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Construct heterarchies

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This paper presents a technique for deriving individual construct heterarchies, and for comparing several such without loss of sharpness in the initial act of constructing. It explains uses – both potential and in practice. The technique is related to Kelly's Personal Construct Theory, and some of its limitations and implications for that Theory are explained.

Introduction

The views of Kelly (1955), around which this issue of this Journal is developed, involve the personal creation of bi-polar constructs on which individual perceived elements are assumed to be located and which assemble together in a heterarchy leading to a small number of base constructs which are the key to the individual personality. While I doubt the universal validity of the bi-polar construct (see also Easterby-Smith, 1980)—especially for visual perception and when used in accounting for the act of design (which is the making of a new construct, which in itself, in Kelly's terms, requires a set of personal meta-constructs that permit the generation of a new personal construct and thus, also, of course, the generation of the personal construct heterarchy), the elegance and simplicity of Kelly's vision has lead to its extensive application through simple mechanization in various program suites, (Shaw, 1978, 1980; Shaw & Thomas, 1978; Slater, 1977, 1980; Bell & Keen, 1980; Leach, 1980; Easterby-Smith, 1980; Eshragh, 1980) that are often found useful and personally rewarding (to the user). The assumed bi-polarity of a construct has even been brought into doubt by one of Kelly's followers (Rosenberg, 1977), and I find no need to insist on it. The relaxation of this requirement brings Kelly's views of heterarchial concept organization closely into line with other constructivist psychologists—especially, of course, Piaget (1972), and also Pask's work on learning and knowledge (Pask, 1972; Pask & Scott, 1972, 1973; Pask, Scott & Kallikourdis, 1973; Pask, Kallikourdis & Scott, 1975).

However, the discovery of (representations of) such personal heterarchies is not necessarily easy. Piaget achieves it by himself analysing his notes of observations made over long periods and of many subjects. Kelly does it through an iterative process of questioning, which also takes a long time. His followers use various modifications (e.g. Fransella, in Fransella & Bannister, 1977), interviews subjects and elicits constructs and their ordering herself). Computerization speeds up the iterative process as demonstrated in other contributions to this issue, but may be somewhat limited—in that it is wholly reflective—and even Pask's learning machines take a long time and suffer (though progressively less so) from their similarly machine-bound imaginations.

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Leaving aside the whole question of the bi-polarity of personal constructs, there remain two distinct technical problems that, although they have been resolved in various forms, could well be better resolved in practice. The first of these is the rapid generation of personal construct heterarchies, within a group of constructs. The second is the comparison of individual personal heterarchies of constructs—between common representations or between common heterarchial forms, without compromising the initial sharpness of individual constructs.

I propose a technique that goes some way towards this, and will discuss some of its implications and limitations not only in Kelly's terms, but also in terms of other constructivist theories, and I will introduce some apparent by-products of the technique.

TECHNIQUE†

The technique assumes a group of constructs (not necessarily bipolar) to be already chosen, but does allow for a portmanteau construct (usually denoted A) which ropresents the supra-ordinate construct "an important construct that's otherwise missing from the group". These are arranged in whatever manner is chosen, although experience suggests that arranging them—anagram-wise—in a circle is a good way, and this is the way we will used here (Fig. 1).

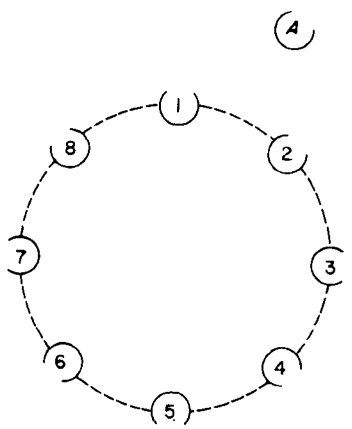

FIG. 1. A circle of eight constructs (here denoted by numbers), together with the portmanteau construct A, which is left outside the circle to highlight its role as covering something that is missing.

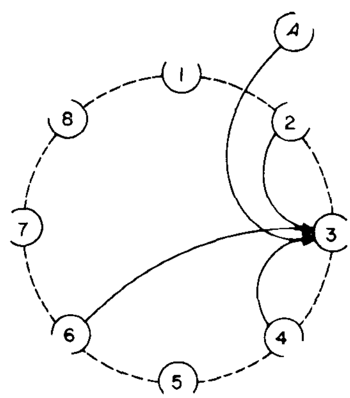

FIG. 2. A circle of constructs being filled in. The arrowhead points to the construct derived from the constructs at the bottom of the arrow stems. Note that more than one derivation may be possible, and that all derivations must be made from at least two other constructs.

Each construct in the circle (excepting, by choice, A) is then considered in turn, from the following point-of-view. It is assumed that construct generation (within the closed-system of the construct group) requires the interaction of at least two other constructs, as is a pre-requisite in Pask's (1975) productive relation between "topics-to-be-learnt", for the following, very commonsense reason: if one construct "topic", or one of the author's "Objects" (Glanville, 1975, 1978, 1980*a*) comes directly from another

† This technique has been described in a borrowed, variant form by Pask (1976). The variation is strange since Pask neglects his own rule for topic generation in not requiring at least two topics to entail another.

without the inclusion of some new information (necessarily from, in this closed-system, other constructs), it can only be the same as the single construct it is derived from (Fig. 2). Thus, a participant will consider whether each and every particular construct can be derived by some sort of (not necessarily, but possibly specified) interaction between two or more other constructs. The derivations specified are shown by an arrowhead, entering the derived construct, the shafts of which emanate from the constructs which, acting together, produce this construct. It is normal—even to be expected—that some constructs will be derivatives of other constructs, themselves derivatives of the first (double-bind), and that some will not be derivatives of any others at all.

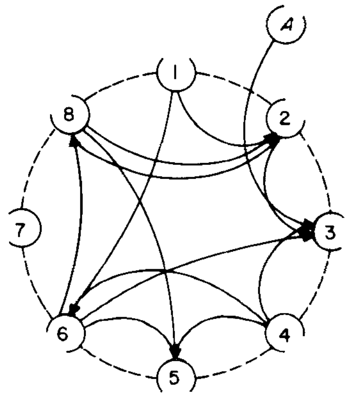

FIG. 3. A filled-in construct circle. Note that constructs A, 1 and 4 have no derivations and will be placed at the base level when the heterarchy is assembled, that there is a double-bind between 2 and 8, and that construct 7 is completely unconnected.

Having thus completed the interconnecting of the constructs in the circle, (Fig. 3), it is necessary to rearrange them to demonstrate the heterarchial structure of each participant's understanding. This is done according to the following procedure:

(i) Isolate out all constructs which have no arrowheads pointing into them, and lay them out upon a line at base level (L_0).

(ii) At the second level (L_1) place all those constructs derived only from those constructs on the base level.

(iii) At the third level (L_2) place all those constructs derived only from those constructs on the base and second levels.

(iv) Continue until there are no more constructs to be derived and place all constructs that appear as top nodes on the same top level, since the only meaning in the levels is within their own branches of the heterarchy (Fig. 4).

There may be four peculiarities that occur within the procedure which need special attention.

(a) Some constructs may not be connected in at all, (e.g. construct 7 in Fig. 3). These are not part of the participant's heterarchy, from which they are isolated. They may be omitted, left on the base line or tabulated separately, at will.

(b) The double-bind mentioned above may be encountered, where one as yet underived construct depends on another underived construct which in turn depends on the first. The normal way to handle this is to put all such constructs on the same level and

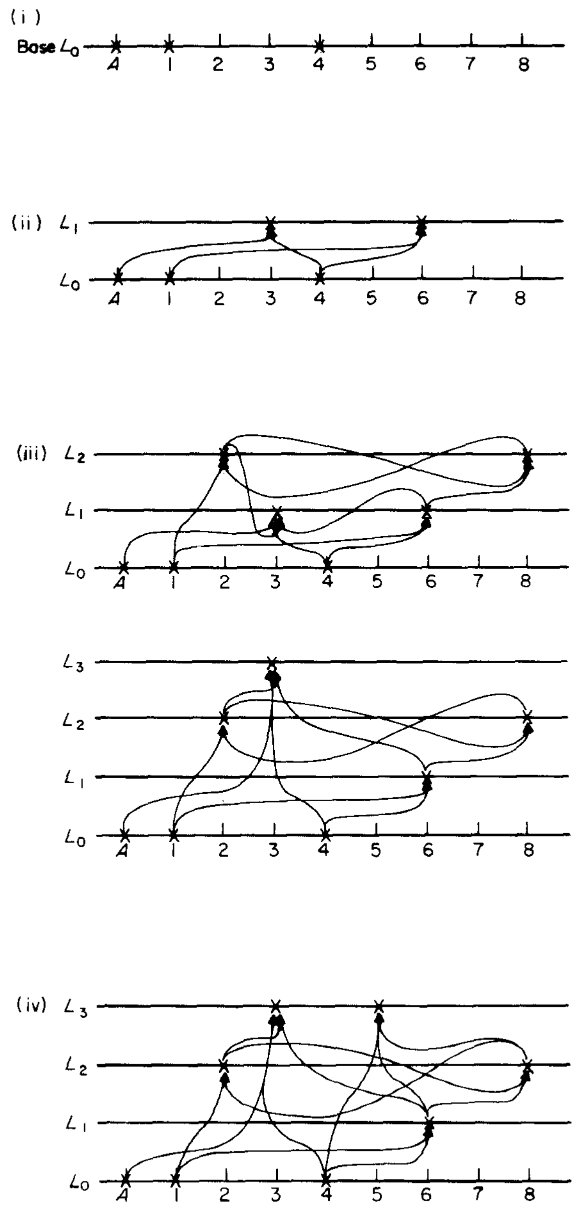

FIG. 4. The creation of the heterarchy from a construct circle, shown in four stages demonstrating the four instructions.

(i) Isolate out all constructs which have no arrowheads pointing into them, and lay them out upon a base line. (The unconnected construct, 7, is omitted.)

(ii) At the second level, place all those constructs derived only from those constructs on the base level.

(iii) At the third level, place all those constructs derived only from those constructs only on the base and second levels. Note the double-bind between 2 and 8, and the second (alternative) derivation of 3, which requires its level to change, as in the lower diagram, to the third level.

(iv) Continue with the derivation of construct 5 (which is derived from three constructs), and note that construct 3, which was raised to the third level since it had a derivation depending on constructs 2 and 6 already being derived, is also a point at the top of the heterarchy.

allow them to be used (together with already derived constructs on lower levels) to derive each other within the same level, (Fig. 5). Such an arrangement may even pertain on the base level. However, there is a justifiable argument that such a double-bind denotes a common but unelicited construct embedded within the constructs in the double-bind. Consequently, the double-bind may be broken by the insertion (on a

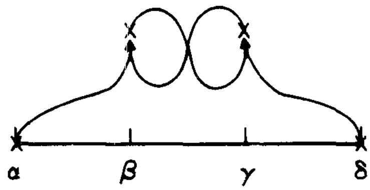

FIG. 5. The double-bind between β and γ, which is resolved by placing both on the same level.

lower level) of a new common construct, quite distinct from the supra-ordinate "spare" construct called A, and which may then be elicited and named, which, together with other constructs on other (lower) levels generates the two constructs that were in the double bind (Fig. 6). Note, however, that the elicitation of such a construct implies an expansion of the original circle of constructs and a possible consequent alteration of the derivative connections, which will in turn require a reformulation of the heterarchy and, possibly, further and novel double-binds.

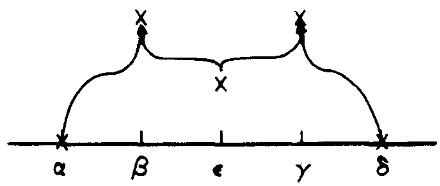

FIG. 6. The double-bind between β and γ, which is resolved by calling upon a new, common construct (ε) placed at a lower level.

(c) A construct may seem to need to appear at more than one level in the heterarchy. Should this be the case, it should always be placed at the higher level. All that has happened is that there are two or more derivations, one (confusingly) relatively simple and another depending on the prior derivation of a construct the simple derivation did not need.

(d) Under certain circumstances (only very rarely found) there are no underived constructs (i.e. ones without arrowheads entering them). In this case, the base level will consist only of double-bound constructs which are derived from but are also in their turn the derivation base of each other. This extraordinary event may be handled by the first double-bind technique. The second, requiring the assumption of sub-base-line constructs seeming a little esoteric. In the only case I have yet met, (Fig. 8(iii), where all constructs except A are on L_1), all constructs were bound to each other. The pathological condition that could create this sort of confusion will be mentioned later!

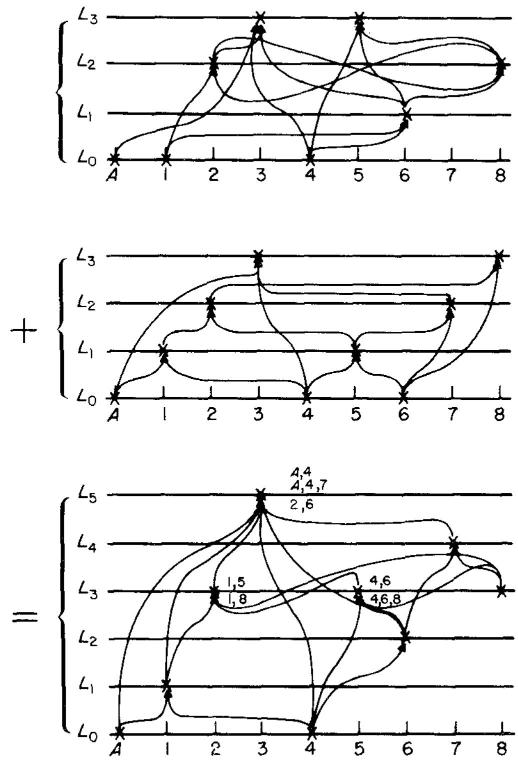

FIG. 7. Two heterarchies combined (alternative derivations are shown by the numbers of the constructs from which they are derived, rather than by separate arrowheads, which would in this case confuse the diagram). Each of the original heterarchies is a particular interpretation of the combined heterarchy, which also permits other, new heterarchies to be made. Note that the number of levels need not in all cases be the same.

Applications

There are three areas of application of this personal heterarchy generation technique.

The first is the obvious one, for which the technique was developed: the personal derivation of a personal heterarchy from a collection of elicited constructs. The technique presented here is reflexive, and distinctively sharp valued, and no more need be said about this application. The examples in Fig. 8 show various different personal derivations actually elicited from a supposedly (but actually dubiously) shared set of constructs.

The second is the social application. This may be thought of in two ways: the common form of heterarchies reflecting different constructs, and the common constructs reflecting different heterarchical forms.

Consider two heterarchies of identical form, but generated from constructs that inhabit different universes—say the universes of mechanical springs and electronic oscillators (an example beloved of Pask). Here the forms of two heterarchies match, but the names of the constructs are different. However, the workings of both are so similar that they are analogous to each other and may both be considered as alternative physical versions of the one abstract heterarchy—viz. oscillator theory. This is a special case, for it may not always be possible to establish similarities between the constructs in different heterarchies with the same form. But it may be, and anyhow the form itself has something to tell us, as we will discover in the third application.

When the constructs are held in common, in name at least, the difference in the form of the individual heterarchies shows up different points-of-view. As such, each heterarchy shows an individual compilation of knowledge. These may be thought of on individual realizations of an Entailment Mesh (Pask, Scott & Kallikourdis, 1973; Pask, Kallikourdis & Scott, 1975; Pask, 1975), that is as Entailment Structures, and their relatedness may be computed by considering each heterarchy as a different unfoldment of a category, (e.g. Ginali & Goguen, 1977; Open University Course Team, 1976, and also Leach, 1980). Being able to look at a collection of such construct heterarchies can also help determine the underlying assumptions made by several individuals and hence of what are conventionally thought of as their semantic networks (e.g. Katz & Fodor, 1963; Winograd, 1972). This is obviously valuable when, for instance, there are irreconsilable differences, beyond negotiation, in industrial disputes, although any similar heterarchy generating technique could be used. The particular advantage of the technique presented here is that the initial sharpness is not lost, and the heterarchy generation is personal.

The comparison of construct derivations has, however, another social application when a collection of these heterarchies is used together. Consider, for a moment, how several textbooks of some common subject differ. It is not that the things-to-be-learned are particularly different (although there may be some differences in terminology and certain fringe topics may not be universally included): rather, it is their precise interconnection and logical development. We normally refer to this as "difference in perspective". There is nothing inherently right or wrong in any of these arrangements: they are potentially valid alternatives, and may, of course, be set up as such, allowing each individual learner to follow whatever bit of whichever argument he finds more appealing.

For some years Pask has used such alternative structurings of fields of knowledge, which are called "Entailment Structures" and are particularized versions of rather more general (and circular) "Entailment Meshes". The problem, however, with this technique is that a researcher has to extract the argument from several textbooks, and the learner cannot modify this arrangment. The technique given here allows a far simpler way of sharing the alternative arguments—that is, of course, of showing alternative construct generation and derivation heterarchies. That such alternatives are useful, Pask has shown. Imagine, for instance, trying to compose a manual on how an internal combustion engine works: the complexity of construct connectivity is considerable and to trim this to fit one overview is thoroughly risky because the particular way one person does it may be virtually incomprehensible for another, (Fig. 7).

The third application is rather more arbitrary. It appears to be the case, but the only reason I can give for it being so is purely speculative.

If personal heterarchies are examined, they appear to demonstrate characteristics of each person's learning ability. Take, for instance, the examples shown. To me, as the teacher of the students who produced them, they reflect precisely the problems I noticed each suffering in trying to execute an architectural project, as shown in the captions to Fig. 8. Such a judgement is, of course, quite subjective but I am not certain how that limitation can be overcome—or even whether it should be.

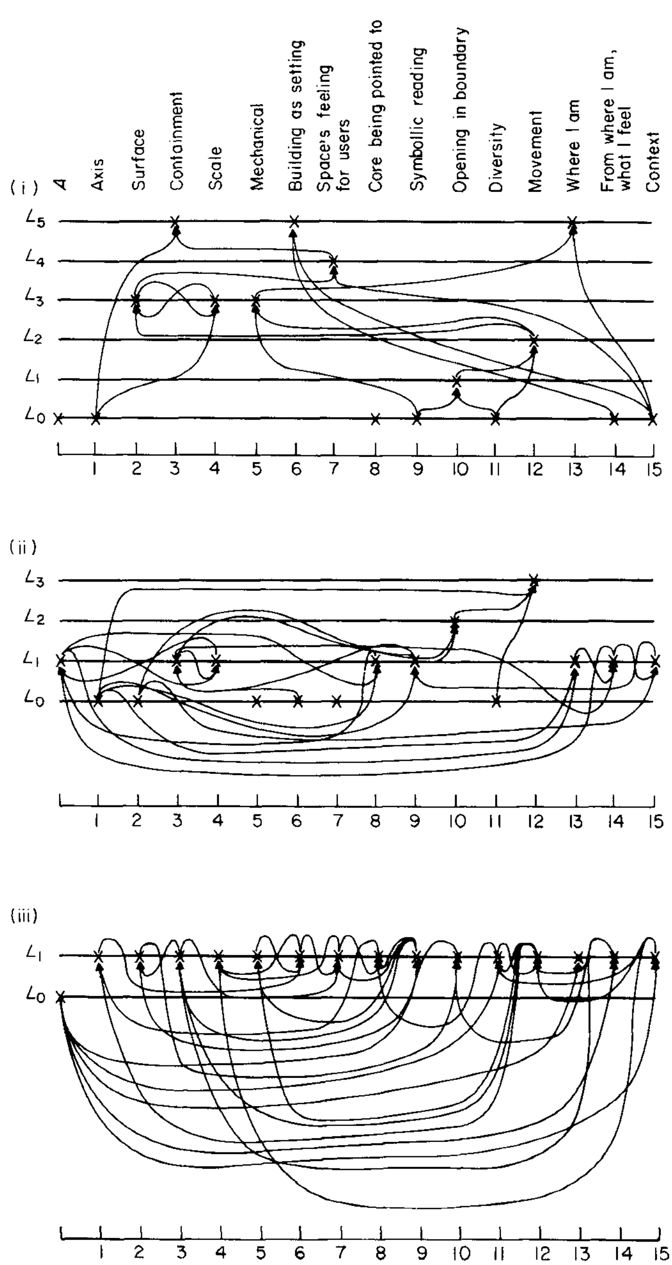

FIG. 8. Three heterarchies of a common subject matter generated by architecture students. Note the considerable difference in form, and the manner in which the reflect learning abilities.

(i) This student's learning was characterized by being relatively straightforward, but had the weakness of trying to please too many people at once.

(ii) This student started well, but, at a point in the middle of a project would get confused and overcomplicate things. If this stage was passed, there was a happy outcome and a good project.

(iii) This student could never get beyond the stage of having an idea and going away to consider it, as a result of which many objections were found, and some other idea would be grasped at. The student did not complete the course.

My explanation of why these heterarchies might reflect learning ability is that, where there are many constructs double-bound, there is a problem of having too much to handle at once (along the lines of Miller's (1956) argument on short-term memory and informative processing), or alternatively, of having to invent sub-constructs which split the double-bind; and that, where there are too many top points in the heterarchy the student is involved in a too-distributed set of goals which is, again, informationally unmanageable. Of course, the extra ordinary student for whom everything is interconnected (Fig. 8(iii)) has a problem very akin to the (as yet fictitious) one for whom none are connected—where do you begin and what connection do you follow—a terrifying problem when looked at in this manner.

Practice

So far, in practice, this technique has been used on four different occasions.

The first occasion, for which the technique was invented, was the analysis of a study syllabus for an architecture course in which the experimenter selected important terms from an international manifesto prepared by the teaching staff, and invited both students and staff to demonstrate their heterarchies. In fact, this was found to be very difficult, because the anagram circle technique had not been incorporated, and the need for construct generation by construct interaction was found to be hard to understand and even harder to remember in use. Furthermore, it was found that selection by each individual from the experimenter's initial selection of the terms that were significant to each of them meant that not only were the heterarchies difficult to extract, they were also consituted of such different terms that about the only thing which could be said of them was that each participant had a unique and distinct interest.

For the second occasion, the names of the constructs were much more rigorously determined by the group (Glanville, Jackson & Pedretti, 1979). Furthermore, the anagram technique had become incorporated. As a consequence, it was much easier to derive and compare the heterarchies. It was on this occasion that the reflection of learning became apparent, and this paper has been illustrated mainly with examples taken from this use.

The third occasion was Pask's use where, from several heterarchies, he does indeed build up entailment meshes, and persuades participants to debate the relevant validity and generalizability of their various heterarchies.

Finally, the technique has been used to generate a symposium syllabus by using the heterarchies that various participants at an earlier symposium (on self-reference) made of a collection of already debated named constructs.

On all occasions except, perhaps, the first, the technique has been found useful and rewarding.

Conclusion

This paper has presented a technique for deriving individual construct heterarchies, and for comparing several such without loss of sharpness in the initial act of construing, and has explained uses—both potential and in practice. The technique has been related to Kelly's Personal Construct Theory, and some of its limitations and implications for that Theory explained.

Kathryn Findlay first required the invention of this technique. Heinz von Foerster suggested the anagram form.

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