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Not just Piaget; not just Vygotsky, and certainly not Vygotsky as *alternative* to Piaget

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Abstract

There have been many interpretations published on the relative importance of the work of both Vygotsky and Piaget: often to the detriment of the latter. This article represents an attempt to discover the meaning and intention of the former by going back to the specifics of what he said and wrote. By reference to what they said of each other it is argued that by the early 30s they had reached almost identical positions regarding child development, and that the work of each is complementary to that of the other. The implications of this position for a theory of intervention for cognitive acceleration are then discussed.

1. Introduction

> As we know from investigations of the process of concept formation, a concept is more than the sum of certain associative bonds formed by memory, more than a mere mental habit; it is a complex and genuine act of thought that cannot be taught by drilling, but can be accomplished only when the child's mental development has itself reached the requisite level. (1)

> Throughout the history of the child's development runs a 'warfare' between spontaneous and non-spontaneous, systematically learned, concepts. (cf. the *Alternative Conceptions* movement). (2)

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> …the development of nonspontaneous concepts must possess all the traits peculiar to the child's thought at each developmental level because these concepts are not simply acquired by rote but evolve with the aid of strenuous mental activity on the part of the child himself. We believe that that the two processes—the development of spontaneous and of nonspontaneous concepts—are related and constantly influence each other. (3)

> …recently psychologists have shown that a person can imitate only that which is within her developmental level. (4)

> Each school subject has its own specific relation to the course of child development, a relation that varies as the child goes from one stage to another. (5)

Quotations from Piaget or from Western applied research from the 60s and 70s?—No, all from Vygotsky, round about 1930[1]. Having laid down his framework of thinking at the pure and applied level of research Vygotsky then goes on to make recommendations for education at the *applicable* level (Belbin, 1979).

> Formerly, it was believed that, by using tests, we determine the mental development level with which education should reckon and whose limits it should not exceed … It turned out that a teaching system based solely on concreteness—one that eliminated from teaching everything associated with abstract thinking—not only failed to help retarded children overcome their innate handicaps but also reinforced their handicaps by accustoming children exclusively to concrete thinking and thus suppressing the rudiments of any abstract thought that such children have. (MiS, p. 89) (6)

In thinking about the relation between 'spontaneous thinking', i.e. the kind of thinking studied primarily by Piaget in the Genevan methodology, and 'nonspontaneous thinking', i.e. the explicit teaching of concepts and procedures characteristic of normal school instruction, Vygotsky suggests there is a subtle relation between the two:

> Since instruction given in one area can transform and reorganise other areas of child's thought, it may not only follow maturing or keep in step with it but also precede it and further its progress. (T&L, p. 177) (7)

In saying that:

> …the development of scientific concepts runs ahead of the development of spontaneous concepts (T&L, p. 147) (8)

[1] The first three quotations are from Vygotsky (1986), *Thought and Language* (T&L) pp. 149, 155, 157. The next two are from Vygotsky (1978), *Mind in Society* (MiS) pp. 88 and 91.

he is in no way saying that teachers may remain ignorant of children's level of mental development. Only three pages later he warns:

> Practical experience also shows that direct teaching of concepts is impossible and fruitless. A teacher who tries this usually accomplishes nothing but empty verbalism, a parrotlike repetition of words by the child, simulating a knowledge of the corresponding concepts but actually covering up a vacuum. (T&L, p. 150) (9)

His formulation of the learning paradox (Bereiter, 1985, pp. 201–226) begins:

> …to introduce a new concept means just to start the process of its appropriation. Deliberate introduction of new concepts does not precede spontaneous development, but rather charts the new paths for it. (T&L, p. 152) (see quote 3 above) (10)

but

> …scientific concepts, like spontaneous concepts, just start their development, rather than finish it, at a moment when a child learns the term or word meaning denoting the new concept. (T&L, p. 159) (11)

Thus far one may doubt whether Vygotsky is describing schooling as he has seen it, or as he thinks it should or could be. It quickly becomes clear that more, much more is needed, if learning, in relation to mental development, is to be optimal. Given the dual and reciprocal relation between cognitive development and conceptual learning within school subjects—that is, as the former develops it makes higher levels of learning possible, but as children are challenged by new school learning demands they may be stimulated to re-process the learning in their own spontaneous manner of processing and hence receive a stimulus to further cognitive development—it follows that revolutionary teaching methods are needed. A first step is suggested: since

> Scientific and spontaneous concepts reveal different attitudes toward the object of study and different ways of its representation in the consciousness. (T&L, p. 161) (12)

it follows that:

> The most promising approach to the problem [*of reconciling laboratory studies of cognition with school achievement measures, necessarily superficial*] would seem to be the study of scientific concepts, which are real concepts, yet are formed under our eyes almost in the fashion of artificial concepts… To uncover the complex relation between instruction and the development of scientific concepts is an important practical task (T&L, pp. 161–162) (13)

In parentheses, I would claim that this is exactly what we undertook, and for the

same reasons, for secondary school mathematics and science in the five-year Concepts in Secondary Mathematics & Science (CSMS) research Programme at Chelsea College, London in the 70s (Shayer & Adey, 1981; Hart, 1981). I say this because Vygotsky was never able to undertake this programme of research before his early death in 1934. But he did work on the other major problem: Just how may schooling be optimised so as to overcome the learning paradox? His answer was:

> '…the only 'good learning' is that which is ahead of development. (MiS, p. 89) (14)

> …the only good kind of instruction is that which marches ahead of development and leads it; it must be aimed not so much at the ripe as the ripening functions. (T&L, p. 188) (15)

This presupposes reconciling all the statements cited above. On the one hand, mere 'cognitive level matching' leaves the children's mental development stagnant (quote 6); on the other, empty verbalism may result if the concept is too far ahead of the children. Moreover a whole programme of applied research is needed first to enable teachers, in each school subject, to know just how far 'ahead of development' the learning they choose for their students should be. I think I would add, too, that we need to know a great deal more about differential cognitive development in the child population than either Vygotsky or Piaget were aware of in the early 30s. Perhaps the most important implication of the CSMS survey of 14,000 children between the ages of 10 and 16 on Piagetian tests (Shayer, Küchemann, & Wylam, 1976; Shayer & Wylam, 1978) is that the range of mental development in any one year group is far, far wider than anyone dreamed, as those teaching in Comprehensive schools have learnt empirically the hard way. In Fig. 1 this is shown both in terms of the CSMS survey and also in a recent whole population assessment of 14-year-olds (KS3 Maths). Any Y7 class is likely to contain pupils ranging from early concrete to mature formal in Piagetian terms.

Bearing in mind his creative contribution to special education in the USSR, I am sure that this would have been taken very seriously by Vygotsky, had his research revealed it.

But most important of all, without a theory of how 'spontaneous development' is related to the progressive inculcation of the child into the culture as embodied in school learning, there is no way in which Vygotsky's 'new formula' for teaching (his words) could be implemented: hence the notion of the 'Zone of Proximal Development' (ZPD).

2. The zone of proximal development

It is a strange fact that both Piaget and Vygotsky were introduced to research in psychology by being asked, in their respective countries, to undertake the replication of the new Binet test of intelligence in the 20s. It is also strange that a concept tied

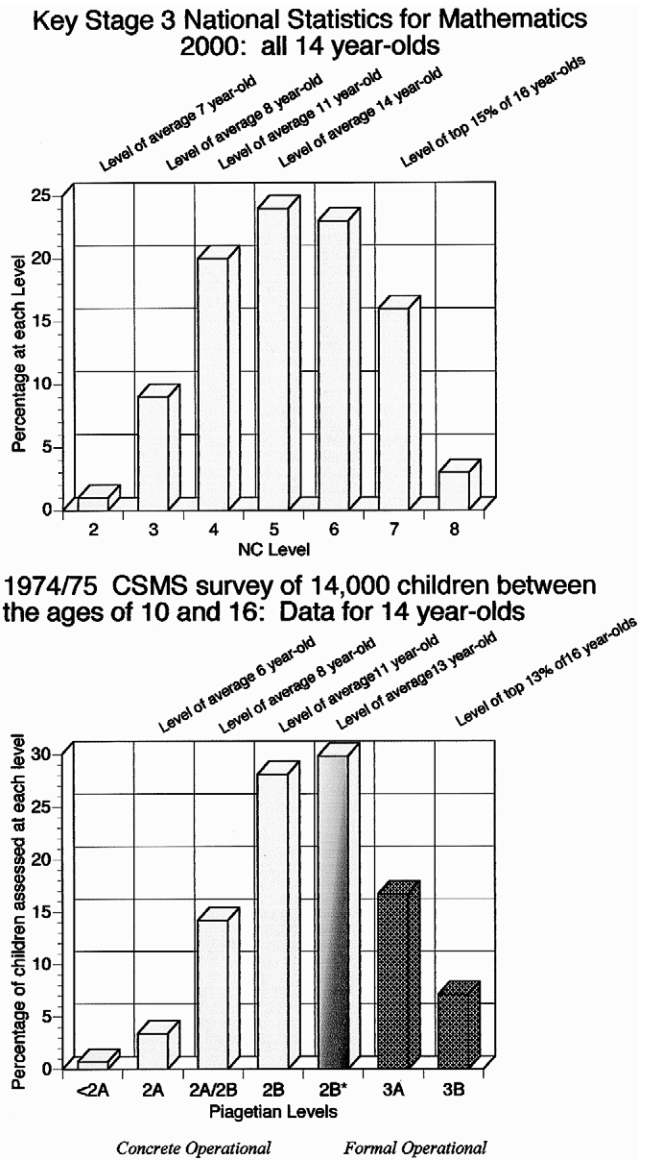

Fig. 1. '12-year gap' shown in two independent sources of evidence.

specifically to the testing of *individual* children should be treated, later, by some authors (e.g. Lerman, 1996) as a theory of the *social* origin of children's development. The essence of the method is this. The child is first given a standard intelligence test, such as the Binet, and his mental age estimated from his score. The psychologist then takes the child through some of the easier items on which he had failed, giving various hints and/or discussing the problems with the child. With this

assistance the child can then solve more of the items, and hence a new mental age can be calculated relating to the limit of the child's success with the mediation of the psychologist. The difference between the two scores represents the 'zone of proximal development' of the child: in Vygotsky's words:

> The zone of proximal development of the child is the distance between his actual development, determined with the help of independently solved tasks, and the level of potential development of the child, determined with the help of tasks solved by the child under the guidance of adults and in cooperation with his more intelligent partners[2]. (16)

Note that 'his more intelligent partners' is just speculative on Vygotsky's part: the research which was actually done was with the psychologist and the child only. Hence one aspect of the solution to the problem of teaching 'ahead of development' is the recommendation: Teach to the limit of the ZPD of the students, but not further. Note that this presupposes the availability of the applied research of the cognitive demand level of the specifics of the school curriculum, which had not been done either at the time when Vygotsky was working, nor, indeed until the 70s, and is far from being universally accepted as feasible even now (Shayer & Adey, 1981; Hart, 1981; Collis, 1975).

It is interesting that in the original paper/lecture in which the ZPD was presented Vygotsky gave an interpretation of it that has shown to be, at least partially, wrong:

> Taking an example of a child, tested at the age of 4 giving an independent mental age of 4.5 years, but having a ZPD extending to 7 years after mediation, Vygotsky predicted that over the next three years the child would reach an unassisted mental age of 7, as predicted from the earlier ZPD, *but that the ZPD of 7 would have remained static at 7* (van der Veer & Valsiner, 1991, pp. 343, 344).

When this process of dynamic testing was initiated to children in a special school at the age of 12, it was found, two years later, that the ZPD of control children had indeed moved up but little (Beasley & Shayer, 1990). But those who had received the Feuerstein Instrumental Enrichment (IE) intervention (in other words, taught just as Vygotsky recommended) had reached the level predicted from their ZPD two years earlier, but now they had a new ZPD reaching about 2 mental age years even further ahead of their new unassisted score.

The educational application Vygotsky cited was this: with children tested by his clinical interview at ages 10, their unassisted score on the Binet predicted less well their school achievement two years later than their ZPD score, that is the *difference* between their unassisted score and their post-mediation score. Hence the theory that the ZPD is a better predictor of *potential* achievement than the child's IQ score

[2] Note: this is not taken from the more usually quoted *Mind in society*, but from a (partial) translation of the original by van der Veer in van der Veer and Valsiner (1991), p. 337—see Vygotsky, 1933/1935.

itself. It follows from this that the experimentally grounded source of the theory of the ZPD is in terms of the behaviour of the individual child, and so this sense of the concept is indicative only of partially formed skills or schemes possessed by that child itself (*not* in his/her social milieu, but mostly derived therefrom), as revealed in the dynamic assessment interview. In the mediation process the children—admittedly in social interaction with the psychologist—construct from their partially achieved skills or concepts the completed skill or scheme required to solve the test items. The *less* the mediation required for success, the nearer to 100% competence the child is. In our replication of this testing process it was possible to differentiate 10 different levels of mediation (ranging from 'Just look again' at one end to giving the solution and the reason for the solution at the other end), and also to describe the qualitative cognitive functions in which the child was strong or weak (Beasley & Shayer, 1990; Beasley, 1984). We also verified the better predictivity of the ZPD, but with the proviso: *only* with those children who had received the IE intervention, that is, only on those children who had received the kind of instruction designed to realise the children's potential, aimed ahead of where they presently are (Shayer & Beasley, 1987).

So what is the connection between this testing process, conducted on individual children, and a theory of optimal teaching in school, and with classes, and also with a more general theory of child development? Unfortunately chapter 6 in *Mind and Society* is somewhat unhelpful for answering this question because it appears to consist of extracts from at least two different papers, given on different occasions and with different contexts, with no indication of where one begins or another ends. Nor is the reference given (we have only a mention, in the preface, of a 1935 book with an English title, which I was unable to locate in English). The only further hint of a connection (MiS p. 90) is the recommendation:

> We propose that an essential feature of learning is that it creates a zone of proximal development, that is, learning awakens a variety of internal developmental processes that are able to operate only when the child is interacting with people in his environment and in cooperation with his peers. Once these processes are internalised, they become part of the child's independent developmental achievement. (17)

Here the ZPD is taken out of the context of individual testing, and displaced to the context of school learning as a social process. We may then perhaps make the further connection to the thought in a paper with a quite different context, *The genesis of higher mental functions* (in Wertsch, 1979, p. 163) in which Vygotsky states:

> We could formulate the general genetic law of cultural development as follows: Any function in the child's cultural development appears twice, or on two planes. First it appears on the social plane, and then on the psychological plane. First it appears between people as an interpsychological category, and then within the child as an intrapsychological category. This is equally true with regard to voluntary attention, logical memory, the formation of concepts, and the development of volition. (18)

In this paper (I guess written several years earlier) the distinction Vygotsky made, in T&L, between spontaneous and nonspontaneous was not there in his thinking, and 'development' is being taken rather globally. But the following statement seems to link the previous two quotations:

> …the connection between the child's natural behavioural development based on organic maturation and the types of development we have dealt with … has a revolutionary rather than an evolutionary character. Development does not take place by gradual alteration or change, by the accumulation of small increments, the sum of which finally provides some kind of essential change: from the very beginning we observe a revolutionary type of development. In other words, we see sharp and fundamental changes in the very type of development, in the motivating factors of this process. (Wertsch, 1979, p. 171) (19)

The kind of 'jumps' in performance one sees when mediating children in the dynamic assessment of their ZPD are revolutionary (although the child may be already three-quarters of the way there, even if one could not see it) like, possibly, similar jumps made by individuals when collaborating with their peers when they internalise some successful performance to which they may have contributed but have, nevertheless, witnessed in a peer and immediately internalised (completed their individual ZPD). Between collaborating peers it would be meaningful to postulate a collective ZPD from which each child can draw as from a collective pool, and the first of the three quotations above is suggesting that it should be part of the teacher's art to offer a learning situation in which the instruction '…marches ahead of development and leads it: aimed not so much at ripe as at the ripening functions' (T&L, p. 188). This is the point where it is necessary to compare Piaget's and Vygotsky's position on development.

3. Piaget and Vygotsky's view of mental development

A major difficulty in interpreting Vygotsky's work derives from what, in my opinion at least, is his major virtue. Each time he gave a lecture or wrote a paper he updated his thinking according to the particular context he was inquiring into at the time. Instead of trying to make himself consistent with what he may have published earlier, or trying to defend himself against other academics (or anonymous referees!), he thinks afresh according to how he saw things at the time (Piaget, I am afraid, was quite different, appearing to show he had always thought of everything and was never inconsistent, only evolving). This dialectical method is quite delightful, but it means the reader has to try to gauge what were the issues Vygotsky was trying to address, and to what extent his thinking had become more powerful. It is more like trying to compare the Verdi of *La Traviata* with the Verdi of *Otello* and *Falstaff*, asking the question, What has been deepened and developed, but also What has been lost?

In Vygotsky's papers from around 1926 until his death in 1934 two closely related,

interweaving but not identical themes are, What is the relation between children's 'spontaneous' thinking (which is what he claimed Piaget studied) and their 'non-spontaneous' or learning-related thinking, and What is the relation between Action and 'the Word'?

If you look at quotations 2, 3, 7, 8 10 and 11, and couple them with 4—

> …recently psychologists have shown that a person can imitate only that which is within her developmental level

—you can see a paradox: from quotation 6 one sees rejected the idea that one should teach only at the level of children's current competence. Likewise quotation 9 rejects as useless teaching too far ahead of where the children are. But if it is true that

> …the development of scientific concepts runs ahead of the development of spontaneous concepts

it is also true that teaching at what has been called the 'N+1' level, where N is the child's current mental level, can challenge the children's thinking in such a way that their 'spontaneous' thinking moves ahead:

> …to introduce a new concept means just to start the process of its appropriation. Deliberate introduction of new concepts does not precede spontaneous development, but rather charts the new paths for it. (T&L, p. 152) (20)

So on the one hand it is conceded that 'natural' or 'spontaneous' thinking inevitably lags behind the intellectual challenge of schooling, but on the other it is asserted that in providing children with new tools for thinking the learning demands of school act as a kind of leading edge impelling their spontaneous thinking to more powerful schemes (to use Piaget's word). Vygotsky never resolved this paradox, but sometimes to locate a valid antithesis to a thesis is itself a great achievement which others can then benefit from[3].

With action and 'the Word' (Vygotsky did use the Greek and biblical sense often in his thinking) one thinks first of Vygotsky's criticism of Piaget in T&L, and of Piaget's later response to that criticism in 1962 (retranslated in Piaget, 2000). It is rather pointless to try to takes sides on that exchange, because on Vygotsky's part he had access only to the work Piaget had done up to 1924, and Piaget did not read Russian so had even less access to the bulk of Vygotsky's later thinking. Piaget's early work *was* open to the criticism of being focused too much on children's words and too little on their action. He admitted this later in his life (see footnote 15 in Piaget, 1962/2000 for references), and Piaget (1962/2000, p. 242) admits by implication that it was only after he had completed the study of his own three children's

[3] cf. Newton—*thesis*: heavenly bodies attract each other with an inverse square law; *antithesis*: action at a distance is an unsatisfactory mystical concept—it would be over 200 years until Einstein resolved this.

development from birth, as reported in *The Origin of Intelligence*—during much of which time there were no words to observe and study—that he was able '…to locate the beginnings of thinking in a context of adaptation which has a more and more biological sense'.

I claim instead that by 1933 the two had reached an almost identical position—in the case of Vygotsky a synthesis achieved possibly by further reflection on his criticism of Piaget taken as antithesis—in the case of Piaget the antithesis being the activity of meticulous recording of his children's actions before they were able to speak. Under the heading, *Word and Action* (in *Tool and Symbol In Child Development*, pp. 166–170 in van der Veer & Valsiner, 1994) Vygotsky begins by rejecting 'In the beginning was the Word' as applying to the development of children's minds. He then quotes from Goethe's Faust, but with the subtle change of italicisation:

> ..... *in the beginning* was the deed

and goes on to reject the idea that speech and action evolve independently of each other or in parallel. He objects (to the positions others had taken):

> Yet we were able to observe on a factual basis how, in the process of development, the child's action becomes social, and how, in losing speech because of aphasia, its practical action falls to the level of its elementary zoopsychological form.

Finally he says:

> We cannot dwell … on either the evangelical or Goethean formula, no matter which word we accentuate.

and hence

> We have attempted, throughout the article, to show how the word, itself intellectualised and developed on the basis of action, raises the action to a higher level, subjects it to the power of the child, puts upon the action the stamp of will. But since we wanted to express all this in one short formula, in one sentence, we might put it thus: if *at the beginning* of development there stands the act, independent of the word, then at the end of it there stands the word which becomes the act, the word which makes man's action free.[4] (21)

Although Piaget would never have expressed himself like that, I can hardly slip a piece of paper between this position and that of the man involved in researching *The Growth of Logical Thinking* (GLT) (Inhelder & Piaget, 1958), and *The Early Growth of Logic* (EGL) (Inhelder & Piaget, 1964).

[4] Note that this quotation differs from that given in van der Veer and Valsiner (1991). It was retranslated from the Russian by Mundher Adhami, and van der Veer confirmed that this is a correct translation.

4. For cognitive development, follow Piaget

Cole and Wertsch (2000) in an interesting position paper placed on the Internet assert:

> There is little doubt in our view that there is still much to be learned from both Vygotsky and Piaget, and in many cases the strengths of one theorist complement the weakness of the other. However, we believe that discussions of these two figure's accounts of mind and its boundaries are not well served by overly rehearsed debates about the primacy of the individual or the social. Instead, we have argued that the more interesting contrast between them concerns the role of cultural artefacts in constituting the two poles of the individual–social antinomy. For Vygotsky such artefacts play a central role in elaborating an account of what and where mind is. In pursuing the line of inquiry, he focused on a set of issues and phenomena that do not appear to have any clear counterpart in Piaget's thinking, and consequently may be more appropriately characterised as being different, rather than directly in conflict with those at the centre of Piaget's project.

In this spirit, I claim that, provided one takes *The Origin of Intelligence* as marking the beginning of the thoroughly well-grounded life-work of Piaget studying all stages of development (excepting ages 3–5) of children from birth to the end of adolescence, then it is the strength of this person that one should rely on. But first it is necessary to clarify what it was that Piaget had described. Vygotsky (T&L, p. 154) claimed that Piaget only described the genesis of children's 'spontaneous concepts'. But in the previous section we have seen that the relation between 'spontaneous and non-spontaneous, systematically learned, concepts' —as Vygotsky rightly states—is an *interaction* in the process of development. Piaget *never* presented these concepts as 'firmly divided and self-contained entities whose interaction is impossible'—Vygotsky was wrong about that (T&L, p. 154). What can be said is that Piaget selected tasks for children little likely to be contaminated by the children parroting 'teacher's right answers'. But the purpose of this was to get below the surface of younger children's performances to find the extent to which they can construct classes, relations etc. in a wide variety of contexts. If one looks at Piaget's sampling unit as being *not* the individual but as a set of children sufficiently varied both in age and ability to elicit both successful understanding and all the steps in the ZPD leading up to the achievement of the scheme studied, one can then view the Genevan methodology as focused on the *qualitative* detail of the study of the ZPD phenomenon, as distinguished from the *quantitative* side which Vygotsky described in his psychometric phase. It is interesting that both used the term 'genetic' to describe their approach to development. Piaget's own view of his methodology as being the study of 'the epistemic subject' (but see Shayer, 1993) is compatible with this description of his sampling unit, within which enough detail can be given to describe all steps or alternatives of development of that 'subject'.

Looking then on Vygotsky and Piaget's approaches to development as *different* in the way suggested by Cole and Wertsch, one can see that Vygotsky's emphasis

on 'nonspontaneous' concepts was a concern with the *dynamics* of development—that which drives it—and Piaget's with the *statics* of development, where they actually are when removed from sources of stimulus: exactly what Vygotsky said one needed to know in order to have a good model of 'instruction' (quotations 4, 13, 14 and 15). Hence the Genevan methodology where the psychologist, while supporting the children by approving all they do and say, *deliberately* avoids mediation, and in fact by offering counter suggestions to gauge the stability of a child's concept, could be described as sometimes offering negative mediation. In this sense one could call the Vygotskian dynamic assessment process, where a variety of mediation is offered to each child, as being focused on the *individual*, and Piaget's as focused rather on the *population*. Yet, paradoxically, a point which is very obvious—although I have never seen it expressed by any commentator, be they either pro or anti Piaget—if you want to see the detailed specifics of what is present in various children's ZPDs, if you want evidence that partially achieved schemes are present in children's minds before they finally achieve them, you will not find Vygotsky ever bothering to show you: instead you will see them recorded in fascinating detail in every work associated with Piaget.

Although there could have been some justification at the time in Vygotsky viewing Piaget"s work with younger children thus:

> In schoolchildren of eleven to twelve, the nonspontaneous concepts completely replace the spontaneous, and with this, according to Piaget, intellectual development reaches its port of arrival. The real culmination of the developmental process, i.e. the formation of mature, scientific concepts in adolescence, simply has no place in Piaget's model. (22)

this could only have been true with respect to the development of concrete operations. I don't recognise this myself as a valid description, but if one looks at the characteristics of the concrete generalisation level one might be forgiven in interpreting it as children having the capacity to use all the concrete operational schemes that Piaget describes fluently in any school learning they are offered, and hence the gap between development and learning capacity to have disappeared. But as soon as one looks at GLT, 20 years later, it is possible to see that many of the aspects of development which Vygotsky described apply more to the development of formal operations than to concrete operations.

In the various chapters researched by Inhelder and Piaget in GLT one can see, exhibited within the specifics of well-chosen contexts, the major underlying schemes (Reasoning Patterns) required for effective thinking in the biological and physical sciences. These presuppose without any doubt (the research was done on the selected population of Swiss gymnasia schools, perhaps the upper 20% or less of the population) adolescents whose development had already long been established in a complex interaction between their mental development and their exposure to and (partial) mastery of the reasoning patterns needed to make their own the concepts of science. As Vygotsky put it:

> …the development of nonspontaneous concepts must possess all the traits peculiar to the child's thought at each developmental level because these concepts are not simply acquired by rote but evolve with the aid of strenuous mental activity on the part of the child himself. We believe that the two processes—the development of spontaneous and nonspontaneous concepts—are related and constantly influence each other. (T&L, p. 157) (23)

Thus all Inhelder and Piaget are doing in GLT is to present adolescents with investigations, related to quite complex thinking underlying genuine mastery of science concepts, which reveal their development of reasoning patterns such as control and exclusion of irrelevant variables required in biological thinking, and proportion and equilibria of systems needed to model physical science. Vygotsky's criticisms of the limitations of spontaneous thinking all vanish as we see they relate only to the middle phase of the development of concrete operations in younger children. The 'spontaneous' thinking of the adolescent is a very different animal to that of the 8–10 year old. As Inhelder and Piaget show in delightful detail, the 'spontaneous concepts' exhibited by these adolescents have already been brought:

> …up to the level of development which would guarantee that the scientific concepts are actually just above the spontaneous ones. (T&L, p. 195)

In claiming that if one needs the specifics of the levels of mental development then it is to Piaget that one should turn, then one should remember that this delivers only the *statics.* To give Vygotsky the last word in this section:

> It became clear that the functioning of intelligence depends upon the structure of thought. Piaget's works are but the most explicit expression of the concern with the structural aspect of thought. (T&L, p. 207.)

5. Fostering the dynamics of development: Vygotsky and Piaget in tandem

Piaget has been represented as studying (and promoting) only the individual, and Vygotsky as focusing on (and promoting) the primacy of social processes of learning (Lerman, 1996). But this is to confound investigational method with intention. Neither engaged in applicable research in the classroom. I have already presented the paradox that Vygotsky's own reports of his work in dynamic assessment were focused only the individual, whereas as Piaget notoriously once said, truly, of the Genevan method 'I am not interested in individuals', for in fact his selection of a good sample of children was typical of the methodology of the biologist seeking to describe a species. I would claim, though, that the delightful human specifics detailed in every book present the same implicit love of children as a good biologist has for the animals he studies.

Les Smith (Smith, 1996; Piaget, 1995) has shown in meticulous detail that—at the abstract level at least—Piaget and Vygotsky occupied very similar territory with

respect to the social origin of thinking. Any reader who doubts this is invited to sit the self-test given in Smith (1996) where one is requested to attribute to the right author 20 brief quotations, there being an equal number from each. Among a score of 'experts' who were given the test unseen at the time, none did better than 16 right, and their mean score was 13 (mine was 12, but then I dodged two items, my uncertainty helping to make Smith's case). Both, in their own ways, stressed the importance of 'construction' by the individual (see quote 3)—in Vygotsky's case covered by the global term 'internalisation', which sometimes means immediate appropriation of a concept made available by another collaborator in learning, and sometimes means (quotation 3) subsequent work by the individual. This second meaning overlaps Piaget's contribution to the art of 'cognitive conflict', the pain and challenge that follow a person finding that his present concepts are not powerful enough to solve a dilemma.

This may be stated more strongly: If Vygotsky was right in conceding Piaget as the Master vis-à-vis 'the structural aspect of thought', how was it that Piaget, setting out in the early 1920s to discover 'How does knowledge develop?' (by implication a dynamic process), in fact spent all his time and that of his scores of co-workers up to 1955 in what was essentially a structuralist enterprise? To answer this it is necessary to imagine the state of our knowledge without Piaget's life-work. It is like medicine before detailed anatomical knowledge was available: before you can intervene to remedy a dynamic function you first must know *what* it is that is in motion and interaction. First Piaget had to describe, like a series of stills from a movie, all the steps of knowledge development all over the psychological spectrum from birth to adulthood. The famous 'Genevan method' crystallised at just about the same time as physicists like Heisenberg realised that there was a problem about describing a system which you have to disturb to observe. Piaget and his assistants had their own solution to describing children's present thinking: it might be expressed 'above all avoid *mediation*'', and by counter-suggestion, if need be, try to elicit only the child's present powers. Hence 'the method' vetoed intervention, vetoed any attempt to *change* the phenomena until the descriptive work was done.

Vygotsky on the other hand studied only the dialectics of change, and in his process of dynamic assessment involving the concept of the ZPD adopted a different solution to the Heisenberg problem. This was: *mediate*, and then measure the extent of the child's performance increases as a result of the mediation—essentially a dynamic process (measuring the extent of the mediation as well was a further gloss on the method, developed by Feuerstein).

The complementarity of their respective work then follows (cf. the wave and particle aspects of electrons and photons). Vygotsky would have needed Piaget's descriptions of development had he gone on in the work of improving schooling, and had Piaget wanted to convert his (correct) intuitions about the importance of collaborative learning among peers (see Smith, 2001 on Piaget's views on education) into school practice he would have needed to draw on the work of Vygotsky.

6. Evidence from intervention studies

This view of the complementary aspect of the work of Vygotsky and Piaget has since 1981 implicitly underlain a substantial programme of intervention research. Those with a taste for statistics will find the evidence in the papers cited.

First it was necessary to see whether intelligence can be enhanced at all. Shayer and Beasley (1987) reported a replication of Feuerstein Instrumental Enrichment (IE) over a two-year period (1982–84) on a class in a Special School. Part of the evidence came from the use of a Piagetian test battery, adapted from the monograph by Shayer, Demetriou, and Pervez (1988), where large-scale evidence on a stage interpretation of Piaget's work was argued. Although by definition Special School pupils are selected from the bottom 5% of the population on standardised tests of English and Maths, it was interesting to see that on Pre-test at the age of 11 the children were assessed at the 35th percentile of the CSMS norms (see Fig. 1). At post-test 20 months later the children were at the 65th percentile, now above the National average for their age. But this was very small-scale evidence.

6.1. Cognitive Acceleration through Science Education (CASE)

The original applied and applicable research was funded by the SSRC at Chelsea College from 1984 to 1987. A summary of subsequent large-scale research on the effects of this two-year intervention set within the context of science learning can conveniently be inspected in Shayer (1999)—itself a response to a challenge offered by Jones and Gott (1998). The first group of eight schools (pupil $N = 1486$) offered PD from King's College from 1991 were given pre- and post-tests of two of the Piagetian class-tasks used in the CSMS survey. The school effect-sizes showed an average increase of 34 percentile points on the CSMS norms. In effect this amounted to a doubling of the proportion of pupils with formal operational thinking.

Evidence for the meaning of these increases in thinking ability in terms of school achievement is given by the Key Stage 3 results of those 12 schools beginning CASE in 1992 ($N \sim 4500$). Not only did the pupils have enhanced results in Science compared with those in control schools: they showed similarly large increases in Maths and English. The results for all subjects indicate that it was the general learning ability, intelligence in fact, which had been affected by the CASE intervention, rather than specific science skills.

Evidence for the transmittability of the CASE methodology was given by the results of five Sunderland schools given PD by Marion Jones, herself one of the teachers initially trained at King's in 1991. These results averaged the same as those of the seven schools given PD at King's.

Finally the GCSE 1999 results from 11 schools beginning CASE with PD from King's in 1994 feature in Shayer (2000). Added-value estimates averaged 1.02 grades for Science, 0.95 grades in Maths, and 0.90 grades in English, with increases in the proportion at C-grade or above of the order of 20%. This is the final evidence that the effect of the CASE intervention is permanent.

7. Intervention toward a theory of instruction

One important insight from Vygotsky is that in 'spontaneous' thinking the movement in the child's mind is from particular instances toward some more general concept which links them, whereas in school learning—particularly that of science—the child first receives the concept at the abstract level, and then has to struggle to find out how it may be applied to different specific contexts. Quoting from West and Pines (1985), Howe (1996) describes this:

> The metaphor is of two vines; one vine representing spontaneous concepts grows upward while the other vine, representing scientific concepts, grows downward. Under the influence of instruction that encourages integration and consolidation the two vines intertwine and grow together as conceptual understanding develops.

How then is one to draw on these various insights to create a general strategy for effective teaching in school? In different ways both Feuerstein through the Instrumental Enrichment programme (IE) and the workers involved in the CASE and CAME[5] interventions have chosen an intermediate *tactical* solution (Feuerstein, Rand, Hoffman, & Miller, 1980; Adey, Shayer, & Yates, 1995; Adhami, Johnson, & Shayer, 1998). Although they express it differently (Feuerstein through the concept of 'cultural deprivation') I believe that both sets of workers addressed the problem shown by the CSMS survey quoted above that in any one year-group or in any one class of 12-year-olds in a neighbourhood High School with a mixed-ability policy, maybe no more than 20% may be functioning at the level of their true mental potential, so that in Piagetian terms their mental levels may range from early to middle concrete right through to mature formal. Before one could dream of an ideal solution to school learning, first one must tackle the problem of the Western environment that has produced 'cultural deprivation' and hence so many people that cannot benefit from schooling once it goes beyond the Primary level. Hence the notion of *intervention* (drawn from medical terminology) as an intermediate tactic to increase the proportion of children by a large amount to a mental level at which they can process their learning during the course of ordinary instructional teaching It is claimed that ample evidence has already been established to show that this tactic can be successful (Shayer, 1999). Perhaps in 30 years time when intervention methodology has been practised with all age groups from 5 through to 14, and most children realise their genetic potential, 'good teaching practice' will have evolved to a seamless integration of instruction and intervention.

Given the twin vine concept on the one hand, and the CSMS survey evidence of wide ranges of mental levels among the pupils on the other, then the first general principle one can enunciate is that any good intervention activity should be in a context that allows processing at several different levels. In this way there are opport-

[5] Cognitive Acceleration in Mathematics Education Projects, funded at King's College, 1993–1995 by the Leverhulme Trust, and 1995–1997 jointly by the Esmée Fairbairn Foundation and the ESRC.

unities for all children in the class possibly to make 'revolutionary' jumps in thinking, each from where they presently are. 'All shall get prizes' would then not be a patronising observation.

But in order to design activities having this characteristic (such as the IE 'Instruments' and the CASE and CAME lessons) it is essential that designers—and those who teach the lessons— are able to look at their curriculum through mental development (Piagetian) eyes, as Vygotsky originally argued was essential. If you cannot assess the range of mental levels of the children in your class, and simultaneously what is the level of cognitive demand of each stage of the lesson activity, how can you plan and then execute—in response to the minute by minute responses of the pupils—tactics which result in all engaging fruitfully?

There then arises the question: How should the teachers conduct these intervention activities? Statements 17 and 18 are suggestive that some kind of collaborative learning should be beneficial, and in case a Western reader is put off by the language of:

> Functions are first formed in the collective[6] as relations among children and then become mental functions for the individual. (Wertsch, 1979, p. 165).

—who can totally resist using the jargon of the times?—he/she could also interpret it in the spirit of a later statement:

> …play also creates the zone of proximal development of the child. In play the child is always behaving beyond his age, above his usual every day behaviour; in play he is, as it were, a head above himself. Play contains in a concentrated form, as in the focus of a magnifying glass, all developmental tendencies; it is as if the child tries to jump above his usual level. The relation of play to development should be compared to the relation between instruction and development … Play is a source of development and creates the zone of proximal development. (Vygotsky, 1933, quoted in van der Veer & Valsiner, 1991, p. 345).

Thus the abstract formulation:

> Research shows that reflection [by the individual] is spawned from argument [in the collective]. (Wertsch, 1979, p. 165, 5 lines later)

implies a process nicely specific, indicating that the main source of mediation for adolescents is their *peers*, rather than 'scaffolding' by adults.

Thus the second general principle used both in the CASE and CAME interventions is that the social conditions must be set up in the classroom/laboratory to allow a communal ZPD to operate with further consequences for the promotion and completion of individual pupils' ZPDs.

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[6] My Russian translator assured me that the Russian word is used much as 'group' is used in English, without carrying as heavy political overtones as the word 'collective' does in English.

Fig. 2 summarises the abstract structure of a typical CASE lesson. Given a context where multiple levels of understanding, say of controlling variables, or of ratio and proportion, are involved, the teacher needs in Act 1 (8–12 min) to introduce the pupils both to what will be involved in the investigation to come and to any technical vocabulary they need. This needs to be done at a thinking level such that at least 80% of the class can enter into a dialogue with the teacher that creates a common understanding of the work to come. In Act 2 (10–15 min) the working groups—typically 3–5 in number—are to work at the task within their group ZPDs.

If Act 2 is to be successful the teacher needs to be mindful of Act 3 to come in the class management strategies he/she uses toward the end of Act 1. In Act 3 (typically 15 min for CASE) each group is to report their ideas to the rest of the class. If, in relation to one concept, a pupil in group 5 needs to complete her partially formed ZPD, a strategy or idea created within group 2, then only Act 3 gives her a chance to witness and internalise it. Act 3 is also the opportunity for the whole class, having established a common ZPD in relation to the investigation, then to reflect metacognitively on what has been achieved. The pupils already know from past experience that they had better have something worth saying[7] when it comes to Act 3, so the teacher will already have induced the flow of some ideas in the pupils in Act 1 and will then have challenged all the groups to use the time announced to

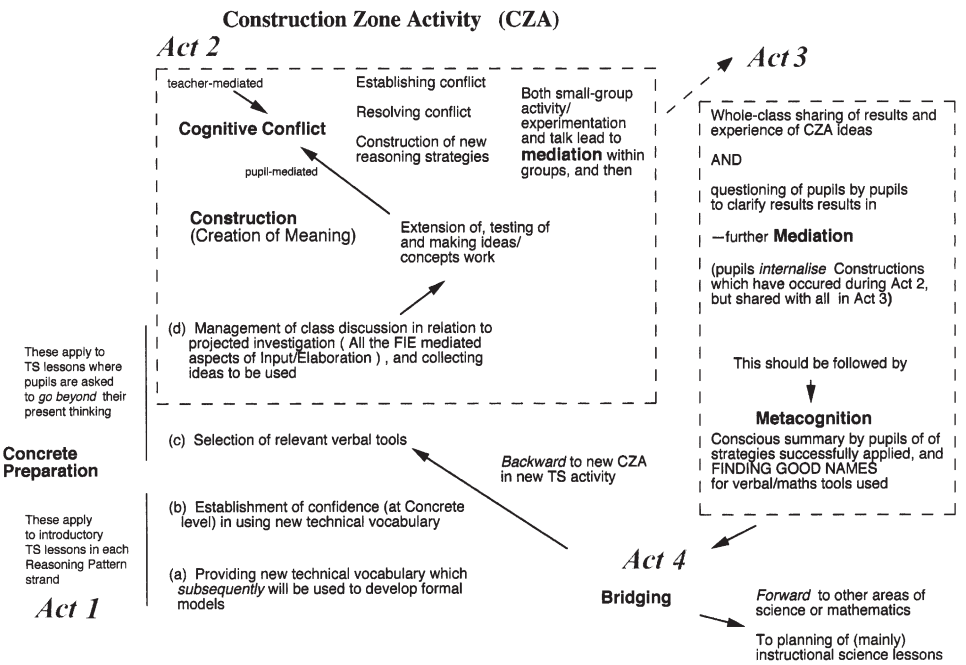

Fig. 2. Technical terms used to describe phases of CASE and CAME lessons.

[7] Otherwise you'd feel a right pratt, as one pupil said when interviewed on Radio Cambridge.

collaborate in finding as much as they can to show and say ('Don't ask me, I shan't answer—it's your ideas that are important').

The teacher processes are described in more detail in a recent publication (Shayer & Gamble, 2001) intended to show science teachers how they can extend to their ordinary science teaching the teaching skills they employ in their CASE lessons.

During Act 2 the teacher's main task is the class scan. He/she only intervenes to enhance group energy where it flags, or to drop in the right question to induce cognitive conflict where a group has become complacent at too low a level of processing. Otherwise she notes all the ideas of interest coming up in different groups (some teachers note names on the whiteboard for reference in Act 3), decides when sufficient has occurred in Act 2 (it is not necessary for all groups to have completed the task), and also makes a plan for how to manage Act 3. Implicit in all of this (but consciously so on the teacher's part) is that it is the peer–peer mediation occurring in the group construction in Act 2, and in the exchange of ideas in Act 3, that is the major driver of intellectual development in the CASE interventions. It is her job to manage the lesson so that peer–peer mediation is maximised, a very different skill from ordinary instructional teaching. Note too the qualitative difference between this art and much that is featured in Newman, Griffin, and Cole (1989), e.g. p. 67:

> …we would propose that the constructive work occurs as much in the interaction between the adult and the child as in the child's internal processes.

No, we argue, the teacher's art is to manage all aspects of peer–peer construction and mediation, a more indirect managerial process. "How do I know what I think until I hear what I say?" (last page of *Howards End*, E.M. Forster) applies even more to a group of children trying to find an idea which will illuminate a science problem, or to find a strategy by which to attack a maths task, and could be complemented by, "How do I know what I think until I hear also what the others say?" In fact, even "…until I hear what I say" implies the response and stimulation of the others and the presence of 'the collective'. Hence the importance of Act 3 of the cycle (*Whole class discussion*, or *Metacognition*) where each group quickly reports to the rest of the class the high points of their discussion, and others are allowed to comment ('I don't agree with what John said, because…'). Bearing in mind the issue of different levels of mental development in the class, and also different depths of interpretation of the agenda, the teacher would be wise, at this point, if she ask first the *less* able children to present any solutions to the lower level aspects of the task she has seen and heard during the Construction period. It is not always the *less* able pupils who benefit from this! Sometimes the more able say that worried them too, but they didn't want to ask. If each group only present what hasn't already come up, this exchange can be brisk and not tedious. Ideally every idea or strategy which has come up in the group discussion then becomes available, for any or everyone, increasing by a large factor the number of opportunities for each to complete their ZPD in respect of this or that concept.

With the maths activities featured in CAME, typically there are not one but two 3-Act cycles, with Act 3 of the first becoming a preparation for Act 2 of the second.

This is because any maths activity draws, more than is the case for science, on other strands of maths processes, each of which needs addressing.

Lest it be thought that the above description implies dropping Piaget in favour of Vygotsky, remember that every moment of the lesson management involves the teacher being aware both of the processing levels of different aspects of the activity, and also how each pupil's response indicates the level that they are processing at, and hence where they are presently moving up towards. In Shayer and Gamble (2001) and also in Primary CAME (Y5/6) each lesson is presented in a diagram cast in Piagetian space, where the hierarchy of concepts is displayed (Adhami, Johnson, & Shayer, 2002).

It is not suggested that this teaching art, integrating the Piagetian (mental level) and Vygotskian aspects (class management) is as easy as current announcements by the British Government office (DfES) about 'Thinking Skills' seem to suggest. You cannot hope of any success—previous research data show this (Adey & Shayer, 1994, chapter 3)—by giving teachers a few days of abstract training and then asking them to go away and apply it to their own subjects. Hitherto—whether it be Feuerstein IE, CASE or CAME—it has required several years with subject specialist research teams to generate portfolios of lesson contexts which fulfil all the criteria mentioned above. In a forthcoming book (Shayer & Adey, 2002) three different recent developments of the art are presented: to Mathematics in the last two years of Primary school, to Performing Arts subjects for 12–14 year-olds in the first two years of secondary school and in the CASE@KS1 intervention for 5- to 6-year-old Primary children (Adey, Robertson, & Venville, 2001, 2002). Each of these teaching programmes only become effective through Professional Development delivered over a period of at least a year, where feedback is given to the teachers as they gain increasing experience of the problems which arise from the lesson activities.

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