

The microgenetic method

Time for change?



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argue for a powerful psychological technique.

MEASURING change is one of the most fundamental aspects of psychology. Yet most research provides a snapshot of the events surrounding change, without describing the process itself. Take the coverage of development in most introductory textbooks, where a diagram shows a staircase with each upward step representing a more sophisticated level of Piaget's four stages. This suggests that each transition is abrupt, simple and absolute, with all shifts from one stage to another occurring together. Yet people who have been able to observe the development of an individual child know that change is much more complex and variable than suggested by the staircase metaphor. Indeed, Piaget acknowledged the complexity of change with the concept of 'horizontal decalage' – the inconsistency in a child's performance in which a certain cognitive ability is shown in some, but not all, circumstances. Furthermore, recent research has shown that abilities that have been thought to show sudden, abrupt change, actually show gradual and variable change over time (Flynn, *in press*; Wellman *et al.*, 2001).

In this article we argue that psychological methods of inquiry that give us more than just a snapshot of the events over time are long overdue. A clear view of change as it is actually happening is provided by the microgenetic method. We describe this approach, provide some examples of its use and reflect upon how

its techniques are being used to address key psychological questions.

What is the microgenetic method?

The microgenetic approach examines change as it occurs, thus attempting to identify and explain its underlying mechanisms. It involves taking repeated measurements from the same participants over the course of transition in the domain of interest. This contrasts with the usual, cross-sectional methodological approach, which provides snapshots of different competences displayed in two or more age groups. The cross-sectional approach is useful when these snapshots are taken for a number of people, so that the individual differences between these competences are examined, or when the snapshots for people in different experimental or clinical groups are compared. Yet these cross-sectional approaches do not tell us about how change occurs, or what mechanisms underpin change.

Likewise, longitudinal studies take multiple measurements over time, but such studies usually have lengthy intervals between testing sessions. Their results again indicate that a change has occurred, but shed little light on exactly how this happens. It may be of interest to know, for example, whether the change in behaviour was sudden or gradual, or to identify whether it was preceded by a particular behaviour, or accompanied by the person doing something in particular. Furthermore, conventional cross-sectional and longitudinal studies focus on group data and treat individual variation as statistical noise. Yet, this variation holds important information about when, and how, change is occurring.

The only way to specify the operations of the mechanisms of change is to closely examine the nature of a transition. This is

just what the microgenetic method involves. It provides this information by following three critical principles:

- Observations must span a known period of change.
- Density of observations must be high in comparison with the rate of the change.
- Observations are analysed intensively to establish the process that gave rise to them.

This method provides detailed information about an individual over a period of transition. Furthermore, it ensures that sudden jumps, regressions and periods of equilibrium are not overlooked. These elements of change provide an indication of how a person's knowledge or ability progresses from one level to another, often more sophisticated, level. Examining individual participants' behaviour over time highlights both between-participant variability, potentially showing different types of transition, and within-participant variability, which is often the indication that change is taking place. It provides an opportunity to examine the differences, and the underlying sources of differences, between individuals over time. For example, the microgenetic method provides an opportunity to identify different groups, which may require different treatment or intervention styles. This can yield answers to questions that cannot be answered by other approaches. Most excitingly for developmental psychologists is the fact that microgenetic studies, 'reveal not just what children know but how they get there' (Granott & Parziale, 2002, p.12). The same may apply to adults acquiring new skills.

The microgenetic approach is adaptable and so allows change to be examined in a number of different domains. To date these have included theory of mind and inhibitory control (Flynn *et al.*, 2004), memory (Schlagmüller & Schneider,

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2002), locomotion (Adolph, 1997), attentional strategies (Miller & Aloise-Young, 1996), understanding of science (Pine *et al.*, 2004), change in clinical groups (Bray *et al.*, 1997; Fletcher *et al.*, 1998), arithmetic (Siegler, 1995) and assessing analogical reasoning (Siegler & Svetina, 2002).

How does the microgenetic approach provide an illustration of an individual's progression through the whole period of change, highlighting and emphasising elements that cannot be captured by traditional methods? According to Robert Siegler (2006) the following five dimensions can all be examined to accomplish this:

- The *path* of change: Is the change qualitative or quantitative?
- The *rate* of change: Is the change sudden or slow?
- The *breadth* of change: Is the change domain-specific or generalisable across domains?
- The *variability* of change: How variable is a person's behaviour across similar tasks within a domain? Can similar patterns of change be seen across individuals?
- The *source* of change: What do the changes in behaviour, such as strategy use, suggest about the source of change?

Is this a new and easy way to study change?

The term 'microgenesis' was used some 50 years ago by Werner (1956) to describe a method of repeating presentations to the same participants to measure discrimination in auditory perception. The method also has its roots in Vygotsky's developmental approach:

...to encompass in research the process of a given thing's development in all its phases and changes...fundamentally means to discover its nature, its essence, for 'it is only in movement that a body shows what it is'. (Vygotsky, 1978, p.65)

Today, the microgenetic method has been used across Europe and the US (see Siegler, 2006, for an up-to-date review). It is fair to suggest that the approach has come in and out of fashion over the past half century. Yet, the number of microgenetic studies has increased rapidly over the last 20 years, and this trend looks set to continue.

It is easy to explain psychology's reluctance to adopt this approach as its main methodological technique. Microgenetic studies are not without their methodological difficulties. Repeated

testing of participants, especially children, can produce boredom and reduce motivation, and this may lead to loss of participants. At the same time, repeated presentation of stimuli can produce practice effects, which mean that a control group (or groups) must be included in studies to establish how much of the change is due to the experimental procedure and how much is due to development.

Microgenetic studies are also expensive in terms of time and labour. Finally, assessing participants on multiple tests over a number of sessions produces a great deal of data, especially when the analysis is undertaken at a trial-by-trial level. The very intensity of the approach, although rich and informative, can make it difficult to reduce the data to a simple set of results and conclusions. It is perhaps not surprising that most researchers opt for the quick fix of the cross-sectional study. However, researchers have designed studies so as to increase motivation and take into account practice effects, and the popularity of the microgenetic method has continued to increase.

Added value

Importantly, sometimes the results of microgenetic research contrast with the findings from cross-sectional research. Two examples of such discrepancies are presented here to illustrate the technique.

Example 1: Examining the success of interventions

Pine *et al.* (2004) conducted microgenetic analyses of children's behaviour, involving intensive observations of gesture, to discover if any behaviours predicted later improvements in scientific understanding. An initial study examined the effect of explaining another's actions on children's understanding of the concept of balance (Pine & Messer, 2000). The study employed a traditional pre-test/intervention/post-test paradigm. In the intervention phase children either observed the experimenter solving balance problems that the child could not solve (Observe Only); or they observed and tried to explain the experimenter solving the problems (Observe and Explain). This study showed that children in Observe and Explain were more likely to improve at post-test than children in Observe Only. So, by examining pre- to post-test change it was shown that explaining another person's actions can bring about cognitive change (see also Siegler 1995).



The microgenetic method provides detailed information about an individual over a period of transition

However, within any study it is rare for every participant to show improvement, and statistical analysis simply confirmed that more participants in one group than the other improved. Nonetheless, 30 per cent of the Observe and Explain group still failed to improve, and 50 per cent of the Observe Only group did. So the researchers went on to conduct some microgenetic analyses of the children at pre-test to see if anything else, apart from the experimental conditions, might have predicted improvement (Pine *et al.*, 2004).

By looking very closely at the explanations about balance that children gave as they talked during the pre-test trials, it was found that the children's speech and hand gestures could be reliably coded into a set of discrete and reliable categories. After carefully scrutinising the children's speech and gestures on all the pre-test trials individuals were identified who showed gesture-speech mismatches at pre-test: these children (about one third of the sample) talked about one element of the task whilst simultaneously producing a

hand gesture that referred to a different element.

The data were then reanalysed including this new microgenetic element, and the match between gesture and speech was found to explain a lot more about the children who did improve (even when in the Observe Only condition) as well as those who did not (even if they experienced the more 'effective' Observe and Explain condition). Children who were in the Observe Only condition but still improved were more likely to have shown gesture-speech mismatches at pre-test, although they did not start off any better or worse at the task. Of those in the Observe and Explain condition who failed to improve, at pre-test three times as many did not produce mismatches compared with those who improved.

This study demonstrates how microgenetic analysis, in this case close examination of gestures produced during a set of trials, can tell us more about when and why interventions sometimes produce change but in some cases do not. Failing to take account of the children's gestures in this study would have meant that an important source of information was overlooked.

Example 2: The development of organisational skills Microgenetic studies sometimes question the conclusions of cross-sectional studies. Schlagmüller and Schneider (2002) investigated the rate of change of organisational skills in children aged 8 to 12 years. They presented a set of tests every week for nine testing sessions over an 11-week period. In each session children were presented with a set of 20 picture cards, each of which contained a picture of an item from a set of categories, e.g. animals, vehicles, fruits. During every session children were told to study the cards and to do whatever they wanted with them to help remember them later. They were given three minutes to memorise the cards. After this the cards were removed, and the children played several word and number games for three minutes. Children were then asked to remember as many of the picture cards as they could. The children's recall was recorded, along with their sorting during learning and their clustering during recall.

Before this study the assumption about the development of organisational strategies was that they gradually increased with age. Yet Schlagmüller and Schneider's

Microgenetic studies may help explain jumps in development

data showed that this was not the case. Children progressed rapidly from non-strategic to strategic performance during the 11-week testing period. They "jumped" from random behavior to nearly perfect sorting scores' (Schlagmüller & Schneider, 2002, p.313). It is only by taking repeated measures from the same people over the period of change – by using by the microgenetic method – that the actual rate of development could be established.

Use in the psychological professions

Not only is the microgenetic method informative about how change occurs, it is also an adaptable approach. It can be used to examine spontaneous or facilitated change in one individual or, indeed, in multiple participants. Measurements can be taken over a single testing session or multiple sessions. Therefore the analysis can examine change session-by-session, or even trial-by-trial. Furthermore, change can be examined within individuals, or with

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pairs of individuals working together with relative amounts of expertise.

Most microgenetic research has examined cognitive development, like the acquisition of mathematical or scientific concepts. However, the technique can be used to good effect within a variety of applied settings. One important aspect of looking at cognitive development using the microgenetic method is the potential for introducing these findings into the classroom. For example, we know the stages and processes through which children make the transition from no understanding to full understanding in domains such as balance (Pine *et al.*, 2004), matrix completion (Siegler & Svetina, 2002), number conservation (Siegler, 1995) and organisational strategies (Schlagmüller & Schneider, 2002). The crucial next step for such findings is for this knowledge to be implemented in a variety of applied settings, taking account of the elements that intervene in the learning process. Evidence from microgenetic studies can help predict when teaching and interventions will be beneficial, and this promises to be a useful tool for implementation into classroom practice.

As well as providing interesting opportunities within an educational setting the microgenetic method has much more to offer the applied community. The application of the approach to clinical settings has been relatively limited (Bray *et al.*, 1997; Fletcher *et al.*, 1998). Such a shortfall in clinical-based microgenetic research seems noteworthy, as change is frequently the main goal of mental health interventions. The method can offer an approach to examine positive change (i.e. rates of improvements through different treatments or interventions) and detrimental effects (i.e. rates and pathways of symptoms that define disorders). Furthermore, it may help to explain why critical life events sometimes have a lasting impact (such as depression or post-traumatic stress disorder) and at other times have no apparent impact. Questions such as these might be answerable when more is known about micro- as well as macro-development (Lewis, 2003).

The microgenetic method also provides an important diagnostic tool for clinicians. In developmental psychological research the approach often reveals competencies at an earlier age than presented in cross-sectional studies. In its intensity of repeated

observations, participants have more opportunities to demonstrate different types of behaviour. So, by taking more measurements researchers can observe behaviours that may be less frequent, but still within a person's repertoire. This approach has the advantage, therefore, of revealing the full range of behaviours that an individual can produce under experimental conditions. For example, repeated observations of people in the early stages of dementia will give an indication of the rate, process and extent of their dementia. It may be the case that their forgetfulness is more apparent with certain types of information, or within certain contexts. Such knowledge can aide in the management of such disorders.

Towards a fuller understanding

Microgenetic methods have much to offer to the understanding of the cornerstone of psychological research – change. This is brought into sharp relief in developmental psychology, as childhood is a period when the pace of change is often dramatic.

If we aim to accurately characterise the very process of change itself, not just its outcomes, developmental and other research needs to go beyond traditional methods of examining cross-sectional or even longitudinal data. Such approaches can only tell us when change occurs and identify a subset of the factors that bring it about. In order to fully understand the mechanisms of change, its trajectory (which is not always smooth), rate and breadth, a greater diversity of microgenetic studies is required. By examining change as it occurs this method can yield more precise descriptions than would otherwise be possible.

This type of rich and detailed data is necessary for constructing formal models of cognitive development. Furthermore, a significant contribution to pedagogic and clinical knowledge can be made since this method furthers our understanding of how instructional and therapeutic procedures exercise their beneficial effects.

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DISCUSS AND DEBATE

Is the microgenetic method suitable for all domains?

Is variability symptomatic of all psychological change?

Have your say on these or other issues this article raises. E-mail 'Letters' on psychologist@bps.org.uk or contribute to our forum via www.thepsychologist.org.uk.

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