A profound disparity revisited: Perception and judgment of abstract identity relations by chimpanzees, human infants, and monkeys

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Abstract

We review the evidence for three important disparities involving the perception and judgment of identity relations by human and nonhuman primates. First, only humans beyond infancy and adult chimpanzees (Pan troglodytes) with a history of language or token training can explicitly judge relations (same or different) between relations (identity and nonidentity) in a matching-to-sample (MTS) task. Second, both human and chimpanzee infants perceive relational similarity as measured in preference-for-novelty tasks. The human and chimpanzee infants, however, do not express this tacit knowledge in judgmental tasks like relational MTS. Third, unlike the human and chimpanzee infants, adult rhesus monkeys (Macaca mulatta) tested with the same preference-for-novelty tasks do not perceive abstract relational similarities and differences despite their sensitivity to physical identity.

Keywords: Comparative cognition; Perception and judgment; Abstract relations; Same and different; Physical and relational identity; Matching-to-sample; Chimpanzees, monkeys and human infants

1. A profound disparity

William James (James, 1890/1981) observed that, "this sense of sameness is the very keel and background of our thinking" (Vol. 1, p 434). The fundamental importance of understanding the perception and use of same/different relations continues to be recognized today by students in both human and non-human cognition (e.g., D'Amato et al., 1985; Goswami, 1991; Herman et al., 1989; Holyoak, 1984; Holyoak and Thagard, 1995; Honig, 1965; Neiworth and Wright, 1994; Oden et al.,...
1988, 1990; Pepperberg, 1987; Premack, 1983a, Premack, 1983b; Sands et al., 1982; Roitblat, 1985; Thompson, 1995; Tyrrell et al., 1991; Wright et al., 1984; Zentall et al., 1984).

Many of the above studies have demonstrated that nonhuman species can make identity judgments of varying degrees of complexity. These judgments can be based on simple physical similarity involving a single dimension like color or shape. They may also occur, however, at more abstract levels involving judgments about common membership in a class or category. Further, an animal's ability to make such identity judgments at any level of stimulus equivalence is typically said to be conceptual if its performance generalizes to new stimuli or new category members.

We contend, however, that none of the findings from these studies contradicts Premack's (Premack, 1978, 1983a, b) claims that there is a profound disparity between humans and nonhuman species in their natural ability to make judgments about the identity of abstract relations. According to Premack, only humans beyond infancy (e.g., Daehler et al., 1979) and those chimpanzees with a history of what he termed 'language-training' (Premack, 1976; Premack and Premack, 1972) can make abstract equivalence judgments about relations between relations including analogies (Gillan et al., 1981). Premack's claim is based on substantial data collected over many years from several different groups of common chimpanzees (Pan troglodytes) at varying ages (Premack, 1976, Premack and Premack, 1983).

In this paper we discuss why Premack's 'profound disparity' should not be unexpected given a hypothetical taxonomy of the computational-representational processes underlying the tasks commonly used to measure identity judgments in animals. In addition, we present two other disparities emerging from recent research on the perception and judgment of abstract identity relations in human and chimpanzee infants, and adult rhesus monkeys. The second disparity has implications for understanding the distinction between tacit and explicit knowledge on the basis of results from the same human and chimpanzee individuals subjected to different tasks. The third disparity suggests that there may be profound perceptual differences between humans and apes, on the one hand, and monkeys, on the other hand, in their ability to detect, let alone judge, abstract identity relations.

2. A taxonomy of procedures for studying identity judgments

Students of comparative cognition may fail to appreciate that the procedures used by Premack and his colleagues to measure abstract relational judgments by chimpanzees are fundamentally more complex than those traditionally used with other nonhuman species. This distinction is true in terms of both the computations and the underlying representations hypothesized to mediate abstract relational judgments (Thompson, 1995; Thompson and Oden, 1993). It is important, therefore, to clarify these distinctions if only to ameliorate the continuing confusion between Premack's position and those of his critics (e.g., see Premack, 1983b).

A taxonomy of these tasks and the accompanying computations and representations is presented in Table 1 which is discussed in detail below. In the upper portion of this Table the letters A through R stand for distinctive individual stimulus items which, depending on the study in question, can be objects, pictures or stimuli in other sensory modalities like sound. It is important to note that the letters in the upper portion of Table 1 are used for expository purposes and are not the actual stimuli presented to animals in these studies.

Identity judgments based on shared physical features are often studied using a match-to-sample
Table 1
Identity tasks

<table>
<thead>
<tr>
<th>Problem Type</th>
<th>Alternatives</th>
<th>Physical Matching To Sample</th>
<th>Same/Different (S/D) Discrimination</th>
<th>Conditional (S/D) Discrimination</th>
<th>Relational Matching To Sample</th>
</tr>
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<tr>
<td>A</td>
<td>B</td>
<td>A</td>
<td>C</td>
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**Problem Type**
- If $[\square]$ THEN $I(+)$
- If $O$ THEN $NI(+)$

**Equiv. Computations**
- $A = A(I)$
- $C = C(I)$
- $F = F(I)$
- $J = J(I)$
- $M = O(NI^1)$

**Relations Between Objects**
- $P = P(I)$

**(MTS) procedure.** Typically, as shown in Table 1a, an animal in a MTS task is first presented with a single object (the sample, A) and then allowed to choose from several alternatives (the comparison stimuli, A and B). In identity MTS shown here the animal is rewarded if it selects the alternative that is physically identical to (i.e., matches) the original sample item. Alternatively, in so-called oddity tasks, the animal would be rewarded for choosing the alternative that does not match the sample. The lower portion of Table 1a shows the hypothesized computational judgments required to complete a matching trial successfully. Here, the letter $I$ refers to the judgmental outcome of ‘Identity’ following a computational match between sample A and alternative A (i.e., $A = A$). The letters $NI$ refer to the judgmental outcome of ‘Non-identity’ following a computational mismatch between sample A and alternative B. In this example, the correct behavioral matching choice can be executed immediately following one such equivalence computation.

Identity judgments can be investigated with tasks other than MTS. For example, as shown in Table 1b, pairs of either identical (e.g., CC) or nonidentical (DE) items can be used as discriminative stimuli for differential responding. In such same/different (S/D) discriminations an animal is rewarded for making one response (e.g., approach) when faced with pairs of identical items and for making an alternative response (e.g., avoid) when faced with a pair of nonidentical items (e.g., King, 1973; Robinson, 1955). As can be seen in the lower portion of Table 1b, correct responses in these S/D tasks, as in MTS, can also be executed following a single equivalence computation between two objects (e.g., $C = C(I)$).

An even more complex variation of a same/different discrimination is the conditional S/D
discrimination task (e.g., Burdyn and Thomas, 1984). Here, as shown in Table 1c, responses to pairs of identical items are reinforced in the presence of one conditional cue, a square; responses to pairs of nonidentical items are reinforced in the presence of an alternative conditional cue, a circle. As shown in the lower portion of Table 1c, this task reduces to two separate S/D discriminations and hence computationally it is no more difficult than the standard S/D task shown in Table 1b. Any additional procedural complexity lies in the fact that the animal in this task must learn the association between the discriminative cue (e.g., square or circle) and its corresponding I or NI computational outcome.

The matching procedure can be used also for studying the ability to judge ‘relations-between-relations’ as described by Premack (1983b). An example of this task might entail requiring an animal to match a pair of identical items like two apples to another pair of identical items such as a pair of shoes. Matching the identical pair of apples to a pair of nonidentical items, such as a paired eraser and padlock, would be incorrect. The animal would be correct, however, if it were to match the nonidentical paired eraser and padlock to another nonidentical pair such as a cup and paperweight.

As is clear in Table 1d, completion of these more abstract relational identity judgments cannot be based on the initial computations of I and NI. Not only must the animal judge the I or NI relations instantiated by the sample and alternative object pairs, but it must then also compute the equivalence between representations of the initial I and NI judgmental outcomes. That is, to successfully complete a test trial the animal must demonstrate in the example shown in Table 1d, that it judges the relationship exemplified by the MO sample as being the ‘Same’ nonidentity (NI) relationship exemplified also by the QR alternative pair. Likewise, the animal must judge the NI relationship instantiated by the MO sample pair as being ‘Different’ from the identity (I) relationship exemplified by the PP alternative pair. In cases where the sample in relational matching consists of an identity pair (e.g., AA (I)) an animal must judge the identity relation exemplified by the PP alternative as being the same as that of the sample. The animal must also judge the nonidentity relation instantiated by the QR as being different from the identity relationship of the sample.

The relational MTS task is fundamentally more complex than any of the other tasks shown in Table 1 (Thompson, 1995; Thompson and Oden, 1993). As noted above, the correct response choice in these other tasks is specified immediately by the outcome produced by a single computation (i.e., match or nonmatch). At the risk of being redundant, we must stress that the relational matching task, imposes additional demands. As shown in the lower portion of Table 1d, once the initial I and NI outcomes are produced their representations must now be directly compared or matched one against the other. These latter computations on representations produce new outcomes represented here as ‘Same’ and ‘Different’. It is only at this point that the appropriate correct behavioral response can be identified and executed. We would argue that this latter set of additional computations constitutes the necessary cognitive core of reasoning about relations-between-relations and, as we have argued elsewhere, necessitates the capacity to form propositional representations (Thompson, 1995; Thompson and Oden, 1993).

3. The profound disparity revisited

In light of the above computational-representational analysis of relational matching it is perhaps not surprising that Premack found that chimpanzees who lacked the benefit of a symbolic representational
system failed to judge relations (same or different) between relations (identity and nonidentity) in a variety of tasks. Premack’s interpretation of the failure by language-naive, but otherwise intelligent chimpanzees, would appear to be contradicted by results reported by Smith et al. (1975).

These investigators reported that one of two language-naive adult chimpanzees apparently mastered a relational MTS task. Their use of differential reward, however, left open the strong possibility of associative learning between specific sample pairs and alternative pairs during close to 200 successive trials. Unfortunately, tests for this possibility were not considered in the results. Given the simultaneous presentation of the sample and alternative pairs in a spatially straight array it is not clear also whether the animal’s choices may have been controlled by nonrelational characteristics such as configurational cues involving symmetry and complexity. In matching studies where differential reward is used, performance on the first trial with novel stimuli is the appropriate criterion for inferring conceptual matching. Trial-1 data were not reported by Smith et al. (1975). Thus, these data, as originally presented, are of questionable relevance to Premack’s claim for a ‘Profound Disparity’ between language-trained and language-naive chimpanzees.

Strong evidence for the role of associative learning in the nonconceptual acquisition and performance of a relational MTS task was demonstrated by Oden et al. (1990) in a study with infant common chimpanzees (Pan troglodytes). As shown in Fig. 1, four infant chimpanzees failed to solve a relational MTS task at the conceptual level. The chimpanzees were first trained to criterion with only two identity and two nonidentity stimulus pairs (Fig. 1: training I). The chimpanzees, however, failed to generalize their performance to novel pairs (Fig. 1: transfer I and II). This failure demonstrated that the apparent matching observed after some 700 acquisition trials resulted from simple associative learning involving individual objects in pairs. Additional relational matching training was conducted with sample and alternative pairs drawn from a large stimulus pool so as to
Fig. 2. Percent preference for physical and relational novelty by human infants and adult rhesus monkeys in paired-comparison familiarization/novelty tasks. (The human data are derived from Tyrrell et al., 1991 and the monkey data are derived from Arlinsky, 1992).

preclude the formation of stimulus specific associations (Fig. 1: training II). None of the chimpanzees' matching performances in these additional training trials exceeded chance levels of responding.

The same infant chimpanzees previously had demonstrated that they judged objects as being identical or nonidentical in a physical MTS task. Only two training stimuli (Oden et al., 1988) were used during acquisition trials and, after having first learned to match a lock with a lock and a cup with a cup, all four subjects transferred this ability to novel items. In two additional experiments these same infant chimpanzees also learned both simultaneous and successive discrimination tasks involving pairs of identical and nonidentical objects (Durlach, P., Thompson, R. and Premack, D., successive and simultaneous same/different discriminations by infant chimpanzees (Pan troglodytes), unpublished data). In one task they were simultaneously presented with one pair of identical items and one pair of nonidentical items. They were rewarded for choosing, for example, only the 'Identity' pair. In the successive task they learned to ring a bell when faced with a single 'Identity' pair and to withhold the bell-ring response when presented with a single 'Nonidentity' pair. Initially, the infant chimpanzees' performances were influenced in part by associative learning, but following additional training with another set of training stimuli, they spontaneously (i.e. correct on Trial-1) generalized correct responding to novel stimulus pairs under nondifferential reward.

Taken collectively these results are consistent with our argument that relational matching is highly likely to be more difficult because of the additional computational and representational demands placed on the subject. In the physical matching, and the successive and simultaneous discrimination tasks, the infant chimpanzees had only to (i) judge the physical equivalence of 2 objects as being identical or nonidentical and (ii) continue making computational equivalence judgments when faced with novel object pairs. None of these tasks, however, required a subject to subsequently compute the equivalence of two identity or nonidentity outcomes as being either the same or different. This latter additional abstract judgment is demanded of the animals in the relational MTS task.
4. A second disparity

A study by Oden et al. (1990) using a familiarization/novelty procedure further helps to elucidate the reasons for the infant chimpanzees’ failure to match relations. One possibility is that they were unable to encode and store the outcomes of ‘Identity’ and ‘Nonidentity’ resulting from their initial computational matches between objects comprising the sample or alternative pairs (see ‘NI', NI², I' in Table Id). If so, then they would be incapable of making the requisite additional judgment of whether these represented outcomes, themselves, were either the ‘Same’ or ‘Different’.

The procedures used by Oden et al. (1990) in this study were similar to the ‘preference-for-novelty’ tasks commonly employed in studies of perception and cognitive development in humans and nonhuman primates (e.g., Fagan, 1970; Fagan and Singer, 1983; Gunderson and Sackett, 1984; Gunderson and Swartz, 1986, Swartz, 1983). All such procedures capitalize on the fact that organisms attend more to that which is novel rather than familiar (Harris, 1943; Sokolov, 1963).

In one experiment Oden and his colleagues allowed the infant chimpanzees to handle a pair of objects mounted together on a display board for a fixed period of time. The object pair constituted either the ‘Identity’ relation (e.g., two identical shoes) or the ‘Nonidentity’ relation (e.g., an eraser paired with padlock). After this initial familiarization trial, the infants were allowed on a second trial to handle a new pair of physically novel play objects. On half of these test trials the novel pair instantiated the ‘Same’ relation (identity or nonidentity) experienced previously during the first familiarization trial. On the other half of the test trials the novel pair instantiated the alternative, and hence ‘Different’, relation.

If the infant chimpanzees were sensitive to the physical properties of the stimulus pairs and insensitive to their relational (i.e., identity or nonidentity) properties then they should have shown at least as much, if not more, interest in what were always novels objects on the test trial regardless of what they had handled on the preceding familiarization trial. An attentional preference for physically novel items as opposed to familiar ones had in fact been demonstrated in these same subjects in a preceding experiment employing a successive familiarization-test trial procedure. In the present experiment, however, the time the chimpanzees spent handling an object pair on the second test trial was influenced by the relation which they had experienced on the initial familiarization trial.

Specifically, the second object pair was handled significantly less if it instantiated the same relation as was experienced on the familiarization trial, albeit with a different pair of objects. If, however, the relation changed across trials, then there was no significant difference in handling times across trials. That is, the animals directed less attention to a BB pair on a test trial than they did to an AA pair on an immediately preceding familiarization trial. Similarly, they directed less attention to an EF pair on a test trial than they did to a CD pair on the preceding familiarization trial. Conversely, the chimpanzees were as interested, or more interested, in an EF pair presented on a test trial as they were in an AA pair presented on the preceding familiarization trial. They were also as interested in a BB pair presented on a test trial as they were in a CD pair presented on the preceding familiarization trial. Thus, whatever the reason for the infant chimpanzees’ failure to match relations, it did not result from their inability to encode and remember representations of identity and nonidentity outcomes.

These results suggest a second disparity in addition to that identified by Premack (1978, 1983b) and discussed above. The additional disparity is that infant chimpanzees spontaneously detect, code and store information about abstract identity/nonidentity relations. Nevertheless, as described above,
these same chimpanzees were unable to judge the equivalence of these relations in a relational MTS task (Oden et al., 1990; Exp. 3).

Interestingly, this second disparity is manifested also by infant humans (Tyrrell et al., 1991). Using a paired-comparison preference-for-novelty test, Tyrrell et al. (1991) demonstrated that 7-month-old human infants, like the chimpanzee infants, spontaneously attended to relational sameness and difference. First, however, in each test, the human infant's perceptual sensitivity to physical identity was demonstrated. The infants gazed at a pair of either identical or nonidentical objects for 10 s on a familiarization trial (e.g., AA or CD). Subsequently, on trial 2 the infants saw two pairs of objects. One pair consisted of the same two objects experienced in the familiarization trial (AA or CD). The other pair consisted of novel objects (e.g., EF or BB). As shown in Fig. 2, during trial 2 the infants looked significantly longer at the stimulus pair comprised of physically novel objects.

In the test for perceptual sensitivity to abstract relations the human infants gazed at a pair of either identical or nonidentical objects for 10 s on the familiarization trial (e.g., AA or CD). Subsequently, on trial 2 the infants were exposed to two pairs of novel objects. One pair consisted of identical novel objects (BB), the other pair consisted of nonidentical novel objects (EF). During trial 2 the infants looked significantly longer at the object pair that instantiated the relation which differed from that experienced on the familiarization trial. That is, if they saw an AA (I) pair on the familiarization trial then they looked relatively longer at the EF (NI) pair than they did the BB (I) pair. Conversely, if they were initially familiarized with a CD (NI) pair they attended to the BB (I) pair more than to the EF (NI) pair.

These data then, which are shown also in Fig. 2, are comparable to those obtained with the infant chimpanzees with a similar procedure. Furthermore, 7-month-old human infants, like the infant chimpanzees, can match physical features (Tyrrell et al., 1993). Results from subsequent experiments, however, indicate that, also like the infant chimpanzees, human infants fail to judge these relations as being the same or different in a relational MTS task (Tyrrell, personal communication, August, 1994).

5. A third disparity

The paired-comparison preference-for-novelty procedure used by Tyrrell et al. (1991) was adapted by Thompson and his students (Arlinsky, 1992; Thompson et al., 1992) to measure whether adult rhesus monkeys (Macaca mulatta) would spontaneously attend to both physical and relational identity relations. As in the Tyrrell et al. (1991) study, both the physical and abstract tests consisted of a familiarization trial followed by a test trial. In the physical familiarization trial the monkeys looked at a single pair of objects (e.g., AA or CD) displayed on a video screen. During the test trial a novel object pair was presented simultaneously with the original and now familiar pair. If the familiar pair was AA then the novel pair was EF. If the familiar pair was CD then the novel pair was BB. During the test phase the monkeys looked more at the novel pair than they did at the familiar pair. The magnitude of this preference for physical novelty, as shown in Fig. 2, was comparable to those obtained with the same subjects in previous experiments employing single objects (Hardenbergh et al., 1991; Thompson et al., 1990). It is also comparable to that reported for infant macaque monkeys (e.g., Gunderson and Swartz, 1986) in similar tasks. Interestingly, however, the magnitude of the percent preference for physical novelty shown by the monkeys was more like that reported for relational rather than physical novelty in human infants (Tyrrell et al., 1991).
In familiarization trials during tests for perceptual sensitivity to abstract relations (Arlinsky, 1992), the same monkeys were shown a single pair of objects which were either identical (e.g., AA or CD). In a test trial two novel objects were presented simultaneously as was the case in the Tyrrell et al. (1991) study. Individual objects in both pairs were physically novel. One pair, however, represented the same identity or nonidentity relation seen in the familiarization trial. The other physically novel pair represented the different relation. Hence, if either an AA (I) or CD (NI) pair had appeared in the familiarization trial then the animals saw BB (I) and EF (NI) pairs on the test trial. Different stimulus sets were used across sessions. In contrast to the tests for perceptual sensitivity to physical novelty, the monkeys did not look more at the novel relation than they did the familiar one (see Fig. 2). This result was obtained with both novel identity and novel nonidentity relations.

Hence, like 7-month-old human infants, the adult monkeys preferred to look at novel objects, but in contrast to the human infants, the same monkeys showed no preference for novel relations. These results suggest yet a third disparity. Specifically, unlike humans and apes, monkeys are perceptually insensitive to same/different relations which transcend physical features. The monkeys presumably did not detect, encode and utilize information about abstract identity and nonidentity relations.

6. Summary and discussion

To summarize, the research described above points to three major between- and within-species disparities. The first disparity is that noted by Premack (1978, 1983a, b). Humans and chimpanzees exposed to a regime of language training can judge abstract relations between relations. Chimpanzees without the benefit of this experience cannot judge such relations although they are otherwise capable of solving complex problems. The second disparity is that infant chimpanzees can detect relational similarity as measured in preference-for-novelty tasks, but they cannot express this tacit knowledge explicitly in a judgmental task of relational MTS. The third disparity is that adult rhesus macaque monkeys, unlike children or chimpanzees, appear to not even perceive relational identity despite the ability of the same animals to detect physical identity in the same and related tasks.

When the first disparity was originally described by Premack it was unclear as to exactly what language training contributed to the abstract problem solving capacities of these animals. Did the experience enable a chimpanzee to perceive what previously had been undetectable properties of the world? Alternatively, did language training provide the chimpanzees with a new representational system which facilitated the explicit expression of otherwise tacit propositional knowledge? Although strong conclusions would be premature at this time, the second disparity would appear to favor this latter hypothesis.

The first two disparities raise the question of what are the necessary conditions for the expression of an otherwise latent representational capacity in adult chimpanzees? We suggested that perhaps the most critical aspect of language training was that it provided concrete tokens symbolically associated with abstract relations of identity and nonidentity (Thompson and Oden, 1993). These iconic symbols enable chimpanzees to express instrumentally what they otherwise only perceive.

According to this interpretation explicit linguistic experience is not a prerequisite for the expression of relational judgments. Rather, all that would be called for is experience with any concrete token which can function as a representational tag for an abstract relation like identity. Recent data collected from chimpanzees who have not had explicit language training are consistent with this view.
(Thompson, Oden and Boysen. Abstract relational matching by language-naive chimpanzees (Pan troglodytes), submitted). These adult chimpanzees readily match relations under conditions of nondifferential reward with samples consisting of paired objects and alternatives consisting of digitized video images of paired objects. The chimpanzees transferred this ability spontaneously to novel stimulus pairs and to novel recombinations of individual items from previously used pairs.

With the exception of one animal, Sarah, a veteran subject from Premack's research program, these chimpanzees had not been the recipients of language-training. They had, however, been previously trained on a conditional same/different discrimination task with tokens and multiple pairs of objects. For example, given two identical items they correctly chose a heart shaped token, and if presented with a pair of nonidentical items they correctly chose a token consisting of a diagonal bar. Perhaps, as suggested by Thompson and Oden (1993), this experience with tokens underlies their ability to match relations. If so, it implies that the tokens were not simply conditionally associated with pairs of identical and nonidentical objects during acquisition of the original discrimination task. Instead they functioned as symbols for the more abstract relational concepts of identity and nonidentity per se (cf., Savage-Rumbaugh, 1986).

Past research has provided ample demonstrations of the symbolic problem solving abilities conveyed upon chimpanzees via 'language training' (Rumbaugh and Savage-Rumbaugh, 1992). Future research should focus on elucidating the actual processes underlying these abilities and how an individual with latent conceptual potential achieves the capacity to express this knowledge explicitly.

The third disparity is that adult rhesus macaque monkeys, unlike children or chimpanzees, do not spontaneously perceive relational identity despite their sensitivity to physical identity. One might argue that this disparity in perceptual capacities between these monkeys on the one hand, and human and chimpanzee infants, on the other hand, may be constrained to only those situations in which arbitrary junk objects are used to construct test stimulus pairs. One may want to argue that a perceptual sensitivity to relations by monkeys may be revealed if stimuli were to be drawn from more ecologically salient stimulus domains like, for example, social displays or functional actions and objects. Perhaps, but if so, it would imply an additional constraint not demanded of either human or chimpanzee. Ongoing research in Thompson's laboratory is directed to this and related issues. Also unanswered, as yet, are the questions of whether the present findings with the macaque monkeys generalize to subjects of different ages and species of nonhuman primates.

Monkeys, like chimpanzees, match on the basis of physical identity and they succeed also on same/different discrimination tasks (e.g., Burdyn and Thomas, 1984; Czerny and Thomas, 1975; King and Fobes, 1975; Scanlon and King, 1976; Thomas and Crosby, 1977; Thomas and Kerr, 1976). We predict, however, that like language-naive chimpanzees, rhesus monkeys would fail to match relations, but for very different reasons. A chimpanzee fails if it lacks a concrete code for mapping abstract relations that are perceived directly. A monkey fails because it does not even perceive these abstract relations of identity and nonidentity and thereby lacks the fundamental perceptual pre-requisite for judging relations between relations. This interpretation implies that monkeys might well learn to use tokens as conditional cues for discriminating between pairs of identical and nonidentical items (e.g., Burdyn and Thomas, 1984). Nevertheless, such experiences would not facilitate transfer of performance to relational matching. This is because there is no abstract representation of identity for which the token can become a symbol. Rather the token is predestined to remain a conditional cue for a particular instrumental response.
7. Conclusion

The comparative perspective described in this paper is not explicitly phylogenetic or ecological, although the findings may have implications for these perspectives also (cf., Brooks and McLennan, 1991; Kamil and Roitblat, 1985; Real et al., 1984). For example, comparisons between closely related species like human, ape and monkey can be informative with respect to formulating hypotheses about the phylogeny of cognitive processes (Thompson and Demarest, 1992). Some ecologically-oriented investigators have proposed that social interactions in nonhuman primates are mediated via judgments of conceptual relations of similarity and difference (e.g., Byrne and Whiten, 1988; Cheney and Seyfarth, 1990). If, however, monkeys prove to be incapable of detecting relational similarities and differences in any domain, then such appeals to conceptual rather than associative processes may be premature at best (Thompson, 1995).

The comparative perspective described in this paper is perhaps best characterized as what Timberlake (1993) has labeled ‘proto-evolutionary’ where different species are compared for a broader and less anthropocentric perspective on fundamental psychological phenomena. The primary goal in all aspects of our research is not to show that one species can or cannot perform any given task. Rather, it is to clarify the conditions under which the cited disparities are or are not manifested. We will thereby better understand the perceptual and cognitive processes governing these similarities and differences both within and between species.

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