

SPEECH DEVELOPMENT AND THE SINGLE SUBJECT RESEARCH DESIGN

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"The starting point for scientific study of human behavior, normal and deviant, is the single case." (Garnezy, 1982, p.5).

INTRODUCTION

In our longitudinal study on the development of speech of cleft palate and normal infants during the first two years of life, we have chosen a single subject design. One of the reasons is our interest in the individual developmental process: we hope to be able to relate early sounds to later use of words.

When reviewing some literature on single case research designs and applied educational or clinical research a polemic between "qualitative" and "quantitative" research methods is obvious (Kazdin and Tuma, (1982); Barlow and Hersen, (1984); Plooij and Van den Dungen, (1985)). Often, it is said, there appears to be a wide gap between research, theory and praxis. The wide gap may be the result of over-emphasis of the scientific value of the group comparison approach of human behaviour, and probably of too many vague terms. Tuma (1982) for example clearly differentiates between case studies and the single subject research designs with a strict methodology. The case study may be seen as the beginning of a research cycle, whereas the single-subject research designs have a function when testing empirical laws.

Especially in the vast field of human behavioural studies emphasis is put more and more on the application of results. When teaching a child with concentration problems, the use of retention curves for numbers is limited. A bad memory for numbers, sleeping problems, and other interacting phenomena may be also part of the problem. This is only one of the complaints from the classrooms. Many between-group studies present teachers with results that are not readily usable in the individual situation since controlled variables in the group can not be controlled in the individual. In every day clinical or educational situations, which are characterized mainly by the planning of behavioural change, many other aspects may interfere with the problem itself.

Many authors in the above cited books turn to history and state that early scientific study of human behaviour was concerned with the individual. The development of speech, language, and thought for example has fascinated many people for many different reasons, as may be deduced from diary studies, anecdotes, and case studies like Itard's reports, and recently Genie, a modern day "wolf child" (Curtiss, 1977). The scientific value of these reports now do not rate very high since only one subject is studied: behaviour and behavioural changes may have occurred by chance and thus results from case studies or diary studies can not be generalized.

In defence of the single case study Garnezy (1982) amongst others stated that important areas of inquiry in human behaviour have been carried out on individuals. Several well-known examples can be given (Garnezy, 1982; Barlow and Hersen, 1984).

- Ebbinghaus' classical retention curve,
- Pavlov's conditioning experiments,
- Piaget's theory on intellectual development,
- Sperry's theory of brain functions and split brain patients.

These studies are important for the state of scientific work today in many areas, e.g. psychopathology, education, medicine, and pharmacology. Yet, why the single-subject method was given less and less scientific value is strange to some authors since the method was successful with regard to generating new insights, theories, and testable hypotheses. It is possibly due to confusing the designs with past abuses of the case study method (Tuma, 1982).

Gradually, scientists started to aggregate single individuals on basis of certain traits, such as etiology, thus creating more or less homogeneous groups. This may be regarded as a short cut in data collection: one experiment with many, more or less identical, subjects versus repeated experimentation with one subject. Both methods have important scientific values and consequences for the application of results.

BETWEEN-GROUP RESEARCH: A QUESTION MARK

Adherents of the single case studies argue that correlational group studies are based on several, incorrect assumptions like independence of variables, and linear relationships (Pearson's correlation coefficient). Denenberg (1982) stressed the complex, interactional nature of the phenomena in major change situations, such as those investigated by developmental research.

"The greatest share of research in this field is based on a model of simple linear causality between early behavior and later behavior. For reasons stated earlier, it is apparent that such a model is grossly inadequate to account for the complexities that underlie developmental processes." (p. 23).

Another assumption which may be false has to do with the transfer of interpersonal correlations to an intrapersonal situation, and transfer of one situation to another. Generalizing from the group to the individual may be hazardous for various reasons. Barlow and Hersen (1984) state for example that results from a truly random sample (representing all relevant population characteristics) will have less relevance for a specific individual, since the better the sample, the more heterogeneous the group, and the better known the variability of the phenomenon in the group. The average response will be less likely to represent a given individual in the group. Or as Denenberg (1982) remarks, "the interperson r (correlation coefficient) not always predicts the individual change in Y when X is varied". So many findings of insignificant correlations (in developmental research) may reflect the interactional nature of variables themselves, since results are based on group averages, not on single individuals.

Bergin and Strupp (1972) recommended intensive study of the individual with appropriate methodological designs to reveal processes of change. This plea for single subject research designs was taken over by other applied researchers, like Denenberg (1982):

"....the study of single individuals, whether animal or human, normal or pathological, can furnish us with important insights, principles, and lawful relationships concerning fundamental behavioral processes and brain-behavior dynamics. Large-scale statistical research using correlational or analysis-of-variance procedures can be viewed as necessary and important preliminary studies that allow us to isolate variables and parameters that we investigate through intensive study of single individuals. The single individual has of necessity to be our research unit if we are concerned with understanding the dynamic of behavioral mechanisms and brain-behavior relationships. The processes governing these relationships occur within a single individual, and statistical averaging over a group is more likely to obfuscate than to elucidate the inherent nature of such processes. In the final analysis, if we wish to understand the individual, we can do so only by studying individuals as individuals, not by studying them as statistical actuarial averages. Interestingly, the statements that I have just made are all supported by animal studies....(p. 20).

He supports his views by stating that genetic variance in for example rats is minimized or eliminated in order to maximize within-group homogeneity, which is often neglected in studies on groups of humans. So, he argues, animal studies are more comparable to repeated measurements in human single cases or twin-studies. Group studies may reveal important variables that are to be studied intensively in the single case. The contrast between the two approaches in research of human behaviour seems big, but several scientists have tried to bridge the gap. In 1962 Allport had stated already the mutual value of individual and group approaches:

"Why should we not start with individual behavior as a source of hunches (as we have in the past) and then seek our generalizations (also as we have in the past) but finally come back to the individual not for the mechanical application of laws (as we do now) but for a fuller and more accurate assessment than we are now able to give? I suspect that the reason our present assessments are now so often feeble and sometimes even ridiculous, is because we do not take this final step. We stop with our wobbly law of generality and seldom confront them with the concrete person." (p. 407).

So, the scientific cycle should start with the single subject. The scientist should be looking for "hidden" sources of variability, revealing variables that may covary. Barlow and Hersen (1984), in search for variables, state it this way:

"The experienced applied researcher must first choose the most likely variables for investigation from amongst the many impinging on the client at any one time." (p. 4).

In that way hypothesized sources of variability in individual behaviour may be detected. The same procedure may be used to detect variability over different situations. In carefully chosen designs large-group comparison

on the detected variables may indicate the variance of the phenomena. Then the procedure should be checked in single subject designs.

IN DEFENCE OF SINGLE CASE RESEARCH DESIGNS

The common argument against single-subject research is that results cannot be generalized: how relevant are the results to other cases, other situations, and other therapists? These arguments have to do with generality and variability of human behaviour, which may change over time. Of course the authors in the consulted books defend the single subject research designs. Kazdin (1982) examined the contributions of single-case designs, and the interface of single-case and between-group research. Methodological characteristics for the single-case designs are given to differentiate them for the more unstructured case studies and in some ways these characteristics are comparable to the sampling decisions in analogue-digital translations of speech sounds.

First, Kazdin (1982) states, single-case designs require continuous assessment of performance. In each phase (of treatment or development) repeated or continuous measures describe the current pattern of performance. Changes in the pattern of performance over time serve as a basis for drawing inferences about intervention (or developmental) effects.

Second, the effects are to be replicated within the same individual; any measure that permits repeated use and that reflects change over time can be employed. (In case studies the description system changes as the behaviour changes.)

In the single subject study it may be assumed that the subject has ten or more possible reactions to external or internal stimuli. Frequent measuring of the reactions may result in a profile, reflecting for example an individual process of change or development. This process is the result of sample comparison over time and the samples are drawn from the subject's population of reactions. If this process or development is duplicated in one or two additional populations or individuals, beyond the original ones, it may be concluded that the processes are not merely chance (Denenberg, 1982). The process is not falsified.

The designs emerged primarily from research on operant conditioning. The methodology has become more sophisticated and statistical methods have been developed. Continuous assessment for example in each phase of treatment of unwanted behaviour, revealing changes in selected aspects of the behaviour (like establishing eye contact while stuttering) and control of desired behaviour for a prolonged period (the wanted behaviour does not change while treating another aspect of the unwanted behaviour) accentuates the power of the designs.

Methodologically, an important characteristic of single case research is the repeated assessment of well-described, defined behaviour. A measure that may be used repeatedly, which does not interfere with the behaviour itself. The designs are not restricted to overt behaviour (to be observed) or to single subjects. The designs may reveal processes in groups of subjects as well. These processes are supposed to result from events,

naturally occurring or from interventions; the variables in those settings affect behaviour differently from each variable in isolation. Applied researchers in the 1950s and 1960s felt in an either-or position with regard to single case versus between-group comparison research, probably because of the near-absence of sophisticated statistics. Now, the applied researcher can decide under what condition one type of design is more appropriate than another. If one is interested in the variability of behaviour in relation to one, two, or more variables (sex, age, etc.) the group design is the most efficient way of gathering the data. If one is curious about the structure of developmental processes this structure is revealed with more ease in the single subject studies. Denenberg (1982) illustrated a descriptive statistical method in a study on consistency of state regulation in infants (Thoman, et. al, 1981). The amount of time spent in the different states during prolonged observation, repeated in four sessions of observation resulted in individual scores (uninfluenced by behaviour of other infants). As hypothesized the inconsistent infants (4) all showed severe medical and/or behavioural problems.

LONGITUDINAL RESEARCH ON SPEECH COMMUNICATION

As said above the development of speech, language, and thought has fascinated many adults. In case studies, and diary studies they reported their observations. But, as reviewed in Bullowa (1979)

"...scientifically oriented people in our culture considered infants incapable of communication since they don't talk." (p. 1).

Yet, many parents know that infants do communicate long before they utter their first word. The parents can interpret the infants behaviour by using many aspects like situation, earlier experiences, mimicry, etc. Until recently the communicative skills of infants were studied while ignoring the context. Speech development was thought to be an audible process, so the scientific approach concentrated mainly on the sounds, neglecting psycho-social aspects, and underlying sensori-motor principles in the development.

At present we are studying mother-infant vocal interactions, in the context of medical, social, educational, cognitive, and linguistic data in normal and cleft palate infants during the first two years of their lives. We have chosen for the single case design, since so many variables interact in longitudinal studies.

We videotape parent-infant face-to-face vocal interactions (biweekly or monthly) during the first two years of the babies. Also, feeding situations during the first year are videotaped. The parents are asked to fill in a checklist of psycho-motor development. During the two years of the infant's development we ask the parents questions about occurring illnesses, educational attitudes of the parents, the infant's temperament, and daily caretaking situations. The infant's hearing is checked in the 8th and 14th month and the neurological development in the 12th and 24th month. At those ages tests are administered on cognitive, speech, and language development (Bayley, Reynell). Results from the videotape analyses are interpreted against the background of the other data.

We have been studying infant sound development since about 1974 (Koopmans-van Beinum and Van der Stelt, 1979). We started with two case studies, recording two male infants for a prolonged period, describing the sounds they produced. We did not rely on some international phonetic alphabeth, but based our transcription of the sounds on the anatomical and physiological capacities of the speech mechanism. Thus, we could indicate three speech motor milestones which reflected a stepwise mastering of speech motor coordination.

In a follow-up study, concerning the third milestone (babbling), we found a mean age of 31 weeks and a range of 30 weeks (18-48 weeks) for the onset of babbling in a group of 51 infants which was followed with regard to their gross motor development for about 9 months. Apart from the onset of babbling we investigated the mother's reactions towards her infant's production of milestones and found that some mothers react, whereas others don't (Van der Stelt, 1983). Since the milestones are of an articulatory nature we hypothesize different "didactic programs": the mothers who react upon the production of milestones are possibly more concerned with articulation, whereas the other mothers possibly react upon intonational, suprasegmental patterns of their infant's sounds. We thus found possible variables important for the structure of the early development of speech sounds. Furthermore, we hypothesize a relation between the mother's program and the infant's first words, as Nelson (1973) proposed. In the acquisition of vocabulary (the first 50 words) she found children with a preference for referential words and others with an expressive preference. The expressive children have a clear intonation but poor segmental articulation (Nelson, 1979). We assume that mothers who do not react upon the milestones, but upon the intonational aspects, will have expressive children, in view of the children's early experience of conversational interaction. Likewise, mothers who react upon the milestones will orient their children towards articulation. With regard to the speech motor development in the first year of life we have indicated six stages (Koopmans-van Beinum and Van der Stelt, in press), delimited by the speech motor milestones. Our hypothesis is that in each speech motor stage of the infant the mothers tend to respond to the sounds systematically. The reactions of the mother to the sounds of her infant may differ in each stage, thus reflecting the infant's level of sound production. In a way the mother and infant are developing their "didactic" program. In our case study (Koopmans-van Beinum and Van der Stelt, 1979) for example, we found that one mother imitated her son's [arə] immediately, first slightly expanding the sound to a correct Dutch word [rarə], then embedding the word in a correct phrase. She did this on several occasions, thus shaping the infant's sounds in the direction of his mother's tongue. Although the didactic programs of different mother-infant pairs may seem variable in the different stages of speech development we hope to find the underlying principles of the programs, relating early sound production and later speech. The programs may be related to pragmatic characteristics in the child's speech after the age of two of the child as well.

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