

Early Verbal Developmental History and Equivalence Relations

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ABSTRACT

Young children demonstrate the derivation of equivalence relations after only a brief training history. Although a number of theories have proposed possible variables that give rise to these effects, the role of the child's preverbal learning history has not been fully addressed. The present paper describes some perceptual skills that may be important for the later emergence of derived performances. Specifically, a distinction is offered between nonverbal and verbal perceptual discriminations. The relationship between these skills is discussed as is the role of receptive language in their development. This account suggests that explicit histories that establish generalized verbal perceptual skills are necessary for the emergence of equivalence. According to this account, equivalence is defined as a by-product of practices within the verbal community, and not as a basic stimulus function.

RESUMEN

Se ha demostrado que niños de corta edad muestran derivación de relaciones de equivalencia tras una historia breve de entrenamiento. Aunque se han propuesto varias teorías para dar razón de tales efectos de derivación, el papel que puede jugar la historia preverbal del niño no ha sido apenas estudiado. El artículo actual describe algunas habilidades verbales que pueden ser importante para la emergencia posterior de ejecuciones derivadas. Específicamente, se ofrece una distinción entre las discriminaciones perceptuales verbales y no verbales. La relación entre estas habilidades es discutida al igual que lo es el papel del lenguaje receptivo en su desarrollo. Esta explicación sugiere que se requerirían historias explícitas que establecen habilidades perceptuales verbales generalizadas de modo que se llegue a producir la emergencia de la equivalencia. Según esta explicación, la equivalencia se define como un subproducto de las prácticas de la comunidad verbal, y no como una función básica de los estímulos.

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The emergence of novel behavior that has not been directly reinforced has received

much attention in the experimental analysis of human and nonhuman behavior in the last twenty years (Epstein, 1985; Epstein, Lanza, & Skinner, 1981; Hayes, 1989; Hayes, Barnes-Holmes, & Roche, 2001; Luciano, 1991; Sidman, 1994; Zentall & Smeets, 1996). Several theories have attempted to account for the emergence of novel or derived behavior in the absence of contact with contingencies of reinforcement (Hayes, Gifford, & Wilson, 1996; Horne & Lowe, 1996; Sidman, 1994). A number of researchers have argued that derived equivalence responding, for example, is an important feature of complex human behavior. This claim is supported by well-established difficulties in demonstrating equivalence in nonhuman organisms and in very young babies (Boolens, 1994; Dugdale & Lowe, 2000; Hayes, 1989; Horne & Lowe, 1996, 1997; Saunders, Williams & Spradlin, 1996; Schusterman & Kastak, 1993). Some researchers have even suggested that the ability to derive novel stimulus relations, equivalent or otherwise, and the behavioral functions afforded by these derived relations, may form the basis of complex behavior itself (Hayes et al, 2001).

A range of complex derived performances have been observed, analyzed and manipulated, all primarily with verbally-sophisticated subjects (e.g., Dymond & Barnes, 1995; 1996; Steele & Hayes, 1991). Only a limited number of articles, however, have focused on the types of history that are necessary or useful for establishing derived performances, such as equivalence (Augustson & Dougher, 1992; Devany, Hayes, & Nelson, 1986, Lipkens, Hayes, & Hayes, 1993; Rehfeldt & Hayes, 1998). This shortfall is surprising given that the development of novel performances has important implications for intervention programs for populations whose complex behavioral development does not follow a normal course (Barnes-Holmes, Barnes-Holmes, & Cullinan, 2001; Eikeseth & Smith, 1992; Luciano, Barnes-Holmes & Barnes-Holmes, 2000, Sidman, 1971).

The current paper proposes a number of prerequisite skills that may facilitate the subsequent development of derived complex performances such as equivalence responding. First, we review very briefly the phenomenon of equivalence (for a more exhaustive account of equivalence see Sidman, 1994), and then describe some behavioral or verbal processes that appear to underlie the formation of equivalence classes. Specifically, we suggest a functional distinction between types of early perceptual discriminations in terms of non-arbitrary or non-verbal perceptual discriminations and arbitrary or verbal perceptual discriminations (e.g., pointing to a red object, because "red" is arbitrarily related to a particular wavelength of light). These processes are referred to as perceptual learning and perceptual-receptive relational learning, respectively, based on the relational or verbal nature of the latter perceptual skills. Furthermore, we suggest that both of these processes might usefully be approached as operant behavior. We then focus on the relationship between these perceptual repertoires, and the learning history involved during the first two years of development. We argue that a history involving both of these perceptual abilities is important for the later development of derived equivalence performances. Finally, we suggest that the absence of this type of history may account for nonhuman failures to demonstrate equivalence, and in part for variations observed in human equivalence performances.

BASIC ACCOUNTS OF EQUIVALENCE

Equivalence responding is readily observed with matching-to-sample preparations and may be summarized as follows. Suppose, for instance, that reinforcement is provided for selecting comparison stimulus B1 as opposed to B2 in the presence of the sample stimulus A1, and for selecting C1 and not C2 in the presence of B1 as a sample. Most verbally able humans learn these conditional discriminations with ease, and in addition they readily demonstrate a series of novel or derived relations between the sample and comparison stimuli. Specifically, symmetrical, transitive and equivalence relations are said to emerge. For example, subjects will select A1 in the presence of B1 and B1 in the presence of C1 (symmetrical relations). They will also select C1 in the presence of A1 (a transitive relation) and A1 in the presence of C1 (an equivalence relation). Similar emergent performances have also been recorded with other experimental preparations, such as respondent training procedures (Leader, Barnes & Smeets, 1996). While there is some variability in human performances across methodologies (e.g., Pilgrim & Galizio, 2000), there is an abundance of data confirming these effects.

Many researchers, however, have encountered difficulties in attempting to establish equivalence responding in nonhuman organisms (see below) and in very young babies (Augustson & Dougher, 1992; Green, 1990; Lipkens, Hayes & Hayes, 1993;). In conditions that commonly give rise to equivalence with human subjects, nonhumans have repeatedly failed to produce unequivocal evidence of equivalence (Dugdale & Lowe, 2000; McIntire, Cleary & Thompson, 1987; Schusterman & Kastak, 1993; Yamamoto & Asano, 1995). Symmetrical responding has been observed in human infants as young as 16 and 15 months and equivalence was recorded with an infant aged 24 months and close to 19 months, respectively in Lipkens, Hayes, & Hayes (1993) and Luciano, Gómez-Becerra & Rodríguez (2001). No studies, however, have reported equivalence or other types of derived stimulus relations in children of a younger age.

Different theories have been formulated to account for the phenomenon of stimulus equivalence. Sidman (1994; 2000) argued that equivalence may be a fundamental and primitive behavioral process that is generated by contingencies and is not reducible to other well-established behavioral processes. According to this view, the development of language may depend on the emergence of equivalence relations. Horne and Lowe (1996) offered a different account of the relationship between language and equivalence in terms of Naming Theory, according to which, equivalence depends upon the emergence of naming. Once a child has learned to name objects and events in the world, and this can be applied arbitrarily to almost any stimulus, this naming process is then said to mediate equivalence performances, by way of intraverbal or common naming strategies. Another account that has addressed the relationship between language and equivalence has been proposed by Hayes and Hayes (1989) and Hayes (1991) in the form of Relational Frame Theory. From this perspective, equivalence responding is only one example of arbitrarily applicable relational responding (other examples include responding in accordance with more-than, less-than and opposite) which is the core process in language and cognition. According to Relational Frame Theory, humans learn these patterns of relational responding at an early age in the course of interactions with the verbal community and with an appropriate history of exemplar training, these relational

skills are sufficiently abstracted so as to be arbitrarily applied to any stimuli.

Clayton and Hayes (1999) presented a respondent conditioning analysis of equivalence based on L. Hayes' previous work (1992; 1996). These authors suggested that respondent conditioning might be a possibly useful direction for future research on stimulus equivalence because it involves the substitution of stimulus functions. With this procedure the functions of one stimulus may come under the control of another stimulus when the stimuli in question are simply spatially and temporally related. In this way, stimulus pairings that have not previously occurred together can be readily accounted for.

McIlvane, Dube and Serna (2001) proposed another account of equivalence that explicitly addresses the variability observed with derived human performances, especially those with developmental delay. According to Stimulus Control Topography Coherence Theory, unexplained variability in equivalence performances can be accounted for in terms of a lack of coherence between the stimulus control topographies specified by the experimenter and those actually generated by the contingencies. According to this account, increasing the coherence between these stimulus control topographies will facilitate the desired equivalence performances (see Carr, Wilkinson, Blackman & McIlvane, 2000).

Although the relative merits of the various theories that attempt to account for equivalence is beyond the scope of the current paper, the most useful account from this perspective is likely to be the one that can reliably provide prediction and influence over the emergence of equivalence at a very young age, and account for variability in later equivalence performances by specifying the relevant history that gives rise to these effects. We shall revisit this issue later.

DIFFERENTIATING EARLY PERCEPTUAL DISCRIMINATIONS

The aim of the current paper is to attempt to describe features of a child's normal history that are relevant to the development of successful equivalence performances, as commonly observed. The present thesis proposes that there are two key perceptual discrimination skills that precede and/or facilitate complex derived performances such as equivalence. For current purposes, these skills are referred to as (i) *non-arbitrary* or non-verbal perceptual discriminations, and (ii) *arbitrary* or verbal perceptual discriminations, because of their foundation in receptive language and their qualities as relational responses.

Nonverbal perceptual learning occurs in the child's earliest interactions with the physical environment (e.g., looking at, moving in, touching, hearing, smelling etc.) and involves functional relations between the organism and the environment, as established by the reinforcement contingencies. Examples of non-arbitrary perceptual discriminations include the child approaching the location in which toys have been found previously or placing wooden pieces into holes when this has neither been socially reinforced nor observed in others previously. Arbitrary or verbal perceptual learning, on the other hand, involves responding appropriately to relations within the environment as dictated by a speaker. This type of verbal control over perceptual discriminations begins to a

large extent during the onset of receptive language, when the child first becomes a listener. Examples of verbal receptive perceptual learning include trained object-word and derived word-object relations, which Lipkens et al. (1993) demonstrated in the absence of an appropriate tacting repertoire. Verbal perceptual discriminations of this kind probably establish partitioning of a stimulus into parts or salient features, as specified along formal or non-arbitrary dimensions (i.e., in terms of size, color, amount of, etc.) (Kozloff, 1974; Lovaas, 1990). These features become functionally equivalent with the whole stimulus and the child can respond appropriately to the stimulus as a whole (i.e., the sum of the parts) or in terms of the relevant formal feature. For illustrative purposes, consider the following example. Children can respond to the same object even when it is presented in different forms, for example, when directly trained to respond to an orange, they can subsequently respond to a whole orange, an orange segment, orange juice, a picture of an orange or even the smell of an orange. When this type of training is conducted across many exemplars, as is the case in normal development, a repertoire emerges which enables the child to respond with functional equivalence to a stimulus and its parts or features when presented in many different contexts. This is, of course, not unlike the type of derived performance commonly observed with experimental preparations used in equivalence testing.

These last perceptual discriminations are probably unique in a verbal environment composed by many objects and activities culturally given or provided by the verbal constructions- as well as composed by the direct verbal behavior of parents. Hence, we will focus in the preverbal history of responding to parts and the whole with functional equivalence in a verbal context. The argument we sustained is that this verbal abilities are developed through many instances in the verbal world the child is living and it happened before the child of short age contacts the experimental preparations which then actualized such discriminations providing the basis for equivalence to emerge. The argument goes to verbal activities prior to naming occurs but which are not present in non-human organisms even those who has received systematic training (see for example, Dudgale & Lowe, 2000).

WHAT IS CONFRONTING THE CHILD IN THE EXPERIMENTAL

A number of experimental procedures (i.e., matching-to sample or respondent conditioning) involve the partitioning of stimulus compounds, such that the subject is required to discriminate a given stimulus as a whole or as a part. Both non-arbitrary and arbitrary relations have been studied in this context. Consider for example, a matching-to-sample trial in which pairing stimulus A with stimulus B is sometimes reinforced in the presence of stimulus C. On other occasions, however, pairing A with C is reinforced in the presence of stimulus D. In training of this kind subjects learn quickly, through differential reinforcement, to respond differently to compounds that have particular stimuli in common. Consider also a trial in a respondent training procedure, in which reinforcement is provided for responding to AB as a stimulus compound and for responding to A when presented as part of another compound (e.g., AB). Moreover, during similar

training, A may be compounded with other stimuli (e.g., when a different function is attached to the stimulus), and the spatial positions of the stimuli are no longer relevant. In this case stimuli B and A may become equivalent as parts of a compound (for example, Stromer, McIlvane & Serna, 1993). Repeated exposures and reinforcement to stimulus combinations such as AB and AC train the organism to respond differently to several parts of the compound, as to differentiate AB from A, while also training the organism to respond equally to AB as to A or to BC as to B, depending on the context. Research on stimulus compounds has demonstrated that compounds function by having separable but substitutable elements (Stromer, McIlvane & Serna, 1993) that allow one stimulus to acquire the functions of another stimulus (Rehfeldt & Hayes, 1998). For example, a function attached to A may also be attached to B and a subject will behave similarly to both stimuli. This type of partitioning and functional equivalence are features of everyday verbal interactions with infants during the first early years, and may serve to prepare children to respond subsequently to experimental procedures which are analogous to this early history.

Given that the world is, in part, a cultural construction and that important perceptual discriminations occur at a very early age through contact with social contingencies provided by adults, it might be the case that perceptual discriminations of a whole stimulus and its parts may become more complex when verbal cues provide the context. On entering an equivalence preparation, therefore, the child's repertoire is full of many instances of perceptual discriminations under verbal control, and the experimental preparation simply actualizes these functions. It is to these early perceptual discriminations that we now turn.

EXAMPLES OF EARLY PERCEPTUAL DISCRIMINATIONS AND VERBAL CONTROL

According to Kantor, a child does not make fine perceptual discriminations in the very early years. More specifically, Clayton and Hayes (1999) suggested that the development of sensory input allows the child to organize the world by initially fusing a stimulus into "a single undivided object", and then enabling its individual parts to become discriminated. Most of the infant's earliest reactions are biological in nature, and many of these are probably similar to the biological reactions of nonhuman organisms. Consider, for instance, early relational performances. In the very early days a baby might respond to his/her mother's voice as a set of noises. The child then begins to respond to the mother's voice in the same way as if the mother is actually present. This ability emerges because of direct temporal and spatial relations with negative and/or positive reinforcing consequences.

The development of additional verbal processes, however, may subsequently allow the young child to respond to nonarbitrary relations, but in a verbal way. Indeed, on any single instance, it is difficult to clearly determine whether a child is responding nonverbally or verbally to nonarbitrary features of the environment. Proponents of Relational Frame Theory have employed the term 'pragmatic verbal analysis' to describe instances in which relational frames are nonarbitrarily applied. Consider the following excerpt from Barnes-Holmes, Hayes, Barnes-Holmes and Roche (in press):

“Two clear cups with milk are placed side by side. They are identical in shape but one is physically larger than the other. A child who is asked “which one has more?” points to the larger of the two cups. Although the pointing may look like a nonverbal event, we do not know if it is verbal or not. We would predict, for example, that a well-trained nonhuman with the relevant history with different sized objects and the nonarbitrary stimulus relation between these particular two objects, would be able to accomplish this type of task.

In terms of perceptual discriminations, pragmatic verbal analysis might involve, on certain occasions, responding to the whole as separate parts, while on other occasions, responding to the parts and the whole as functionally equivalent. For example, a child may learn to respond to the mother’s nose, mouth, eyes, and hands, while at the same time responding to the same features of another individual (e.g., daddy’s, sister’s or a doll’s nose, mouth, etc.) and these same features of the child him/her-self. At the same time, during the course of interactions with these individuals, the child learns to see the mother both as a whole (i.e., “mummy”) and as parts (i.e., her nose). For example, when the young child in the example above is presented with a puppet, and asked, “Where is the puppet’s nose?” he/she may now be able to respond appropriately.

Many exemplars of interactions such as these establish a context for verbal relational responding that will enable new response patterns to emerge in the presence of particular verbal. Furthermore, the child learns to abstract the salience of various parts or features in appropriate verbal contexts. During the course of these interactions, these responses come under the control of increasingly complex and subtle forms of contextual verbal control. In other words, the non-arbitrary features of the environment participate in equivalence and other types of relations (e.g., relations of coordination) and come under the control of increasingly subtle verbal cues.

During the early years there are many other occasions that require a child to interact with the environment in terms of partitioning or combining stimuli. Many of these early interactions involve receptive language, and require the child to point to, give, and look at, objects or actions in the context of particular verbal cues (e.g., “Look what mummy has” or “Look at bear’s mouth”...). This involves responding in a non-vocal way to different verbal and nonverbal stimuli. However, these receptive responses increasingly come under the control of verbal cues in novel environments. Furthermore, interactions such as these set the stage for what are initially non-arbitrary discriminations to participate in arbitrary relations (e.g., the naming of objects and actions).

For illustrative purposes, we will present four specific examples of common and increasingly complex interactions that establish partitions of the environment that are initially perceptual but which become increasingly verbal:

(1) A child’s mother or primary caregiver participates in a great many activities. As a consequence of contiguity and contingencies of reinforcement, her voice, her movements, her scent etc. all acquire the functions of this particular individual, in such a way that when the child subsequently hears “mommy” the perceptual functions of the mother are generated. For example, young children often look to or approach the door when the word “mommy” is presented. This process occurs with many other stimuli and as such the young child is exposed to a type of multiple exemplar training.

(2) A child sees the most frequent individuals such as mommy, daddy, sister or even a

favorite teddy bear conducting many activities in many contexts, and quickly learns to respond to these individuals as if they were functionally equivalent (i.e., mommy is always the same person, whether she is wearing different clothes or engaging in different activities).

(3) During early infancy, a child perceives his/her mother as a complete stimulus, but with regular interactions with this person, the whole stimulus becomes deconstructed into parts, depending on the context (e.g., “look at mommy’s nose and daddy’s nose”). As described above, abstraction of these perceptual discrimination skills will subsequently facilitate the child responding appropriately to the statement “show me the puppet’s nose”. Although this response involves a generalized perceptual discrimination of non-arbitrary features of the environment, it may also be a verbal response, because it participates in derived arbitrary verbal relations.

(4) Children learn to respond with functional equivalence to whole objects and parts of objects based on physical dimensions alone or when used in conjunction with verbal stimuli. For example, a child may group together jigsaw pieces based on non-arbitrary dimensions (e.g., color, touch, sound etc.). This skill begins prior to the onset of receptive language by way of reinforcing and modeling the matching response along non-arbitrary dimensions. Training of this kind may help the child to partition the environment along a range of non-arbitrary dimensions.

As described above, however, a child who is asked to match a teddy’s nose with a teddy or to point to the “red” pieces is responding to the environment verbally, and not entirely in terms of the formal stimulus dimensions. With verbal stimuli (e.g., “Match the things that go together”) the child learns to respond to the relation between the parts (i.e., the nose) and the whole (i.e., the teddy) such that in the presence of appropriate verbal cues, he/she can respond to stimuli as a part or a whole, even when the relation between these is not based on physical dimensions. Perhaps the best and simplest example of functional equivalence involves the relationship between words/names and objects. Simple naming facilitates responding to an object and its parts identically, and a form of symmetry emerges between the object and the part and vice versa, as well as between the name of the object, the object itself and parts thereof. When these relations between words, objects and object parts are practiced across numerous exemplars, the relational responses between these stimuli are likely to generalize. This bi-birectionality between word-object (and parts), and object-word applies both receptively (i.e., sound-object/object-sound) and expressively, and as such can be observed at a very young age. According to Relational Frame Theory, this bi-directionality is one of the core defining properties of verbal relations and verbal responses.

The type of relational responding described above must necessarily involve derivation. A child, for instance, may be asked to “put the big pieces of the puzzle together on one side and the small pieces on the other”, or to “pick up the bear that is bigger”. Responding in accordance with relations such as “bigger than” or “smaller than” (i.e., the relational frame of comparison), for example, is thereby abstracted across a number of exemplars and can be subsequently derived in novel environments, even in the absence of variations in physical dimensions. In early interactions, such as matching puzzles, the child’s responding may of course, have been directly trained but subsequent and more complex performances are likely to be increasingly derived, and thereby verbal in nature.

In summary, during the course of normal development, a child is exposed to many exemplars that give rise to perceptual receptive operants which enable the child to subsequently respond to a novel object as a part or a whole without explicit training. The child can then see and behave with respect to the world in many different ways. During the first two years of life, many non-arbitrary relations are quickly incorporated into verbal relations, and indeed it is difficult to determine which is occurring at any particular point in time. As the child becomes increasingly verbally skilled, it is likely that more verbal responding occurs, and more verbal cues are provided by significant others. This allows for greater perceptual-receptive responses to form classes or operants with derived or generalized properties. This history of partitioning, composing and relational responding to verbal cues occurs alongside and participates in the development of expressive language and comprehension.

ABSENCE OF THE RELEVANT LEARNING HISTORY

Retarded children often lack these preverbal histories and not surprisingly many subsequent repertoires of generalized or derived responding do not emerge. Indeed, many early language and cognitive training programs involve specific instruction in the types of activities and examples described above (Guess, Sailor & Baer, 1976; Kent, 1974; Kozloff, 1974; Lovaas, 1990). Programs such as these, however, are often designed to generate specific instances of behavior but are not designed specifically to establish derivation or generalization other than stimulus generalization (Luciano, 1996). In order for these interventions to be improved upon one suggestion might be to identify “keystone behaviors” during early child development. One such skill may be the type of perceptual/relational generalized operant described above. Establishing such a skill based on direct reinforcement of many exemplars would facilitate greater generalization in the absence of reinforcement and non-arbitrary stimulus variations. Future research might address the extent to which useful interventions may be developed from this account and might address the need to relevant analysis of the verbal repertory of children before and while contacting the experimental preparations.

A rich verbal environment will facilitate the development of verbal perceptual discriminations as operant behavior. In a normal verbal environment these activities occur very frequently and commence at a very early age. A child of one and a half years old, for example, has already learned many conditional discriminations in the context of receptive language. Simultaneously, the child has learned perceptual discriminations when dealing with the formal environment and formal stimulus dimensions. The differentiation of these skills, and the relative opportunities provided for engaging in these behaviors, is a gradient for subsequent derivation skills. It follows from this suggestion, therefore, that small children can come to demonstrate stimulus partition and substitution when exposed to only a brief history of conditional discrimination training, such as equivalence training. During an equivalence-type task, for example, a child may not see the stimulus AB as one stimulus but, may partition this stimulus into two parts (A and B). When A or B is subsequently presented alone, the child might

respond to them similarly, instead of responding in accordance with their positions, because the child has a long history in which the position of the stimuli has not been discriminated as relevant, and a long history of responding similarly to a whole and its parts. The child responds to parts of stimuli as functionally equivalent. The child might respond to parts or combinations of stimuli as equivalent, and then when presented with AB or BC, and when A is then presented in relation to C, the child might respond to C with the function of B. Of course, with verbally competent children other repertoires may also be involved in completing this task (e.g., naming or rule following). The differentiation of opportunities to engage in these types of nonverbal and verbal perceptual discriminations in the early years may also be a gradient for future derivation skills.

With such histories, only a relatively limited period of explicit training in conditional discriminations would be required for children to demonstrate equivalence. Indeed, derivation is almost inevitable, and a number of studies have demonstrated the difficulty in suppressing this behavior in the context of an equivalence-type task (e.g. with small children see the emergence of equivalence relations even against experimental direct contingencies in Valero, 1990, and Ybarra, Luciano and Gómez, in press, and with adults in Gómez, Barnes-Holmes and Luciano, 2001).

CONCLUSIONS

In the current paper, we attempted to argue that derived relational performances emerge, at least in part, from early perceptual discriminations, which become increasingly verbal in the context of receptive and then expressive language. It was also suggested, therefore, that individuals with such a rich verbal perceptual history demonstrate derived performances, such as equivalence with minimal training. This account differs from other interpretations of equivalence as a biological given or as a by-product of the development of expressive naming skills. The interpretation offered in the current article is in agreement with L. Hayes (1992,1996), who emphasizes substitutional stimulus functions but the current thesis adds to Hayes' account by describing the early verbal interactions that may give rise to functional substitution. The current analysis is also in agreement with Relational Frame Theory which emphasizes the importance of abstracted or derived relational skills as generalized operant behavior, as well as the importance of a history of multiple exemplars in establishing such skills. This interpretation, overall, emphasizes the importance of the early learning history in the subsequent development of complex cognitive skills.

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