and 13-year-old pair members' baselines on both tasks. Results showed trained 8-year-olds to be indistinguishable from 13-year-olds in timesharing, whereas the 8-year-old baseline group showed significantly greater decrements in timesharing and higher baseline scores on both tasks. These data provide support for the hypothesis that timeshared performance is directly related to level of baseline performance.

Baseline Differences, Attention, and

Age Differences in Timesharing Performance

A major theme emerging from reseach on cognitive development is that attention deployment improves with age. Results of research utilizing a variety of paradigms, including incidental learning (Hagen, 1967), component selection (Hale & Morgan, 1972), selective listening (Doyle, 1973; Maccoby & Konrad, 1966), tachistoscopic recognition (Liss & Hiath, 1970), and timesharing (Lipps Birch, 1976), have led to the generalization that children become more flexible and efficient with development in modifying their attentional strategies to maximize performance on the task at hand.

In a general review of the developmental literature on temporal limits of information processing, Wickens (1974) suggested that irreducible developmental differences in information processing exist and are responsible for many observed age differences. However, he also cites data from developmental studies of visual search (Gibson & Yonas, 1966), simple reaction time (Elliott, 1970), and continuous tracking (Pew & Rupp, 1971), which suggest that factors such as practice, motivation and incentives affect children's performance to a greater degree than they do adults' performance, and that some of the observed age differences are not due to irreducible differences in central processes, but to the effect of practice which covaries with age.

The most frequently reported result in the developmental literature is that when the same task is given to children of different ages, older children show superior performance. Children differing in age commonly show differences in baseline levels of performance in control conditions, making it difficult to interpret the effects of experimental manipulations. This point has been discussed by Maccoby (1969) in the context of selective listening, by Hale and Flaugher (1969) with respect to distraction effects, and by Lipps (1975) in the context of timesharing. The most common procedure for dealing with age differences in baseline performance is to apply a mathematical transformation to the data. The most simple transformation used is a conversion from absolute to proportional change score. These proportional scores are generally relative either to baseline or to the interval between baseline and ceiling, floor, or chance levels of performance.

An example of the use of proportional change scores appears in a study of children's timesharing performance (Lipps Birch, 1976). Seven-10-and 13-year-olds performed two tasks; each child first performed each task alone and then performed the two tasks concurrently. The tasks to be timeshared were a same-different matching task presented auditorily and a compensatory tracking task. The younger children showed larger error scores in single task baseline performance and also showed larger decrements in timesharing even when the data were transformed and proportional change scores used. Because age difference still appeared in the transformed data, they were interpreted as providing support for the hypothesis that with development there is an increase in the flexibility and efficiency of attention deployment. A closer look at these data makes this interpretaion questionable. It was possible to select several younger children whose baselines on the two tasks alone were equal to those of older children. For pairs matched on baseline performance there were no age differences in timesharing performance. This suggests an alternative interpretation of the obtained age differences: baseline levels of performance on the tasks alone are directly responsible for the observed age difference in timesharing performance. That is, children of different ages perform with different proficiency on the two tasks alone and these differences are sufficient to account for the obtained age differences in timesharing. The post hoc analysis of selected individuals is not a satisfactory way to obtain definitive evidence on this point. It could be argued that the failure to note age differences in timesharing for this selected group was due to the fact that the "best" younger children were paired with the "worst" older children. The purpose of this experiment was to determine whether age differences in timesharing performance would be found if the baseline performance of younger and older children was experimentally equated.

Method

Subjects

Subjects were 24 8-year-olds (mean age 8 years 7 months) and 12 13-year-olds (mean age 13 years 2 months). Half of the children in each age group were males, half females. All children had vision and hearing within the normal range and IQ scores between 101 and 119. All were middle class and attended elementary school in Normal, Illinois. Twelve of the younger children were randomly assigned to the training group and the other twelve to the baseline group.

Apparatus and Materials

The tasks to be timeshared were an auditory same-different matching task and a one dimensional compensatory tracking task. They were the same tasks as used in the previous experiment by Lipps Birch (1976), where a complete description can be found.

Auditory matching task. The stimuli for the auditory matching task were three, four, and five letter words from Thorndike and Lorge (1944) frequencies of 1-AA. Fifty-eight nouns were selected. Each noun could be classified as a member of one of four categories (12-16 words per category): animals, parts of the body, clothing and food. Same-different judgments were based on whether the two words in a pair were from the same or different categories. Children were told the categories before beginning the task and were instructed to say "yes" if the two words in the pair were from the same category and "no" if they were from different categories. The order of the pairs was randomly determined in all 24 lists, with the restriction that not more than three "same" or "different" pairs occurred in succession. Within a list no word appeared in more than three pairs and each list contained 15 "same" and 15 "different" pairs. Presentation rate was one pair every two seconds, allowing each stimulus list to be presented in one minute. All stimulus lists were recorded in the same female voice. During the presentation of the auditory matching task all stimuli and responses were recorded using a Sony Model TC-80 cassette recorder.

Compensatory tracking task. A Simplified Electronic Tracking Apparatus (SETA) of the type described by Gain and Fitts (1959a) was connected to a Hewlett Packard oscilloscope with a 15 cm display screen. The apparatus automatically calculated the subject's integrated absolute error (IAE) score for each one minute trial by summing the absolute discrepancy between the problem input and the subject's output during each trial.

On the display screen the subject saw two dots, a stationary target dot, which in combination with the target displayed the discrepancy between the problem input and the subject's output. In performing the tracking task the child manipulated a control knob with his preferred hand in order to keep the moving dot on the target in the center of the screen. The child was seated approximately 40 cm from the display screen and the experimenter was seated to the right of the subject.

Procedure

Subjects were seen individually in a sound attenuated laboratory room. All sessions were approximately one half hour long. The 13-year-olds were given nine baseline trials on each task alone. Half of the children were given the tracking task first, half the auditory matching task first. Immediately following these baseline trials the timesharing trials were given in which the child performed the two tasks concurrently, with the instruction to "pay attention to both games and try hard to do as well as you can on both". The 8-year-olds assigned to the baseline group were treated the same as the 13-year-old baseline group.

Each of the 8-year-old training group subjects was randomly paired with one of the 13-year-old group of the same sex. The 8-year-old pair member was then given practice on each task alone until the criterion of performance equivalent to that of the 13-year-old pair member was reached. Criterion on the auditory matching task was met when total errors and omissions on a three trial block for the 8-year-old pair member were within $\pm$ 1 of the 13-year-old pair member's score. For the tracking task criterion was met when the 8-year-old's median score on a three trial block was within $\pm$ 2 IAE units of the 13-year-old pair member's score. The number of trials required to reach criterion varied from 48 to 156 on the tracking task and from 84 to 180 on the auditory matching task. The number of sessions required varied from 4 to 13 on the tracking task and from 7 to 15 on the auditory matching task.

Each child in the training group was told the final scores he needed to obtain on each task in order to match the 13-year-old pair member's performance. As an extra incentive to improve performance the children in the training group were paid 1 cent for each training trial that showed an improved score over the previous trial. Children in the baseline groups were paid 1 cent per trial noncontingently and subject in all groups were paid 1 cent for each timeshared trial, and 15 cents per session for their participation. During training sessions children performed four to five three-trial blocks per session on each task. When criterion was reached on one task but not on the other, three trials per session were given to maintain performance on that task, while practice trials on the other task were continued.

As soon as a subject in the training group reached criterion on both tasks, the timesharing trials were given. Children in the training group had not performed the tasks concurrently prior to that time. Fifteen timesharing trials were given. During training subjects were seen five days per week, special events and attendance permitting.

Results

The results are summarized in Figure 1, which presents the 95% confidence intervals for the alone and timeshared conditions for the 8-year-old baseline, 8-year-old training and 13-year-old baseline subjects. The auditory matching errors are presented in Figure 1a and the tracking task integrated absolute error scores are presented in Figure 1b. Each confidence interval was calculated from the data from the appropriate condition based on the first nine trials for each of the twelve subjects. The pattern of results is the same for both tracking and auditory matching tasks and the results for the two tasks will be presented together.

Insert Figure 1 about here

For both the auditory matching and tracking tasks in the alone condition, performance of the 8-year-old group upon completion of training is indistinguishable from that of the 13-year-old baseline group, where as the 8-year-old baseline group has higher error scores. These results demonstrate the effectiveness of practice for the 8-year-old training group. The mean errors on the auditory matching task for the 8-year-old baseline, 8-year-old training and 13-year-old baseline groups were 9.5, 4.7 and 5.1 respectively, and the mean tracking scores were 51.0, 21.4 and 23.2 IAE units respectively. The data for the 8 and 13-year-old baseline groups replicate the results of the previous experiment (Lipps Birch, 1976), with the younger subjects showing significantly higher baseline levels on the tasks alone (tracking $t(22) = 10.78$, $p < .001$, auditory matching $t(22) = 3.46$, $p < .01$).

The focus of the experiment was on the question of whether level of single task baseline performance is sufficient to account for level of timeshared performance. The results presented in Figure 1a and 1b indicate that this is the case. The pattern of results for the three groups in timesharing repeats the one obtained for the alone condition, showing that once subjects are matched on baseline performance they are also matched on timeshared performance. When the performance of the 13-year-old group is compared with that of the two 8-year-old groups, the 8-year-old training group is indistinguishable from the 13-year-old group in timesharing whereas the 8-year-old baseline group show significantly larger error scores than the 13-year-old group (tracking $t(22) = 11.47$, $p < .001$; auditory matching $t(22) = 3.59$, $p < .01$). The mean scores in the timeshare condition for the 8-year-old baseline, 8-year-old training and 13-year-old baseline groups are 14.6, 6.2, and 7.3 respectively for the auditory matching task, and 80.0, 26.8, and 24.9 for the tracking task.

As shown in Figure 1 going from the alone to the timeshared condition produced significantly larger decrement scores on both tasks for the 8-year-old baseline group than for the 13-year-old baseline group (tracking $t(22) = 7.14$, $p < .001$, auditory matching $t(22) = 3.32$, $p < .01$). This result also replicates the earlier finding (Lipps Birch, 1976). Further, if the data are analyzed using proportional decrement scores, the same pattern of results is obtained.

The results reported above indicate the high degree of similarity between the 8-year-old training group and the 13-year-old baseline group in timesharing. To compare these two groups in more detail a three way analysis of variance was performed on the tracking data with age (2), trials (9), and pairs (12) as factors. The same analysis was performed on the auditory matching data except that only ten pairs were included in the analysis because two subjects in the training group failed to reach criterion on this task, one due to absence and the other due to refusal to participate further. The F ratios for the main effect of age for both tasks were formed using the age x pairs interaction as the denominator and both were very small and non-significant (tracking $F(1,116) = 1.75$, auditory matching $F(1,98) = .22$) reflecting the very high degree of similarity between the two groups on both tasks in timesharing. The age x pairs interaction was significant in both analyses (tracking $F(11,116) = 6.44$, $p < .001$; auditory matching $F(9,98) = 24.5$, $p < .001$), indicating that within some pairs the 8-year-old pair member showed superior performance while in others the 13-year-old showed superior performance. The only other significant F ratio was that for pairs on the tracking task ($F(11,116) = 4.19$, $p < .01$), indicating that the pairs differed from one another in level of timeshared performance.

A comparison of the initial six trials on each task alone for the two 8-year-old groups indicated that the two groups did not differ prior to the training of the one group (tracking $t(22) = .46$, auditory matching $t(22) = .35$).

Discussion

These data provide strong support for the hypothesis that performance in timesharing is a function of level of single task baseline performance. Equivalent levels of baseline performance produce equivalent levels of timeshared performance. This result is obtained when baselines are experimentally equated for subjects at different levels of development as well as for subjects of different ages paired on the basis of initially equivalent baseline performance (Lipps, 1975). If attention deployment becomes increasingly more flexible and efficient with development, then developmental differences in timeshared performance should appear for children of different ages despite single task practice which equates baseline performance. The attention deployment hypothesis is clearly unnecessary in order to account for the data in the present experiment.

The consensus has been that although baseline differences in performance covary with age and can be affected by practice incentives and instructions, baseline differences are not of much interest except as they create problems of interpretation. In contrast, the construct "attention" has been of central interest to investigators, who have assumed that age differences in performance obtained as a result of an experimental manipulation are evidence for developmental differences in attention (Hale & Flaugher, 1976,; Lipps Birch, 1976; Maccoby, 1969), despite the confounding of experimental treatment effects with age differences in baseline performance.

The results of the present experiment indicate that if baseline differences are noted for subjects of different ages it is not sufficient to perform a mathemathical transformation of the data and, if the age x treatment interaction remains, to conclude that irreducible developmental differences exist. If this procedure is followed with the data from the 8 and 13-year old baseline groups, significant age differences in absolute and proportional decrement scores are obtained. Within the prevailing view this would be sufficient evidence for developmental differences in attention. However, the major result of the present experiment is that once baseline differences are experimentally equated, no age differences in performance remain to be attributed to developmental differences in attentional processes.

The important implication of these results is that baseline differences for subjects of different ages do not merely present an annoying technical difficulty. It is not simply a question of which transformation to perform on the data in order to interpret the results as evidence for irreducible developmental differences in posited central processes; rather these data suggest that once baseline differences are experimentally controlled, there may be no remaining age differences in performance to attribute to constructs such as attention.

References

Boyle, A. Listening to distraction: A developmental study of selective attention. Journal of Experimental Child Psychology 1973, 15, 100-115.

Eliott, R. Simple reaction time: Effects associated with age, preparatory interval, incentive shift, and mode of presentation. Journal of Experimental Child Psychology, 1970, 9, 86-104.

Gain, P., & Fitts, P.M. A simplified electronic tracking apparatus. WADC Technical Report No. 44, 1959.

Gibson, E., & Yonas, A. A developmental study of the effects of visual and auditory interference on a visual scanning task. Psychonomic Science, 1966, 5, 163-164.

Hagen, J.W. The effect of distraction on selective attention. Child Development, 1967, 38, 685-694.

Hale, G.A., & Morgan, J.S. Developmental trends in children's component selection. Research Bulletin 71-3. Princeton, N.J.: Educational Testing Service.

Hale, G., & Flaugher, J. Distraction effects in task of varying difficulty: methodological issues in measuring development of detractibility. Research Bulletin 76-1. Princeton, N.J.: Educational Testing Service.

Lipps, L. Age trends in children's timesharing performance. Unpublished doctoral dissertation, The University of Michigan, 1975.

Lipps Birch, L. Age trends in children's timesharing performance. Journal of Experimental Child Psychology. 1976. 22, 331-345.

Liss, P., & Haith, M. The speed of visual processing in children and adults: Effects of backward and forward masking. Perception and Psychophysics, 1970, 8, 396-398.

Maccoby, E.E. The development of stimulus selection. In J.P. Hill (Ed.) Minnesota Symposia on Child Psychology, Minneapolis, Minn.: University of Minnesota Press, 1969, 31. 68-96.

Maccoby, E.E., & Konrad, K. Age trends in selective listening. Journal of Experimental Psychology, 1966, 3, 113-122.

Pew, R.W., & Rupp, G. Two qualitative measures of skill development. Journal of Experimental Psychology, 1971, 90, 1-7.

Thorndike, E.L., & Lorge, I. The Teachers Word Book of 30,000 Words. New York: Bureau of Publications, Teacher's College, Comlumbia University, 1944.

Wickens, C.D. Temporal limits on human information processing: A developmental study. Psychological Bulletin, 1974, 81, 739-755.

Footnote

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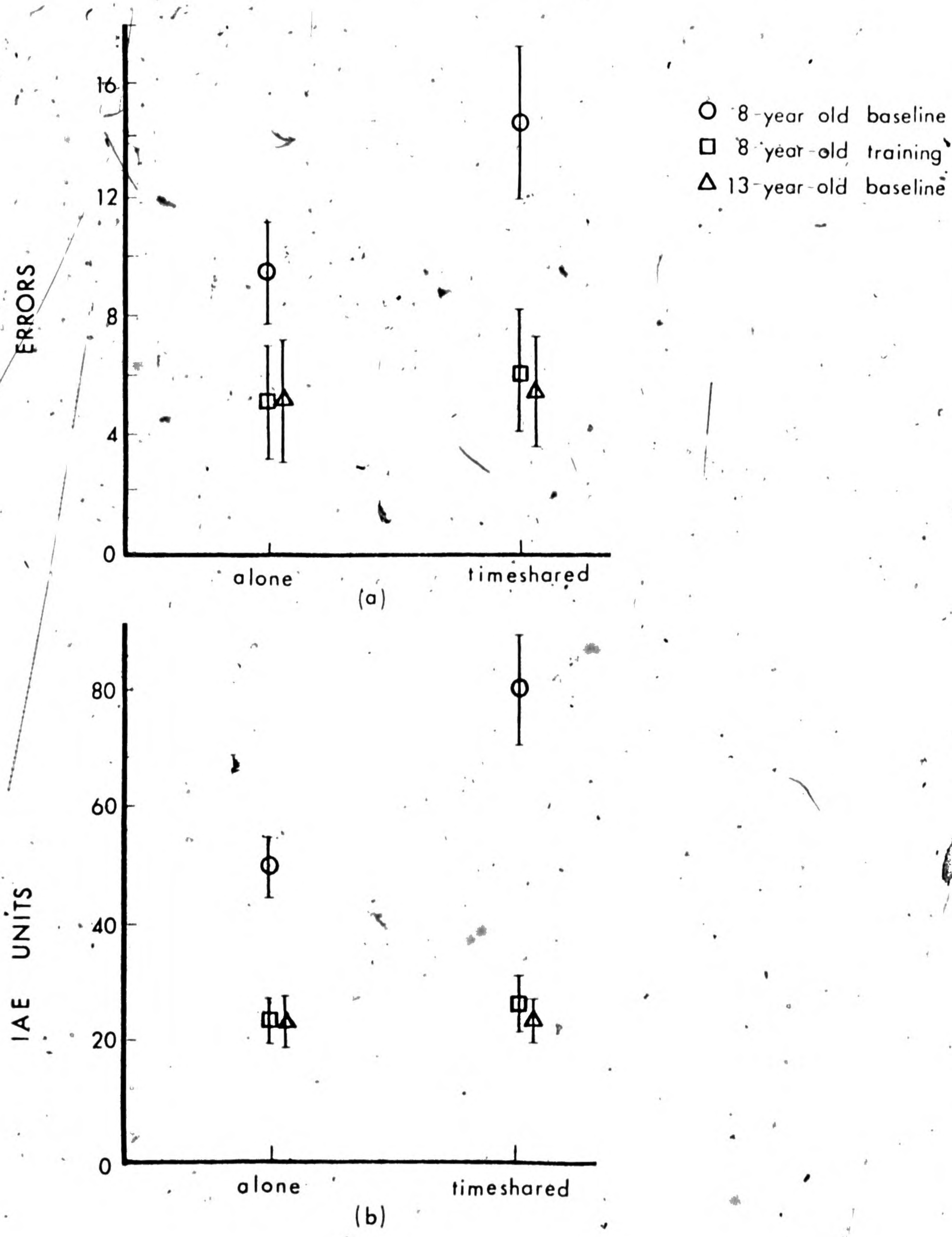
Requests for reprints should be sent to Leann Lipps Birch, 209 Child Development Lab, 1105 W. Nevada, Urbana, Illinois 61801.

Figure Caption

Figure 1. 95% confidence intervals in alone and timeshared conditions for tracking and auditory matching tasks.



ERRORS
16
12
8
4
0
alone
timeshared
(a)
8-year old baseline
8 year-old training
13-year-old baseline
IAE UNITS
80
60
40
20
0
alone
timeshared
(b)