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ABSTRACT

The conceptualizations of morphogenic processes suggested by systems theorists provide a useful framework for describing growth and development in complex adaptive self-directing organisms. These processes involve changes in (1) a system's structure, state, or functioning; (2) discontinuities in development; and (3) at least two kinds of developmental paths--equifinality and multifinality. Equifinality holds that a given outcome can be reached from any number of different developmental paths. Multifinality holds that similar initial conditions may lead to dissimilar outcomes. An example of equifinality is seen in a sample of children who were observed interacting with their mothers at 3 and 24 months. At 3 months the groups differed on several social behaviors, but at 24 months they differed on only one. Thus, individual differences observed at 3 months did not lead to differences at 24 months. Multifinality is explored in a longitudinal study of children assessed for attachment classifications at the age of 1 and for emotional functioning at the age of 6. Measures revealed that 6-year-old boys who were securely attached to their mothers exhibited fewer behavior problems, but that female behavior at 6 years did not significantly differentiate among attachment groups. Thus similar initial conditions led to dissimilar outcomes. Equifinality, multifinality, and stability may be useful principles for developmental research (BN)

Equifinality and Multifinality:

Diversity in Development from Infancy into Childhood

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Trying to make sense out of human development and data, may often produce the state of mind, William James used to describe infant perception

"One great buzzing booming confusion." (pg 488)

Searching for understanding as well as prediction (Harre & Secord, 1972) from infancy into childhood can be a frustrating task. The study of continuity and change defines the area of developmental enquiry (e.g., Kagan, 1971; Wohlvill, 1973; Lewis & Starr, 1979; Lewis, 1986). Developmentalists are looking for order in change and are attempting to identify continuities in behavioral systems which are transforming and reorganizing.

Longitudinal studies that have examined measures in infancy as predictors of later status have focused primarily on personality traits, such as temperament, or discrete behaviors in normal populations (Bell, Weller & Waldrop, 1971; Escalona, 1968; Kagan, 1971; Macfarlane, Allen & Honzik, 1954; Schaefer & Bayley, 1963; Thomas, Chess & Birch, 1968). The findings from such studies suggest that within the normal range of personality variation prediction of later behavior patterns made from ratings or observations in infancy may be poor (Beckwith, 1979; Kagan & Moss, 1962; Kessen, Haith & Salpatek, 1970; Kohlberg, La Crosse & Ricks, 1971; Macfarlane et al., 1954; Sameroff, 1975; Schaefer & Bayley, 1963; Thomas et al., 1968). Despite evidence to the contrary, our initial inclination in conceptualizing and planning a study and later in data analyses is to rely on the stability or the ordered change template of development (Gergen, 1977).

In searching for patterns of consistency and change, it is hard to resist looking for the "sacred" law of causality from classical philosophy, namely a law which states that similar conditions produce similar effects and that dissimilar results are attributed to dissimilar conditions. Much of our research is dictated by this straight forward causal principle. For example,

when we try to determine why two groups of individuals are different, we look for differences in environment, or personality or biological factors. While developmentalists are fully aware that the "sacred law of causality" yields an inadequate model for explaining development, the idea of discovering simple rules is still compelling. We want to be able to state for example that insecure infants beome poorly adjusted children, or that responsive mothers produce healthy children. The idea that initial conditions determine later outcomes continues as a fundamental premise for much work in child development.

Simultaneously with adherence to the classical law of causality we also see an emphasis on the interactive, transformational nature of development (Sameroff, 1984; Lewis, 1982; Feiring & Lewis, 1978; Lerner & Spanier, 1978; Bronfenbrenner, 1977). From a systems point of view causal models can take many forms and at the very least, there is attention (if not measurement or analysis) directed towards a multicausal reciprocal framework. Exploration and description of plasticity, multilinearly and multidirectionally of human development is called for as a fundamental necessity (Lerner & Spanier, 1978).

The conceptualizations of morphogenic processes suggested by systems theorists (e.g. Buckley, 1967; Campbell, 1959, & Maruyama, 1963) provides a useful framework for describing growth and development in complex adaptive self directing organisms. This framework of development begins with the given of a potentially changing environment characterized by constrained variety and an adaptive system whose persistence and elaboration to higher levels depends on the successful mapping of some variety and constraint into its own organization on at least a semipermanent basis. Four basic ideas are seen as important for the function of an adaptive system, and these are applicable to biological, psychological or sociocultural systems.

1. Some degree of plasticity so that there is constant exchange between organism and environmental events.

2. Mechanisms for providing adaptive variability so that new problems of variety and constraint in a changeabale environment can be met.

3. A set of selective criteria for determining the adaptability or degree of match between variations in the organism and the environment.

4. Mechanisms for propagating or preserving adaptive mappings of the environment.

From these four propositions we can derive two basic principles of development morphostasis and morphogenesis. Morphostasis refers to those processes in complex system-environment exchanges which tend to maintain a systems given form or organization. Morphostasis may represent developmental processes that lend themselves to observation of continuity. Morphogenic processes may by their nature be harder to observe and predict since they involve changes in a systems structure, state or functioning. Morphogenic processes may involve discontinuities in development. At the extreme morphogenesis can be related to catastrophes and radical changes (e.g. in terms of continuing levels of Y at some point leading to a steep change in X). Morphogenesis involves at least two kinds of developmental paths: 1) equifinality and 2) multifinality. Equifinality holds that a given outcome can be reached from any number of different developmental paths. In this case, similar outcomes may not be the result of similar initial conditions or mediating processes. In this paper, we will consider an example of equifinality in the examination of the development of first-born and only children in the opening two years of life. Multifinality is the opposite developmental principle to equifinality, whereby similar initial conditions may lead to dissimilar outcomes. Thus, for example, two children developing in similar ecological environments or who begin with similar characteristics may

end up with different adaptive coping styles. In this paper we will explore an example of multifinality in regard to early mother-infant attachment and later emotional adjustment.

Equifinality: The Example of First and Only Born Children

The subjects consisted of a subsample of first born and only children who had been participing in a longitudinal study from infancy into childhood and adolescence. For this discussion we focus on the social interaction of 56 first born children and their mothers at 3 and 24 months. The sample contained 21 only children (children who did not acquire a sibling in the first 48 months of life) and 35 first-born children (children who acquired a sibling between the ages of 24 and 36 months). It should be noted that all the analyses comparing only and first-born children at 3 months were retrospective in nature, that is, in reality, all the children were only borns, (had no siblings), at 3 months of age. By 24 months of age, 10 children had already become first borns, and the remainder of the sample of first borns acquired siblings by or soon after 36 months of age.

At 3 months of age infants and their mothers were observed at home for a total of 2 hours during which the infant was awake. At 24 months mother-infant dyads were observed in a playroom laboratory for a free play period and then a separation and reunion. The mother-infant interaction data at 3 and 24 months was coded in several ways (Lewis & Lee-Painter, 1974). A distinction was made between behaviors that occurred in interaction (as an initiation or a response) and those that simply occurred. This scheme allowed for the recording of both the frequency and the nature of the mother-infant interactions.

First we will briefly examine mean differences in behavior between first-born and only groups at 3 and 24 months and then go on to explore the

developmental paths from 3 to 24 months. The details of this study (subjects, methods and results) have been presented elsewhere (Feiring & Lewis, 1984) here we focus on summarizing results relevant to the principle of equifinality.

At 3 months of age, onlies showed a tendency to move, cry, and burp and sneeze more than first borns. First borns, on the other hand, showed a tendency to vocalize, play, smile, suck, and feed more frequently than only borns. Taken together, the data suggested that at 3 months first-born children were less fussy and more sociable than onlies. When their infants are 3 months old, mothers of onlies touched, bathed, rocked, kissed, played with, looked at, vocalized to the infant, vocalized to others, and read or watched TV more than mothers of first borns. The data indicate that mothers of onlies were more frequently in proximal contact (touch, rock, kiss, bathe) with their infants than mothers of first borns. Mothers of onlies were also more frequently engaged in distal contact with their child (looking and vocalizing) than mothers of first borns. Given the tendency for onlies to cry more, it was not surprising to find that their mothers rocked them more than mothers of first borns. It was possible that only infants, because they were more fussy, required or demanded more monitoring behavior on the part of the mother.

Consequently at 3 months, there appeared to be both differences in infants and their mothers. However, at 24 months there were no differences between onlies and firsts, except that only infants showed more toy play in response to maternal direction giving than did first borns. Maternal behavior at infant age 24 months indicated that mothers of onlies tended to show more approval than mothers of first borns. No other differences in behavior were noted.

These findings appear to reflect equifinality in that individual differences observed at 3 months have not led to differences at 24 months but rather different antecedents seems to result in similar outcomes. Of course, it can always be argued that the 3 month differences were not reliable or that

the attributes which showed differences were not sufficient for distinguising groups that one would expect to show developmental differences. There is also the explanation of regression to the mean whereby statistically the only born groups would have shown less extreme scores over time. Regression to the mean however does not have to necessarily be a statistical phenomenon but can reflect psycho-social processes as well. To the extent that a sociable child is the desired norm, mothers may behave so as to shape their children to fit their model of the "good" child.

The mean differences we have found do not speak to the relationship between early behavior and later outcomes but they do indicate the possibility of equifinality. At this point, we turn to results from a correlation analyses which examined early child and mother behavior and later child outcomes.[1] The point here is the exploration of possible differences in developmental paths which lead to similar outcomes.

First borns who were sociable early in life tended to be sociable later on. Also, the more the first borns played, the less likely they were to seek proximity and comfort from the mother at 24 months. On the other hand, only borns who were less sociable at 3 months were the ones who tended to be more sociable at 24 months. In particular, it was the self-stimulating only born, in contrast to the alert playful first born, who was more social-play oriented at 24 months. Also, early social play for onlies positively predicted comfort seeking from the mother at 2 years, while for firsts the relationship was negative. These findings suggest that first borns show a more consistent developmental path from early sociability to later sociability and from early play to more play and less comfort seeking from the mother. Onlies appear to undergo a developmental transformation from less sociable behavior to more sociable and mother-oriented behavior at 24 months. These patterns are

interesting in light of the early mean differences between first borns and onlies at 3 months. Onlies were more fussy than firsts at 3 months and had mothers who were more proximally oriented. By 24 months, however, only born and first born infants were not different in their social behavior. Perhaps it was the mother's responsiveness to her fussy only-born 3-month-old that somehow influenced the transformation from the fussy, self-stimulating only born into a more sociable child at 24 months.

It is interesting to note that there were fewer significant relationships between the early and later behavior for onlies than there were for first borns. This suggests that first borns' own early behavior was a better indicator of their later behavior. This was less true for only borns.

From the mother-child longitudinal analyses, it appeared as if mothers' behavior toward onlies was a better indicator of these children's later social behavior at least in comparison to the infant's behavior. In particular, a relationship between early maternal involvement as characterized by caregiving and social interaction, and later child sociability with mother was noted for the only-born mother-child dyads as compared to first-born dyads. The data indicated that for onlies, later child social characteristics were more closely related to early maternal social characateristics than to child characteristics. The pattern of significant correlations suggested that the behavior of mothers had more impact on only children's development than on that of firsts. This may have been attributable to the fact that onlies were more fussy as infants and demanded more early maternal attention and intervention. Increased maternal involvement may have lead to changes in the onlies' social behavior from a less sociable to a more sociable individual. In contrast, first-born infants tended to be more sociable at 3 months than onlies, and this early first-born sociability was positively predictive of later sociability.

Considering Equifinability these data indicate that while both only and first born children end up showing similar levels of sociability at 3 months, their developmental paths are different. For first borns, some degree of continuity is observable, early sociability leads to later sociability. Of course, it must be acknowledged that the maternal environment, at least to some degree may operate to maintain sociability since this characteristic is usually viewed as desirable by parents and society. Hence we do not suggest that the first borns behavior fits a trait model $C_{t1} \rightarrow C_{t2}$ but that the interaction between child sociability and maternal environment is compatible for maintaining early infant sociability; perhaps this reflects a morphostatic type processes whereby the system tends to maintain adaptive behavior. For onlies, it appears as if a more morphogenic processes is at work whereby irritable infants become more sociable. The correlational analysis suggest that the similarity in 24 month outcomes for sociability in first and onlies is equifinal whereby the mothers of onlies act in ways different than mothers of first in order to facilitate the sociability of their infants.

While the principle of equifinality is implicated in these findings several qualifications must be noted. First the only borns may become more sociable no matter what mothers do. If this were the case equifinality still would be observable but for different reasons than we have suggested. Another problem is that of small sample sizes and unreliability of findings. Finding equifinality may thus be a statistical artifact. Still another qualification in the identification of equifinality has to do with the time span we choose to consider in terms of initial condition and later outcome. Where we draw the boundary for "final" outcome may influence whether we observe similar or different outcomes. In the example of equifinality discussed here the final outcome is social behavior at 2 years of age. Equifinality may not be observed

for 1 year social outcomes or for later childhood and so forth across the life span.

Considering the findings we must also acknowledge that, once we have noted some continuity (first born) and some change (only borns) a large portion of the variance in later child outcome is not accounted for by the early child or mother factors we measured and still remain unexplained. While this may be due to poor measurement, or choosing the wrong or not enough phenomena to study, it is also important to consider that prediction from earlier to later outcome may be very limited because developmet is discontinuous (Lewis, 1986). Human development may be best characterized by the confluence between the individual and the environment so that the individual is in a state of continuous change (Gergen, 1972). This confluence may be viewed as emergent across time. Consequently development at time 2 cannot be derived, or may be derived to a very limited degree, from pre-existing conditions or attributes at time 2. To the extent that the determining confluence is subject to chance or rare events, it will be aleatory in nature and thus hard to predict. For developmentalists this is a particularly difficult state of affairs because it suggests that contemporaneous rather than longitudinal predictive work may be more useful in understanding human functioning. This aleatory change template (Gergen, 1977) may fit more phenomena than we would like given our scientific proclivity for prediction and continuity models. It may be that in addition to pursuing more complex models of development which include equifinal type processes we must also work within a great deal of constraint where prediction is concerned.

Multifinality: The Example of Early Attachment with later behavior problems in girls and boys:

As stated previously, multifinality is the principle whereby similarity in early conditions do not lead to similar outcomes. As we have just discussed

in regard to the aleatory template, discontinuities in development may be prevalent and characteristic of the human life course. While the classical law of causality would indicate that similar conditions result in similar outcomes, this is often not true for human development. Obviously differences in history between t_1 and t_2 can yield different outcomes. In fact much of our developmental research from infancy into childhood would suggest that similar antecedent conditions may lead to dissimilar outcomes especially as one lengthens the time between observations.

One example of mulifinality comes from our work in antecedents of behavior problems (see Lewis, Feiring, McGuffog & Jaskir, 1984). The sample consisted of 113 children and their mothers seen at one and six years as part of a longitudinal study on social and cognitive development. The socioeconomic status of the sample was white middle class; mothers and fathers had an average of 15.32 and 13.86 years of education respectively. At one year of age infants and mothers were observed in a free play type setting. In addition to observation of frequency of child and mother behaviors (e.g. look, smile, vocalization, touch), assessment at one year of attachment classification was obtained. When the children were six years of age, mothers were asked to complete the Child Behavior Profile (CBP) in order to get an estimate of the child's emotional functioning. The CBP, provided a total score which enabled us to differentiate children with emotional problems from those without problems. Mothers also completed a stress questionnaire which asked about stress events (e.g. death, illness, accidents) that had occurred in the family in the past two years.

Analyses of variance by attachment classification(A = Avoidant, B = Secure, and C = Ambivalent Attachment Quality) and sex were performed on the behavior problems scores. The results of these analyses revealed that boys

who were securely attached to their mothers in infancy exhibited fewer behavior problems at six years of age, thereby displaying a "healthier" psychological profile than boys who were insecurely attached. Female behavior ratings at six years did not significantly differentiate among attachment groups, although females classified as ambivalent C type attachment quality in infancy were rated as somewhat "healthier" than secure B or avoidant A females, who did not differ from each other.

Insert Figure 1 about here

Figure 1 presents the behavior problems profiles for females (Figure 1a) and males (Figure 1b). Inspection of these profiles suggest that C females show the lowest while C males show the highest scores on the behavior problems subscales. Further in regard to the total behavior problem score C and A females showed significantly lower scores than C and A males ($F_{2, 107} = 6.75$ $p < .001$) Scheffe = .01 $C_{♀} < C_{♂}$; Scheffe = .05 $A_{♀} < A_{♂}$) so that mothers of insecure females report them to have fewer behavior problems than mothers of insecure males.

Initially we expected that the absence of insecurity between mother and child and the presence of positive social interaction in combination with a low amount of mediating stress events would predict fewer behavior problems at six years. While this hypothesized developmental path held true for males it did not describe the development of females. Females who showed the fewest behavior problems had shown insecure relations with their mothers in infancy (i.e. type C attachment); stress events did not prove predictive of later status. No sex differences were found in the variability of the measures used to assess the factors in infancy and later adaption so statistical variation could not account for gender differences in the apparent paths from early

social relations with mother to later problems.

Consequently to some extent these findings demonstrate the principle of multifinality in that ambivalence in males and females did not lead to the same behavior problem outcome at six years. Of course, it can be argued that the group for analysis should be based on sex and attachment type in order to define similarity in antecedents. However, the literature on attachment does not suggest that sex differences should make a difference for predicting the path from early security to later adaptability. Retrospectively, it may be evident that early ambivalence in the mother-daughter vs mother-son dyad may have very different meaning for current and subsequent functioning. We are reminded of Lewin's (1954) dictum of interpreting behavior within the person's psychological field. The same construct of security may have different meaning for male and female children. From this perspective, the example we have given here would not constitute an illustration of multifinality since dissimilar antecedents may lead to dissimilar outcomes.

The findings for males from this study yield support for continuity and prediction in terms of the classical principle of similar conditions yielding similar outcomes while simultaneously providing support for the aleatory view of development. In particular 40% of the insecure males show some continuity in terms of poor early and poor later adjustment. Prediction of 40% of a sample is very moderate from the comparison of 100%, but very impressive from the level usually achieved in empirical work which spans 6 years of time from infancy into childhood. On the other hand for 60% of the insecure sample, prediction fails, and the continuity model does not apply. Thus it appears that aleatory processes can be inferred from our data. The group of insecure males who start out as similar, at least in terms of insecurity of attachment, demonstrate multifinality - some show good adjustment and some show poor

adjustment. Of course, the events in between year 1 and year 6 may be expected to be different and the data do show that stress events play some role in the prediction of outcomes. Yet for a number of insecure males, and for females prediction, at least in the traditional sense of stability in factors across time, is not possible.

Understanding development may require entertaining and utilizing contradictory models - such as the stability or aleatory ones, depending on the phenomena to be explained. Equifinality and multifinality as well as stability may all be useful principles and not mutually exclusive ones.

Models based on morphogenic as compared to stability (morphostatic) type processes not only call for different conceptualizations but different measurement strategies as well (Hertzog & Nesselroade, 1987). Conceptualizations of developmental stability usually propose that trait or behavioral dispositions will remain stabile over time and can be estimated statisticly using first-order autoregressive modeling techniques. Conceptualization of morphogenic processes, on the other hand, will not be adequately represented by autoregressive statistical techniques. In fact, inclusion of autoregressive coefficients in a model not based on the stability "trait" model will obscure the morphogenic processes to be estimated. Estimation of morphogenic type processes and examination of individual differences that take into account that individual variation at one point in time may be a function of labile as well as stabile factors, require a new class of modeling techniques which employ different assumptions other than those used in the stability autoregressive ones (Hertzog & Nesselroade, 1987; Hargens, Reskin & Allison, 1976). These assumptions include elimination of autocorrelation across time and the inclusion of simultaneous concurrent influences within a give time point. Further exploration of such modeling techniques and elaboration of the morphogenic models of development that they

can estimate will offer some hope of explaining a broader range of developmental phenomena in conjunction with reliable measurement.

FOOTNOTES

In order to characterize social behaviors of mothers and children in terms of general categories, factor analyses were performed on child and mother behaviors separately at each of the age points. This factor analysis was performed on the total sample of children participating in the longitudinal study included, in addition to only- and first-borns, second-, third- and fourth-born children (Jaskir & Lewis, 1981). Factors that described child and mother behavior patterns at each age level were derived for the total sample and then used to derive scores for the subsample of first-born and only children. The social factors at 3 months for infants were; alert, self stimulation, feed, object play and for mothers were; toy play, caregiving, social interaction and nonattending. The social factors at 24 months for infants were; solitary toy play, comfort seek, social play, and proximity to mother.

In order to carry out the child -- child and mother -- child longitudinal analyses on only-born and first-born groups, we generated two correlation matrices: one with the correlations across time for all social factors for first-born children and their mothers, and one for only-born children and their mothers. Each matrix was then examined for significant relationship across time for firsts as compared to only groups. The correlation matrices were subjected to a Fisher Z transformation, and differences between correlations for first and only groups were tested when appropriate. Social factor scores, rather than individual behaviors, were used in the analysis, in the belief that the findings would be more conceptually comprehensible as well as psychometrically valid.

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Figure 1

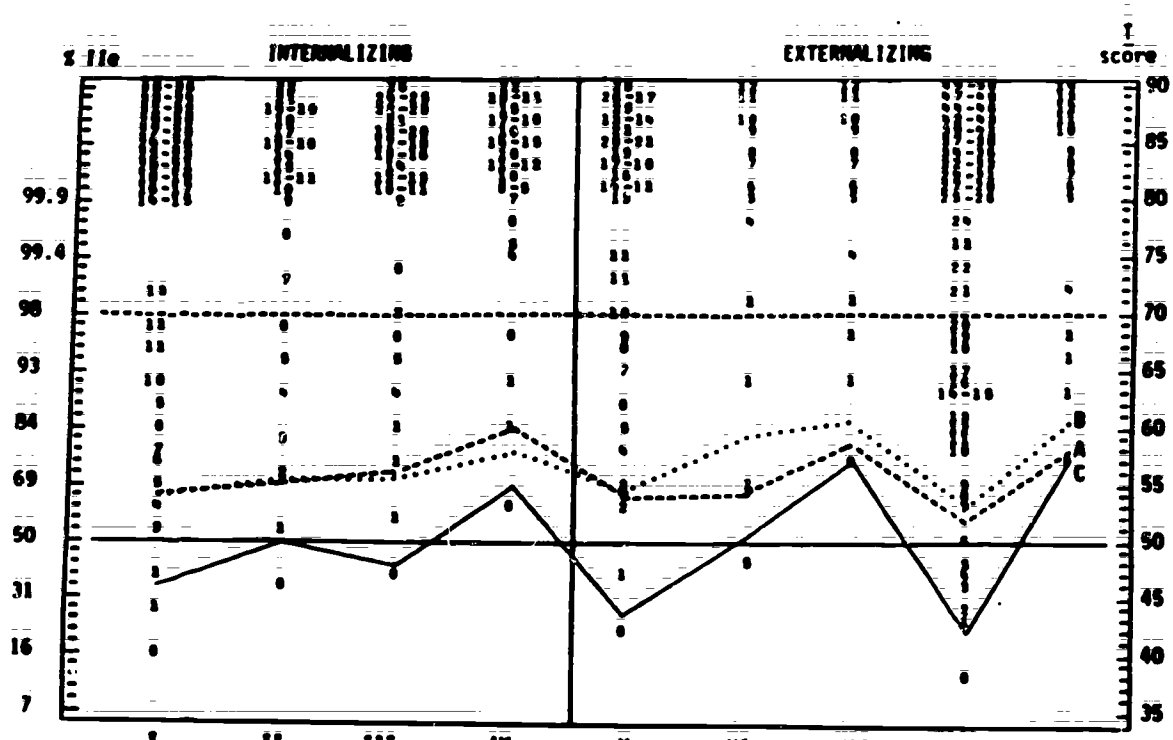

Figure 1a. 6-year mean child behavior profile scores for females by 1-year attachment classification.

Group A----
Group B····
Group C——

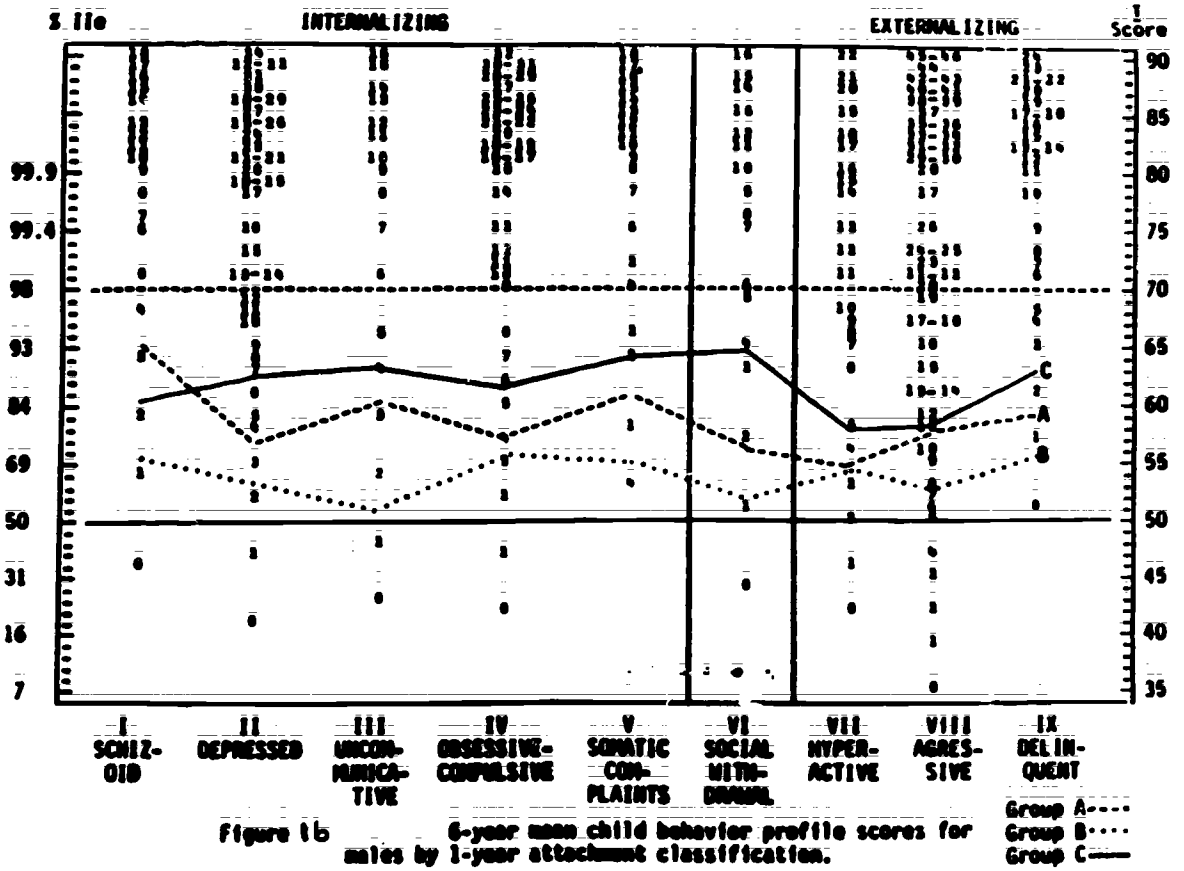

Figure 1b. 6-year mean child behavior profile scores for males by 1-year attachment classification.

Group A----
Group B····
Group C——