

Hum. Dev. 22: 217–224 (1979)

On Necessary and Specific Capabilities in Evolution and Development

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Key Words. Cognitive development · Cognitive processes · Developmental psychology · Language · Language development · Psycholinguistics · Theory of evolution

Abstract. An argument is presented showing that the postulation of psychological capabilities that are jointly necessary to and specific to other capabilities involves strong theoretical commitments that have not generally been recognized. The argument is first developed in terms of examples drawn from language development and evolution. It is then generalized beyond language and, further, shown to apply to acquired capabilities as well as to innate capabilities. The discussion presents a particularly strong example of the interdependence among general psychology and the developmental-evolutionary perspectives.

‘A ... view, that has been typical of much of current psycholinguistics, is that the mechanisms of language learning are largely species-specific and task-specific ...’

(*Fodor et al.*, 1974).

As indicated in the above quotation, concern for the possibility that there exist psychological capabilities that are specific to the task of developing language has been widespread. This has, perhaps, been a part of the revolt against the claims of generality for the laws of learning: principles of learning that are specific to language development are tautologically not general laws of learning. Not as explicit but, nevertheless, strongly implicit in this concern is an assumption of the task-necessity of these task-specific capabilities. This also is evidenced in the above quotation: the mechanisms of language learning are clearly necessary to language development. As task-specific learning capabilities would be counter examples to the generality of the laws of learning, so would task-necessary learning capabilities be counter examples to the explanatory adequacy of the classical laws of learning.

The basic logical structure in this example which I wish to examine is the postulation of a psychological capability (e.g., the mechanisms of language learning) which is both necessary and specific to some other psychological capability (e.g., the development of language). It seems likely that task-necessary capabilities and task-specific capabilities do exist, and even that some of them may be associated with language, but the postulation of capabilities that are jointly necessary and specific encounters certain logical constraints on the potential origins of such capabilities that do not appear to have been explicitly addressed. In the language development example, the postulated necessary and specific capability is presumed to be innate, a product of evolution, so the constraints on potential origins become constraints on the potential biological evolution of such capabilities. In other examples, the necessary and specific capabilities may be presumed to be products of individual development, in which case the constraints on origins become constraints on that development. I will develop the basic argument first in terms of innate capabilities, with language as the primary example, and then indicate how it generalizes to the case of developmental origins.

The Problem

Consider first a task-necessary, but not task-specific, capability. An example would be general cognitive capabilities that are necessary to language development, but not specific to it. Such capabilities can evolve with respect to their more general task manifestations (general problem solving, perhaps) and, once evolved, are available for other tasks for which they may be necessary (e.g., language). Conversely, consider a task-specific, but not task-necessary, capability. An example might be certain articulatory refinements which are specific to language but not necessary to it. In these cases, the general task capability (language) will, in general, evolve prior to the task-specific capability (articulation refinement) and will itself provide the selection pressure that results in that specific capability. That is, language will itself provide the selection pressures for the evolution of language-specific refinements.

A capability that is jointly task-necessary and task-specific, however, on the one hand, would seem to have no alternative task environments within which it can evolve (it is specific to one) and, on the other hand, it cannot evolve within the general task environment to which it is specific because it must exist prior to that environment (it is necessary to it). Thus, jointly necessary and specific capabilities would seem to have no framework within which selection pressures could

bring about their evolution. It is the exploration of this problem that yields the constraints on the potential origins of necessary and specific capabilities.

The Argument

One logical possibility for the evolutionary emergence of jointly task-specific and task-necessary capabilities is that they spring into being simultaneously with the general task capability for which they are necessary and specific. If both emerge instantaneously and simultaneously, by coincident mutation, say, then the problems of frameworks for selection pressures do not occur. The difficulty with this all-at-once, or saltatory, evolutionary model is that, although it is certainly a logical possibility, its material possibility is flatly contradicted by the theory of evolution. It requires the assumption of what *Mayr* (1970) calls bean bag genetics, in which each gene is assumed to have an independent fitness characteristic, and thus in which new phenotypic capabilities can emerge simply by the (mutational) insertion of a new bean (gene) in the bag (genotype). Bean bag genetics is false. Evolution is always and inevitably gradual. Furthermore, in the case under consideration, even if we granted the possibility of saltatory evolution, a necessary and specific capability still requires the *simultaneous* saltatory emergence of both the general capability and of its necessary and specific foundation: a vanishingly unlikely occurrence.

Lenneberg (1967) gives some indication of having recognized this difficulty with respect to language (though it is not entirely clear just what difficulties he is referring to), but he then simply dismisses it as outside his area of concern. In the construction of a model, it is certainly legitimate, within reason, to leave delineated empirical problems for later resolution, or for resolution within a different field, but this is so only when those problems concern empirical specification within general areas of possibility. If the problem is that the proposed model is flatly contradicted as impossible by established theory, then that contradiction must be explicitly addressed and either the model or the theory must be modified or rejected accordingly: the fact of the contradiction cannot legitimately be simply abandoned. It is clear at this point that the postulation of jointly necessary and specific capabilities encounters difficulties that similarly cannot be simply ignored.

A set of possibilities for the evolutionary origin of jointly necessary and specific capabilities can be derived from the realization that a task-specific and task-necessary capability need not have been specific to the given task in the evolutionary past. That is, it could have been first necessary and only later

become specific (clearly it could not be first specific and later become necessary: a necessary capability must exist prior to that to which it is necessary). This, of course, entails that the particular necessary and specific capability was once manifested in general task capabilities in which it is no longer manifested (it is now specific to one), and the question arises of what happened to those alternative task manifestations. Exploration of this question yields four possibilities, two of which encounter their own unlikelihoods, and two of which provide the basic potentialities for the origin of jointly necessary and specific capabilities.

There are two basic possibilities concerning what might have happened to such alternative task manifestations: (a) the alternatives may have simply died out, or (b) they may have evolved into new task capabilities. Their dying out is both a logical and a theoretical possibility, a possibility that must be considered with regard to purported necessary and specific capabilities. But such evolutionary disappearance (as opposed to transformation) is not common, and this cannot be considered a strong likelihood. If, on the other hand, the alternatives have evolved into new general task capabilities, then a still further pair of possibilities arises: the alternatives either no longer use the particular necessary and specific capability of interest, or they still do use it. No longer using it is another possible but unlikely case of evolutionary disappearance. The second possibility, however, yields a very interesting implication: if the alternative general task capabilities have evolved into new general task capabilities that still use the particular necessary-and-specific capability, then those 'alternatives' must have evolved into the current general task capability of interest, i.e., the alternative(s) must have been precursors to the current general capability, because the particular capability is now specific to that single current general capability. There are no other current 'alternatives' for the old alternatives to have evolved into. This general case of precursors gives rise to the most likely and most interesting possibilities for the origins of task-necessary and task-specific capabilities.

There are two fundamentally different ways in which evolution out of precursors can yield task-specific task-necessary capabilities. One involves a basically material relationship between particular and general capabilities, while the other involves a basically logical relationship between them. The first possibility is that the general precursor serves as the context within which the particular capability evolves, which, in turn, then serves as the context within which the precursor undergoes an evolutionary transformation into the current general capability. Thus, the particular capability, once evolved, would be

specific, but not necessary, to the general precursor, but could be both necessary and specific to the general capability derived from that precursor. With respect to language, for example, it is conceivable (though not necessarily plausible) that some protolanguage consisting entirely of undifferentiated sentence-sounds (call sounds) might have led to the evolution of the ability to produce and process auditorily composite signals (perhaps in order to deal with strings of 'sentences'). This auditory-composite ability, in turn, might have served as the foundation for the evolution of the ability to produce and process messages composed of meaningful subunits (words). The auditory pattern recognition capability would, in this case, be necessary and specific to the meaning pattern recognition capability.

The second possibility for the evolution of task-specific task-necessary capabilities out of precursors begins as in the preceding case, but then involves a notable difference. As before, the general precursor serves as the context for the evolution of the particular ability. But the emergence of the particular capability, instead of providing the context for the evolutionary transformation of the general precursor into its current form, as in the first case, now *constitutes* that transformation of the general precursor into the current general capability. That is, the difference between the current general capability and its precursor is precisely that the current form uses the particular capability while the precursor did not. With respect to language, it might be claimed, for example, that some protolanguage served as the context within which duality of patterning evolved, and that duality of patterning constitutes the difference between protolanguage and language (*Hockett, 1973*).

This second possibility is fundamentally different from the first in that the necessity of the particular capability for the general capability is material or functional in the first case and logical in the second. That is, in the first case, the particular capability is materially necessary to the functioning of the general capability, while in the second case, the particular capability is definitionally a part of, or logically implied by, the general capability: the relationship is one of logical necessity, not just material necessity. In the example given, the duality of patterning is trivially a necessary part of the definition of language but, in principle, such a logically necessary connection could involve deep and nonobvious logical theorems: if we had independent definitions of the particular and the general capabilities, it might be not at all apparent that there was a relationship of logical necessity between them.

Thus, the postulation of innate jointly task-necessary and task-specific capabilities makes an indirect commitment either to a very particular pattern of

evolution out of precursors, or to an equally particular logical implication (or to one of two unlikely additional alternatives involving evolutionary disappearance). The evolutionary pattern possibility involves theoretical and factual claims which require defense, and the logical implication possibility similarly involves logical claims which require defense. Furthermore, those defenses must take special care regarding not only the possibility of the model being simply wrong, as might be expected, but also regarding the possibility of having confused one case for another. For example, there is the risk of an inadvertent and circular definitional connection between specific and general capabilities, when an empirical evolutionary connection or a deeper logical connection was intended. There is also the interesting possibility of an intended evolutionary connection when a deep and unnoticed logical connection is, in fact, the case. In any case, it is clear that the postulation of innate necessary and specific capabilities involves stronger commitments than has generally been recognized. At a minimum, it would seem to be incumbent on any such model to give at least some indication of what the precursor might be with respect to which the necessary and specific capability evolved, e.g., what could the precursor context be within which purported language-necessary and language-specific mechanisms of learning might have evolved?

Other Examples from Evolution

The case of innate necessary and specific capabilities has been illustrated with respect to language, primarily because that is the area in which the clearest claims of necessity and specificity seem to have been made. The argument, however, applies generally. Furthermore, it applies as well when the commitments to necessity and specificity are unintended and implicit as when they are explicit. For example, models of number development commonly postulate some presumably innate foundation, e.g., subitizing, or primitive counting (*Klahr and Wallace, 1976*), which might reasonably be considered to be not only necessary but also specific to number development. In the light of the preceding argument, it is, therefore, reasonable to ask of such models either that they indicate in what way such foundations are *not* specific to number development, or to acknowledge such specificity and give some indication of what the precursor context-of-evolution might be. The question, of course, can be asked concerning any postulated innate necessary foundation for any kind of development: the development of role taking, empathy, moral development, and so on.

One interesting focus for the question is the underlying capability which makes possible movement from one developmental stage to the next, e.g., reflective abstraction (*Beth and Piaget*, 1966): it is clearly necessary, but is it specific; if not, in what way; if so, what is its precursor context-of-evolution?

Extension to Development

The argument, thus, applies to any potential innate necessary and specific capability. The basic form of the argument, however, applies even more generally: if certain reasonable assumptions are accepted, it applies equally to noninnate, developed or learned, necessary and specific capabilities as well. That is, it applies to *any* necessary and specific capability. The form of the argument requires only one assumption: the emergence of a capability, whether phylogenetically or ontogenetically, is an adaptive construction based upon, and within the context of, already existing capabilities. From this assumption, the extreme unlikelihood of the simultaneously saltatory emergence of the particular and the general capabilities, and the unlikelihood of evolutionary or developmental disappearances, both follow. And, given those unlikelihoods, the argument follows. Such an assumption of adaptive constructionism is intrinsic to the theory of evolution; that assumption has been introduced into psychology most forcefully by *Piaget* (e.g., 1971), and now forms part of the implicit background perspective for many psychologists. Even the operant concept of 'shaping', however, would seem to presuppose the gradualism and contextualism upon which the argument depends. Thus, the basic argument is not restricted to the evolution of innate capabilities: it would seem to hold across broad ranges of approach to learning and development as well. (The one exception to the argument, and an important one whose possibility must be taken into account, is teleological action, which is quite capable of yielding both saltatory emergence and disappearance.)

The generalization of the argument from innate to acquired capabilities yields a corresponding new range of potential examples. It also implies that the basic questions to which the argument gives rise can be legitimately asked even if the model under consideration makes no commitment whatsoever regarding the innate-acquired distinction. Thus, if it is proposed that some particular cognition or cognitive ability is necessary to a certain emotion, we might ask if that necessity is material or logical; we might also ask if that cognition or ability is specific to that emotion; if not, in what way not; if so, what could the precursor context-of-origin for that cognition or ability be? Related patterns of questions

could be asked concerning postulated relationships between particular cognitive representational capabilities and particular problem-solving capabilities, or between competence motivation and competence-acquiring activities, between particular forms of irrationalism and corresponding psychopathologies, and so on. In some cases, the answers to the questions will seem obvious; in others, not at all obvious. One interesting possibility is that examination will show that the issues under consideration are not 'capabilities' at all, and thus may be outside the purview of the argument: for example, we seem to want to dub every possible developmental and behavioral tendency as some kind of a motive, when alternative models are available and sometimes quite plausible. In any case, the questions are important and seldom asked.

In general, then, the postulation of jointly necessary and specific capabilities involves stronger commitments and encounters deeper questions than has generally been recognized. Furthermore, the postulation of a capability as either necessary or specific might well repay attention to the possibility that it is also the other, and, thus, that it encounters the commitments and questions appropriate to the jointly necessary and specific case. Also, any purported necessary capability might be questioned as to whether that necessity is functional or logical in nature. Lastly, and most generally, the above discussion is simply a particular example of the interdependence among general psychology and the developmental-evolutionary perspectives: any proposal that something is a certain way must ultimately face the question of how it could possibly have come to be that way.

References

- Beth, E.W. and Piaget, J.: *Mathematical epistemology and psychology* (Reidel, Dordrecht 1966).
- Fodor, J.A.; Bever, T.G., and Garrett, M.F.: *The psychology of language*, p. 436 (McGraw Hill, New York 1974).
- Hockett, C.F.: *Man's place in nature* (McGraw Hill, New York 1973).
- Klahr, D. and Wallace, J.G.: *Cognitive development: an information processing view* (Wiley, New York 1976).
- Lenneberg, E.H.: *Biological foundations of language*, p. 374 (Wiley, New York 1967).
- Mayr, E.: *Populations, species, and evolution*, pp. 162, 366 (Harvard University press, Cambridge, Mass. 1970).
- Piaget, J.: *Biology and knowledge* (University of Chicago Press, Chicago 1971).

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