The Role of Internal Inhibition and the Frontal Lobes in Child Development

R. LYNN, VALERIE COMPTON

University of Exeter, United Kingdom

Abstract—The theory that children show a predominance of excitation over internal inhibition and that this is due to inadequate development of the frontal lobes is explored and extended. Experimental results show that children resemble leucotomised monkeys in their difficulty in overcoming an initial preference in discrimination tasks.

A NUMBER of writers in the Pavlovian tradition have maintained that children are characterized by an excess of excitation over internal inhibition. In this respect children could be said to resemble anxiety neurotics, whom Pavlov regarded as in a similar state of disequilibrium. The well known restlessness and hyperactivity of children is certainly in tune with this view of their nervous processes. At a more experimental level, Luria (1961) has conducted a number of experiments which he interprets along the same lines. In these experiments the Ivanov-Smolensky conditioning apparatus is used, in which the subject is conditioned to press a bulb to one stimulus but not to another. It was found that young children aged 2-5 years find it much easier to learn to press (the positive reaction) than not to press (the negative reaction). This finding follows naturally from the theory that the excitatory processes are stronger than the internal inhibitory processes. The very fast conditioning of young children (Braun and Geiselhart, 1959) may be cited as additional evidence in favor of the theory.

Luria has pushed the theory somewhat further by suggesting that the gradual strengthening of internal inhibition during childhood is due to the development of the frontal lobes (Luria, 1961). This hypothesis accords well with Konorski's (1961) view that the effects of damage to the frontal lobes in primates can be understood as resulting from a weakening of internal inhibition. These "frontal" animals are characterized by hyperactivity, distractability and overactivity in discrimination situations, all of which could result from a weakness of inhibition. Putting the Luria and Konorski hypotheses together, we can advance the theory that there are similarities between children and frontal primates because in both the frontal lobes are not fully effective, and that this results in a predominance of excitatory over inhibitory processes.

The present paper is concerned with further exploration of this theory. Its empirical implications can be phrased, in a manner familiar to psychologists, in the following way: children are to adults as frontally damaged monkeys are to intact monkeys. Our method has been to take a well-established impairment following frontal damage to monkeys, and to see whether the same impairment exists in children vis-à vis adults. The impairment chosen occurs in discrimination learning tasks, where the subject has to switch from his initially preferred choice to his unpreferred choice. While prefrontal monkeys can learn a discrimination task well when their initial preference is correct, they are impaired when their initial preference is not correct and they have to alter it. (Brush, Mishkin and Rosvold, 1961; Rosvold and Mishkin, 1961; Konorski, 1961). It is this feature of frontal lobe damage that we have sought evidence for in young children.

Experiment I: Baited vs. Unbaited Discrimination Learning

Procedure: The first experiment is concerned with the difficulty of suppressing a preferred response. The procedure followed that of Brush, Mishkin and Rosvold (1961) in their experiments on frontally damaged and intact monkeys. Ss were 16 children with an age range of 3.0-4.7 years and 6 young adults aged 18-19 years. Ss were seated at a table and had to learn a discrimination between two beakers of different colour, under one of which a sweet was to be found. The following instructions were given: "Here are two beakers. Under one is a sweet. I want you to choose one of the beakers, lift it up, and see if the sweet is underneath. If it is, you can keep it. Then I shall lower this board so you can't see which beaker I'm putting the sweet under. Remember, each time there will be a sweet under one beaker, and nothing under the other one—you see how many sweets you can get."

Each S was tested in a 'baited' and 'unbaited' condition on two separate occasions separated by six days. A 'baited' condition means that on the first trial sweets were placed under both beakers, so that the S's first choice appeared to him to be correct. This beaker was then made the correct beaker for a further twenty trials. In this condition the S's initial preference is reinforced. In the unbaited condition, neither beaker had a sweet on the first trial and the beaker chosen was designated incorrect, so that S had to overcome his initial preference on the later trials. The order in which the Ss did the two tests, beaker colour and right-left positions were balanced.

Results: For the children the mean number of errors for the baited condition was 2.93 and for the unbaited condition 5.75: this difference is significant at $P<.01$ using the Wilcoxon matched-pairs signed ranks test. For adults errors for the baited condition were 0.75 and for the unbaited 0.60 and this difference is not significant.

This result shows that children, but not adults, resemble frontally damaged monkeys in having difficulty in suppressing a preferred response.

Experment II

Procedure: The second experiment was concerned with suppressing a reinforced response, which was induced experimentally and then had to be overcome. The procedure followed that of Brush, Mishkin and Rosvold's (1961) experiment on monkeys. A preference for one beaker was induced by being presented alone for five trials, always with a sweet under it. After these trials a second beaker was added and the Ss now had to choose for a further 15 trials. In one condition the originally reinforced beaker continued to be the correct beaker. In the second condition the other beaker was the correct one. Each S was tested in both conditions with balanced orders and positions.

Results: For the children the mean number of errors for the first condition was 0.85 and for the second condition 5.25; this difference is highly significant at $P<.005$ using the Wilcoxon test. For adults the mean errors were 3.00 and 3.52 and this difference is not significant. This result again shows that children, but not adults, resemble frontally damaged monkeys in their difficulty in overcoming a reinforced response and substituting another response.

Discussion

The experiments show that children share with prefrontal monkeys a difficulty in overcoming initial preferences in discrimination problems. The result adds to the similarity between children and prefrontal monkeys observed by other investigators, namely their hyperactivity and distractability. The most obvious explanation for these similarities is that the frontal lobes of children are not fully developed so that their behavior approximates in some respects to that of other primates with frontal lobe damage. Fortunately there is independent evidence from another source which corroborates this interpretation. This is the EEG evidence, which shows that the child's frontal lobes do not become mature until about the age of 12 years (Lindsley, 1960).

At a theoretical level it would seem that a fairly good case can now be made for the view that the frontal lobes are concerned with the maintenance of internal inhibition. The theory explains well the features of the behavior of children and frontal monkeys considered here. Their hyperactivity follows naturally from the theory. Their distractability can be understood as a result of inadequate inhibition of irrelevant stimuli which in the adult and intact animal are ignored or suppressed. The theory has also predicted the present finding of the peculiar difficulty of children in suppressing a preference in a discriminaton task, which again can be understood in terms of a weakness of the inhibitory processes.

References

Braun, H. W., and Geiselhart, R. (1959): Age differences in the acquisition and extinction of the conditioned eyelid response. *J. Exp. Psychol.*, 57, 386-388.

Brush, E. S., Mishkin, M., and Rosvold, H. E. (1961): "Effects of object preferences and aversions on discrimination learning in monkeys with frontal lesions." *J. Comp. Physiol. Psychol.* 54, 319-325.

Konorski, J. (1961): Discussion of Rosvold and Mishkin's paper in "Brain Mechanisms and Learning" ed. Fessard et al. Oxford, Blackwell.

Lindsley, D. B. (1960): "Attention, Consciousness, Sleep and Wakefulness." In Handbook of Physiology, ed. Field. Washington: American Psychological Society.

Luria, A. R. (1961): Speech and the Regulation of Behaviour. Oxford: Pergamon Press.

Rosvold, H. E., and Mishkin, M. (1961): "Non-sensory Effects of Frontal Lesions on Discrimination Learning and Performance." In "Brain Mechanisms and Learning" ed. Fessard et al. 555-576.