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ABSTRACT

This study examined the relationship between infants' early physical environment and their subsequent performance on the Stanford Binet Intelligence Scale. A total of 23 infants were observed twice a month in their own homes starting at 12 months of age and continuing through 24 months of age. These observations were subsequently coded into 30 item categories which were derived from the Purdue Home Stimulation Inventory and which reflected the physical environment. The Binet was administered at 31 months in the child's own home. Data were anlayzed by means of correlations between Binet performance and physical environment indices for each 3-month time block between 12 and 24 months. Results indicated that the amount of verbal interaction directed toward the child and the physical responsivity of the environment were consistently and positively related to Binet performance across all time blocks. Other physical environment items, including the presence of noise/confusion in the home, environmental predictability, variety of objects available to the child and a lack of physical restraints on exploration, were related to Binet performance only at specific age levels. Analyses by sex indicated that relationships for females appeared earlier then male relationships and that stimulus variability was uniquely related to female development while a responsive physical environment was uniquely related to male development. (Author/JMB)

Relationship of Infants Physical Environment To Their Binet Performance at 2 1/2 Years

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Relationship of Infants Physical Environment
To Their Binet Performance at 2 1/2 Years

With the growing availability of human and infrahuman evidence it is becoming increasingly clear that the early experience of the organism is quite important for cognitive-intellectual development (Hunt, 1961; Uzgiris, 1970). Accepting the importance of early experience, recent research, particularly with humans, has turned to the question of what aspects of the early environment are most relevant for subsequent cognitive-intellectual development. Most of the available evidence has been concerned with the relationship of interpersonal or mother-child interaction variables upon subsequent development (Bayley and Schaefer, 1962; Stern, Caldwell, Hersher, Lipton and Richmond, 1969; Clarke-Stewart, 1973). In contrast, there is relatively little evidence on the relationship of the physical, inanimate environment to early cognitive-intellectual development. What evidence is available suggests that physical environmental parameters such as availability of stimulus material (Moore, 1960) short term (Yarrow, Peterson, and Jankowski, 1972) and long term (Wachs, 1976) variety of stimulus material, a "match" between organismic level and stimulus complexity (Yarrow, 1963; Elardo, Bradley, and Caldwell, 1975; Bradley and Caldwell, 1976) and responsivity of the physical environment (Yarrow, et al., 1972; Wachs, 1976; Riksen-Walraven, reference note #1) are positively related to subsequent cognitive-intellectual development. In contrast, the presence of noise-confusion in the home (Wachs, Uzgiris, and Hunt, 1971; Wachs, 1976; Wohlwill and Heft, reference note #2), overcrowding (Belmont and Morolla, 1973; Wachs, 1976) irregularity in scheduling even' in the home (Elardo, et al., 1975; Bradley and Caldwell, 1976;

Riksen-Walraven, reference note #1) and physical restrictions on the child's exploration (Williams and Scott, 1953; White and Watts, 1973; Wachs, 1976) are all negatively related to infants cognitive-intellectual development.

Unfortunately, much of the above evidence is limited by two factors. First, it is concerned with infants below two years of age with little evidence on development after this time. Second, environmental measurements are typically taken at one point in time thus minimizing the possibility of finding an interaction between age of child and stimulus class as they relate to development. What evidence is available on the latter question does in fact suggest that this interaction may exist such that classes of stimulation that are effective at one age level may be irrelevant at other age levels (Elardo, Bradley, and Caldwell, 1975; Hanson, 1975; Wachs, reference note #3). The present paper reports a follow-up of an earlier project in which physical environment parameters between 12 and 24 months were related to infants Piaget scale performance between 12 and 24 months (Wachs, 1976, reference note #3). In the present project the physical environmental parameters were related to the infants subsequent Binet performance at 31 months of age.

Procedures

Subjects

The original sample comprised 39 infants who were taking part in our previously noted longitudinal study. Of the 29 infants still in the original project sample at 24 months 23 of these were available for another testing 7 months later. Of these 23 infants 17 were male and 6 were female. Preliminary testing indicated no significant evidence for selective attrition in either physical environmental parameters or Piaget scale performance between 12 and 24 months.

Instruments

The 30 physical environmental parameters were derived from sections I-III of the Purdue Home Stimulation Inventory (PHSI) (Wachs, 1976, reference note #3). One third of this inventory is obtained by questioning the mother. The remainder of the items are obtained by direct observation of the child's home. With the exception of item SL6 (interobserver reliability = 46%) interobserver agreement for the 30 items of the PHSI ranged from 69% to 100% with the median interobserver agreement being 85% (Wachs, reference note #3). Analysis also indicated an extremely high cross-time stability for most PHSI items with the majority of items showing cross-time stability coefficients of +.65 or greater over the second year of life (Wachs, reference note #3).

The Stanford Binet (Form LM, 1960) was used as our psychometric measure of intellectual functioning.

Method

In the month prior to the child's first birthday several initial visits were made to the child's home to get children and parents adapted to the presence of an observer. Starting at 12 months of age and continuing through 24 months of age all children were formally observed in their own homes. There were two observations per month and each observation was 45 minutes in length. Section III items were obtained by time sampling observations after each 15 minutes of observation. Section I and II items were obtained by interviewing or direct observation once a month after the last 45 minute observation period. To minimize observer effects, by having the observer as familiar as possible, the same individual observed the child during the twelve month period. For those infants available for for a final testing, the Binet was administered in the child's own home when the child was between 31 months 0 days and 31 months and 15 days of age. When needed, a second testing session was used. None of the examiners had ever previously observed the child they tested.

Analysis

Predictor variables were the 30 items comprising PHSI I-III. For each PHSI item the data were collapsed into four 3 month time blocks: 12-14, 15-17, 18-20, and 21-23 months. Because all 30 PHSI items received a score each month the problem of low frequency items was avoided. The criterion variable was the child's level of Binet performance. Because 5 of the 23 children failed to establish a basal score, a Binet IQ or MA could not be obtained for these children. To avoid a further loss of subjects, since all children were tested during the same age period it was decided to use the number of Binet items passed as the criterion variable. Thus, the primary data analyses were product moment correlations between PHSI items at each time block and subsequent Binet performance. These analyses were run for the original sample and for males and females separately. Differences between male and female correlations were analyzed by means of the z transformation test for significance of the difference between two independent correlations (Edwards, 1964). Because of the small number of subjects when the sex breakdown was done, particularly for females, the results for males and females must be regarded as highly tentative at best. Because of the unfavorable ratio of predictor variables to sample size, multivariate techniques were not utilized.

Results

Total Sample

The correlations between Binet performance and PHSI items at each time block are shown in Table 1. Results indicate that one item, CE1, the number of audio-visually responsive toys, is positively and significantly related to Binet performance across all time blocks. In addition to CE1, for the 12 to 14 month time block the data indicates that decorations in the child's room (VS8), temporal regularity as indexed by regularity of naptime (EP1) and a lack of overcrowding (SL3) are positively and significantly related to Binet performance while the presence of noise-confusion in the home (SL5) is negatively related. At 15 to 17 months, AV responsive toys, room decorations, lack of overcrowding and temporal regularity are again positively related to Binet performance as is the time per day parents spend reading to the child (LS1). The total number of individuals (SL7) and the total number of strangers (SL7a) in the home during each 15 minute time block are found to be negatively related to development. Between 18 and 20 months, besides AV toys and time spent reading which again appear, level of Binet performance is also positively related to changes in play objects possessed by the child (VS10) and a lack of physical restrictions on child's exploration (VS11). Between 21 and 23 months besides reading time, room decorations and AV toys which again are positively and significantly related to delopment, level of Binet performance is again found to be positively related to a lack of overcrowding (SL3) as well as to the presence of a stimulus shelter (SL2 - a place a child can go to get away from noise, people, and interference) in the home.

Analysis by Sex

The correlations for males and females that are significantly different from zero are presented in Table 2.

At least on the surface the results presented in Table 2 would suggest not only that male development is related to different sets of items than female development but that for those items which are related to both sexes significant female correlations tend to appear ahead of the male correlations (LS1, VS8). However, the fact that one correlation is significantly different from zero but a second is not tells us nothing about whether the two correlations are significantly different from each other. A more sensitive test to indicate differential reactivity of the sexes to environmental stimulation would be a z test to determine whether male or female correlations that are differentially discrepant from zero are also significantly different from each other. Analysis by z test indicates that of the 30 male and female correlations which are significantly different from zero 11 also show differential significance between the sexes. Results indicate that the negative correlations between the number of sibs in the home and subsequent Binet for females (SLS) are significantly greater than their corresponding male correlations between 12 to 14, 15 to 17, and 18 to 20 months. Similarly, the positive correlation between number of caretaking adults (VS3) between 12 and 14 months and 31 months Binet for males is significantly different from its corresponding female correlation as are the negative female correlations on this item with the corresponding male correlations between 18 to 20 and 21 to 23 months. In addition, the positive female correlations between changes in room decoration (VS9) and subsequent Binet are significantly different from their corresponding male correlations betwen 12 to 14, 15 to 17, and 21 to 23 months as is the positive female correlation between changes in child's play objects (VS10) between 15 to 17 months with its corresponding male counterpart. Finally, the positive female correlation between number of strangers in the home (SL7a) and subsequent Binet between 21 and 23 months is also significantly different from the corresponding male correlation.

Discussion

The overall pattern of results indicates that while some early physical environmental parameters show a consistent relationship to subsequent development, others are related only at particular ages. Among the physical environment items that are consistently related to subsequent Binet performance are the presence of audio-visually responsive toys, lack of overcrowding, and adequate numbers of visual decorations in the child's room. Of these three the most critical item is item CE1, the number of audio-visually responsive toys. This item taps what we have called a "physically responsive environment". Previous research has indicated the relationship of this item to cognitive development in the first year of life (Yarrow, et al., 1972) and the second year of life (Wachs, 1976, reference note #3). The present paper extends the relevance of this item for development into the third year of life as well. The importance of this item seems to lie in the fact, based upon both naturalistic observation (Provence and Lipton, 1962) and experimental evidence (Watson and Ramey, 1969) that infants deprived of a responsive environment tend to stop responding to the environment. This tuning out of the environment not only reduces the infants intake of environmental stimulation but also minimizes the infant's willingness to display adaptative behaviors (Provence and Lipton, 1962). In addition, non-responsive infants are also more likely to promote further non-responsivity from those around them (Osofsky and Danzger, 1974) and thus a vicious circle develops. While much of the environmental responsivity comes from the infants parents or other caretakers, the present pattern of results, combined with those noted earlier, strongly suggests the relevance of non-social responsivity to development as well. These results may have definite implication for institutional or residential settings where there is a lack of adult interaction. The general pattern of data suggests that in these institutions, where a socially responsive environment is missing, efforts should be made to provide a physically responsive environment for the infant so as to avoid the detrimental effects associated with living in a totally non-responsive environment. The relationship of overcrowding to intellectual development has been noted in previous human (Dandes and Dow, 1969; Wachs, 1976, reference note #3) and infrahuman (Calhoun, 1962) studies. This relationship of overcrowding to development may relate either to greater interference with the child's ongoing transactions with his environment or to a greater probability of disturbances in parent-child relationships (Galle, Gove and McPherson, 1972). The final item, room decorations, could be dismissed as simply an index of socio-economic status. We would prefer to contend the reverse however; namely that the presence of adequate room decorations rather than being another socio-economic index is in fact one of the environmental parameters that may cause socio-economic differences in early cognitive-intellectual functioning. As noted in previous research (Kennedy and Wachs, reference note #4) differences in development which are not predicted by gross socio-economic indices may be predicted by more finally grained measures of the environment such as VS8.

Besides the above 3 items a number of other items were found to be related to development only at 1 or 2 age periods. An argument could be made that these time effects reflect the differential reliability of the PHSI items at different ages. However, given the high level of interjudge reliability and high level of cross time stability of our physical environment items this argument seems not to be relevant here. Rather we would argue that these results reflect the operation of periods of optimal sensitivity to differential aspects of the environment. As such, our data could fit within the framework of Thompson's (1966) developmental differentiation theory. As noted previously, most early experience research tends to measure the relationship of environment to development only at one age point and makes the implicit assumption that the obtained results will generalize to other age periods. The present data, as well as previous data, (Wachs, reference note #3; Bayley and Schaffer, 1962; Elardo, Bradley and Caldwell, 1975; Hanson, 1975) suggests that this strategy may be an oversimplified one and that greater attention should be paid to the possibility of age differences in sensitivity to various aspects of the environment.

The importance of individual-organismic factors can also be discussed in regard to the sex differences reported in the present paper, although this discussion must be tempered by the small sample size. Although a number of sex differences have been noted here the most consistent effect suggests that female development seems uniquely related to indices of variety - change of stimulation in the home (VS9, VS10) with the female correlations on these items being significantly greater than the corresponding male correlations. This finding replicates a similar finding in our earlier project (Wachs, reference note #3). This finding also is reminiscent of the data by Weizmann, Cohen and Pratt (1971) indicating that attentional behavior by females was facilitated by being placed in an unfamiliar (varied) environment rather than a familiar one with the contrary result being found for males. However, due to the general lack of data on sex differences in reactivity to environmental stimulation it is difficult to go beyond simply noting the similarity of results between our study and that of Weizmann et al. Clearly any theoretical rationale for sex differences in reactivity to environmental stimulation must await further data upon which an adequate theory can be based. However these results have definite implications for educational remediation and early interventions strategies in terms of suggesting that simply exposing male and female infants to a standard "enrichment curriculum" at the same point in time may not be the most optimal strategy. Hopefully, further data relating to sex differences in reactivity to environmental stimulation can be used to expand and develop our understanding of the role of individual difference factors in the developmental process.

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TABLE 1

Correlations between 31 month Binet Performance and PHSI Items measured between 12-24 months

PHSI Item Code	PHSI Item Summary	Time Blocks 12-14	15-17	18-20	21-23
VS1	Times per month child taken out of neighborhood.	.19	.06	.22	-.028
VS2	Times per month child visits neighbors.	-.16	-.39	.13	.02
SLS	Number sibs at home.	-.13	-.06	-.04	-.25
SLA	Number adults at home.	.00	-.01	-.01	-.02
VS3	Number caretaking adults.	.24	.29	.08	-.25
PI1	Categories child given training in.	.02	.00	-.05	-.25
LS1	Time per day reading to child.	.34	.42*	.62*	.52*
EP1	Regular Naptime.	.51*	.59**	.45	.42
EP2	Regular Mealtime.	.23	.20	.06	-.05
EP3	Child has own toys.	-.17	-.08	-.02	-.40
SL2	Presence of stimulus shelter.	.22	.13	.42	.70*
VS4	Free access to maniputable items.	-.03	.17	.36	.36
VS5	Number of available maniputable items.	.40	.27	.25	.10
LS2	Rate of maternal speech.	.30	.24	.34	.42
SL3	Rooms/people in home.	.47*	.47*	.30	.62**
VS6	Number childrens books.	.17	.28	.32	.25
CE1	Number of audio-visually responsive toys.	.62**	.58**	.54*	.73**
VS7	Mobile over crib	.20	.20	.24	.20
VS8	Number decorations in childs room.	.51*	.43*	.38	.52*
VS9	Changes in room decorations.	.03	.25	.21	.15
EP4	Toys kept in one place.	.02	-.18	.06	.18
VS10	Changes in childs toys.	.27	.21	.49*	.21
VS11	Physical set-up of home restricts exploration.	.12	.38	.52*	-.05
STE	State of Child	-.08	-.11	.07	-.09
SL4	Number stimulus sources on.	-.12	.00	.19	-.18
SL5	Noise/confusion rating.	-.44*	-.20	-.39	-.29
SL6	Activity level rating.	-.17	-.25	-.22	-.30
VS12	Floor freedom time.	.09	-.04	.12	.28
SL7	Number of people in home.	-.26	-.51*	-.09	-.24
SL7a	Number of strangers in home.	.15	-.50*	.19	.35

* $p < .05$
** $p < .01$

TABLE 2

z Tests between Male and Female Correlations that are Significantly Different from Zero.

PHSI Item Code	PHSI Measured between (months)	$r_{PHSI-Binet}$ Male	Female	z
VS2	15-17	-.53*	.16	1.18
SLS	12-14	-.04	-.83*	1.96*
	15-17	.03	-.83*	1.96*
	18-20	.06	-.83*	1.99*
VS3	12-14	.52*	-.74	2.45*
	15-17	.51*	-.56	1.92
	18-20	.39	-.92**	3.17**
	21-23	-.02	-.99**	4.67**
LS1	15-17	.36	.81*	1.19
	18-20	.61*	.63*	0.06
	21-23	.52*	.45	0.15
EP1	15-17	.52*	.85*	1.08
SL2	21-23	.78**	.72	0.18
SL3	21-23	.66**	.74	0.26
CE1	12-14	.66**	.57	0.24
	15-17	.67**	.45	0.51
	18-20	.69**	.15	1.11
	21-23	.82**	.11	1.64
VS8	12-14	.39	.85*	1.31
	15-17	.28	.85*	1.51
	21-23	.60*	.30	0.60
VS9	12-14	-.18	.81*	2.09*
	15-17	-.01	.93**	2.76**
	18-20	-.10	.97**	3.60**
VS10	15-17	.02	.90**	2.32*
	18-20	.46	.83*	1.09
SL5	12-14	-.59*	.38	1.70
SL7a	15-17	-.44	-.82*	1.06
	21-23	.33	.94*	2.28*

*p < .05

**p < .01