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Young children category learning: a training study

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Abstract From an integrative approach, this work focuses on the role of conceptual mechanisms, such as comparison and conceptual-based inference, and sociopragmatic support in young children's taxonomic categorization. "Experiment 1" assessed whether 3-, 4-, and 6-year-old children succeed in detecting taxonomic relations on their own. A clear developmental trend was found: 6-year-olds succeeded, whereas 4- and 3-year-olds relied primarily on perceptually based categories. "Experiment 2" assessed if 3-year-olds are able to change their perceptual response into a taxonomic categorization as a function of the co-occurrence of contingent category information and feedback in an interactive process with an adult (experimenter). A pretest–posttest training study compared 3-year-olds' performance in four conditions: comparison, conceptual-based, information-only, and feedback-only. A perceptual–totaxonomic shift was found only in the comparison and conceptual-based training groups. Children who only received either category information or corrective feedback did not make such a shift. The results show that social interaction with supportive adults is a mechanism that drives conceptual understanding in early childhood.

Keywords Categorization · Comparison · Conceptual-based inference · Sociopragmatic support

Children form concepts that help them organize and make sense of the surrounding world at an amazing rate. In order to explain this feat, a large body of research has been devoted at examining the type of information children may rely on (for reviews, see Madole and Oakes 1999; Mandler 1998; Quinn 2002). Some studies have demonstrated that, in some circumstances, young children rely on perceptual aspects, such as shape (e.g., round) or distinctive features (e.g., wheels) (Baldwin 1992; Bowerman 1976; Clark 1973; Cohen and Oakes 1993; Gentner 1978; Gentner and Imai 1995; Graham and Diesendruck 2010; Graham et al.

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2004; Imai et al. 1994; Landau et al. 1988, 1998; Rakison and Butterworth 1998; Smith et al. 1992) whereas, in other circumstances, they categorize on the basis of deep, non-obvious, conceptual aspects of the objects, such as function (e.g., can be eaten), casual properties (e.g., has eyes so it can see), or relations to other things in the world (e.g., grows on trees) (Golinkoff et al. 1992; Kemler Nelson 1995; Markman 1989; Markman and Hutchinson 1984; Waxman and Gelman 1986; Waxman 1990; Waxman and Kosowski 1990).

Other studies have investigated the factors that may help children go beyond perceptual features and attend to deep and less obvious object characteristics. Some of them focused on children's conceptual capacities while others on the socio-pragmatic support.

Considering children's conceptual capacities, research has shown that words serve as cues to pay attention to taxonomic relations (Markman and Hutchinson 1984; Waxman and Markow 1993) and that very young children use conceptual information to make category inferences (Booth et al. 2005; Gelman and Coley 1990). Other account proposed that comparison among instances trigger insights into the category structure (Gentner and Rattermann 1991; Namy and Gentner 2002).

As far as the role of the social support, some studies have described the strategies parents use to help children determine the hierarchical level of a new word (Callanan 1985, 1991; Gelman et al. 1998). In this line, Rogoff et al. (1984) identified parents' scaffolding techniques that provide optimal guidance in classification tasks while Garton (2001) described ways in which the instruction given by adults in social interaction contexts may enhance children's understanding of word meaning.

In order to understand how children form categories, it seems important to investigate how conceptual capacities and socio-pragmatic support influence one another in the service of categorization. As Callanan (1991) and Nelson (1985, 1996) argued, the problem of how the mind builds the category system of a given cultural and linguistic community must be studied combining what children bring to the task with what they receive from it. In the current research, we address the issue of category understanding by combining children's conceptual capacities with the social support they receive. Our main interest is to examine the role of conceptual mechanisms, such as comparison and conceptual-based inference, and socio-pragmatic support in taxonomic categorization. We hypothesized that, if young children are provided with comparative and conceptual information within a socio-pragmatic context, they will be able to detect taxonomic relations to categorize objects.

A relevant question constituted the age at which children might benefit from these sources of support.

Piaget's early theory of conceptual development (Piaget and Inhelder 1959) held that children's categorization evolves from a thematic or perceptual organization, present in the preschool years, to a taxonomic one, attained not before 6 or 7 years. Yet, later research has shown that thematic, perceptual, and taxonomic relations are available at younger ages (e.g., Bauer and Mandler 1989; Fenson et al. 1988).

Furthermore, studies have argued that, even infants as young as 9 months have some insights into the nature of taxonomies (e.g., Quinn 2002; Mandler 2000), although these early notions are quite different from the taxonomies evident later in life (Rakison 2000). Concerning lexical concepts, Mandler (2004) proposed that infants form basic-level categories by matching the words they are faced to with the global pre-verbal conceptual categories. Later on, during the preschool and early school years, children make substantial gains in the understanding of taxonomies (Mandler 1992; Nelson 1973).

According to Blaye and Bonthoux (2001), the predominance of conceptual categories may also depend on contextual factors related to the nature of specific tasks used by the studies. For example, many of the studies on taxonomic categorization employed tasks in which the standard (e.g., an apple) was related to other objects either thematically (e.g., a knife, used to cut the apple) or taxonomically (e.g., an orange, the same kind of entity) (Markman and Hutchinson 1984). However, as many researchers have pointed out (Gelman et al. 1998; Imai et al. 1994), one problem is that taxonomic alternatives (e.g., orange) tend to look more similar to the standards (apple) than thematic ones do (knife), making it likely that perceptual similarity, not conceptual commonality, is what supports the taxonomic choice.

Within the studies that have tested the development of taxonomic categorization pitting taxonomic and perceptual choices against each other, Kotovsky and Gentner (1996), for example, showed that 4-year-olds chose randomly, whereas 6-and 8-year-olds progressively perceived common higher-order relations. Also, Baldwin (1992) and Imai et al. (1994) found that 5-year-olds were more likely to grasp taxonomic relations between familiar objects than 3-year-olds are, although none of the groups succeeded. Taken together, these results illustrate a conceptual-shift between 3 and 6 years of age.

In order to refine our knowledge concerning the early stages in children's ability to grasp taxonomical relations, "Experiment 1" compared 3-, 4-, and 6-year-old's conceptual ability to categorize objects taxonomically with no training. With the results of this experiment, we also intended to establish a baseline to test our main hypothesis concerning the role of comparison, and conceptual-based and socio-pragmatic support in children taxonomic categorization.

Experiment 1

This study investigates 3-, 4-, and 6-year-old children's ability to grasp taxonomic categories using a version of the word extension forced-choice paradigm.

We designed a task based on the one used by Imai et al. (1994) in order to test categorization abilities in a word paradigm pitting conceptual and perceptual choices against each other. We adapted the task for Spanish-speaking children and modified the materials to ensure that the pictures included familiar objects. Our category item selection followed the one used by Waxman et al. (1997) when they studied taxonomic categorization in Spanish-speaking children.

We predicted that 3- and 4-year-olds would categorize mainly on a perceptual way and that there would be a shift from perceptual- to taxonomic-based choices from 4 to 6 years. We also predicted that, although categorizing predominantly in a perceptual way, there would be differences between 3- and 4-year-old children's performance.

Method

Participants

Forty-eight children participated in this study—15 3-year-olds (range=2.7–3.6, six girls and nine boys); 16 4-year-olds (range=4–4.7, four boys and 12 girls), and 17 6-year-olds (range, 5.11–6.8, four girls and 13 boys).

In this and the following study, the participants were recruited through the day care centers they attended. A written consent from the parents was requested. All participants were from Rosario (a large city of Argentina); they were predominantly middle class.

Materials

We used nine triads of colored pictures. Each triad evaluated one of three taxonomic categories: Fruit, Animal, and Vehicle. They consisted on one picture that served as the *standard* (e.g., apple), and two alternatives related to the standard in different ways: The *taxonomic choice* (grapes) shared a conceptual relation but was perceptually distinct; the *perceptual choice* (balloon) shared perceptual similarity but was outside of the target category. A complete list of stimuli can be found in Table 1. A toy, Winnie the Pooh bear (W.P.), was used to help children engage in the task.

Design and procedure

In this and the following study, children were tested individually in their preschools. Children were told that they were going to learn Winnie the Pooh's special names for things. The task consisted in familiarization and test. During the familiarization, the experimenter showed the child a picture of a cat providing a novel label to give the idea that W.P.'s words were different from current Spanish words. This was done to eliminate the possible effect of the mutual exclusivity bias (Markman and Wachtel 1988) or lexical contrast (Clark 1988) on children's willingness to use novel words to refer to familiar objects. Two practice trials followed in which the experimenter presented a picture of a standard object, saying: "See? This is a *Tini* in W.P. talk. Can you help W.P. find another *Tini*?" Two choice pictures were presented; one was identical to the standard, and the other was unrelated. All children were successful in the practice trials tasks.

The test followed utilizing the same general procedure, except that the triads now contained the taxonomic and perceptual alternatives. Children were shown a standard picture and two choices. A nonsense word was applied to the standard, and children were asked to extend this name to one of the two choices. Three different labels were used, one for each category: *Dax* (Animals); *Bliket* (Fruits), and *Nec* (Vehicle). Children were encouraged to categorize the objects, but no feedback was given.

All children were tested with the nine triads listed in Table 1. The presentation of the trials within each set was random but maintained the same order (Animal–Fruit–Vehicle). The left/right location of the perceptual and conceptual choices was counterbalanced across trials.

Table 1 Materials used in "Experiment 1"

Trial	Standard	Alternatives	
		Conceptual	Perceptual
Fruit	Apple	Grapes	Balloon
Vehicle	Bike	Car	Glasses
Animal	Snake	Cow	Belt
Fruit	Pear	Plum	Light-bulb
Vehicle	Motorcycle	Lorry	Binoculars
Animal	Snail	Dog	Umbrella
Fruit	Strawberry	Banana	Ball
Vehicle	Motorbike	Bus	Sunglasses
Animal	Caterpillar	Monkey	Scarf

Results

Since the distribution of scores was asymmetric, non-parametric tests were used. Analyses were performed on the number of conceptual responses as dependent variable; percentages are also informed for clarity purposes. First, we analyzed children's performance against the chance level (50 %). Neither 3- nor 4-year-old children performed above chance (3-year-olds, 23.7 %, 32/135 choices, x^2=37.3, gl. 1, p<0.001; 4-year-olds, 47.9 %, 69/144, x^2= 0.25, gl. 1, p=0.61), while 6-year-olds selected the conceptual alternative above chance (69. 2 %, 106/153, x^2=24. 3, gl. 1, p<0.001).

Then, we compared the proportion of trials in which children selected the conceptual choice by age. As predicted, we found differences among the three age groups, x^2=61.4, gl. 2, p<0.001. Post hoc analyses (Mann–Whitney U tests) confirmed differences between 3- and 4-year-olds, z=2.5, p=0.01, and between 4- and 6-year-olds, z=2.5 p=0.02 (Fig. 1).

These results show that 3- and 4-year-olds predominantly matched objects perceptually, although the older group was more likely than the younger one to respond conceptually. Six-year-olds mainly focused on taxonomic responses when extending the meaning of the novel word.

Two additional analyses further explored these effects. First, we tested if the outcome of 6-year-olds was a result of a learning effect. Children's proportion of taxonomic responses was not different between the first (59 %) and the fifth trial (54.5 %), McNemar, p=1, nor between the fifth (54.5 %) and the ninth trial (42.9 %), McNemar, p=0.1, indicating that children already began the task with an awareness of taxonomic relations.

We also examined the pattern of performance of individual children. Using the binomial formula, a child must select the category match on at least seven of the nine trials to perform reliably above chance. Eleven of the 17 6-year-olds met these criteria, whereas four of the 16 4-year-olds and only one of the 15 3-year-olds did. According to Fisher's exact test (p values=0.01), there was a reliable difference between 3- and 6-year-olds' and between 4- and 6-year-olds' patterns of performance.

Discussion

This study shows that 3- and 4-year-olds relied on perceptual commonalities to categorize objects. On the other hand, by 6 years, children went beyond and formed conceptual

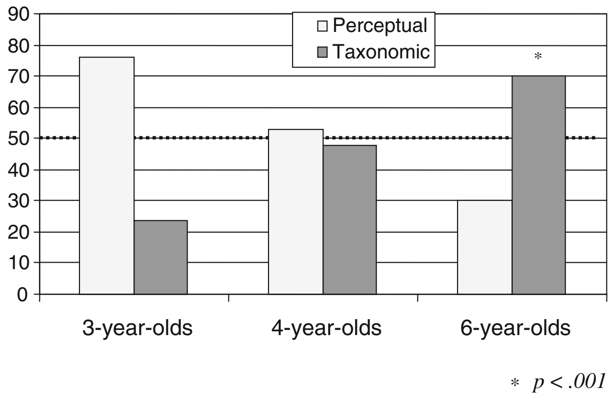

Fig. 1 Mean proportions of conceptual responses by age (*p<0.001)

structures. These results are in line with studies that demonstrated that preschoolers rely mainly on perceptual properties when extending the meaning of a word (Imai et al. 1994; Baldwin 1992). They are also consistent with findings that showed an increased sensitivity to perceive taxonomic relations in early school years (Chipman and Medelson 1979; Kotovsky and Gentner 1996).

The results of this experiment provide further information on the relational shift applied to category development. It also refines our knowledge regarding differences in early categorization. With this base, we now move to our main goal, to test the hypothesis concerning the co-occurrence of children's conceptual capacities and the socio-pragmatic support in the early steps of category learning.

Experiment 2

The goal of this study was to test whether 3-year-olds could switch from perceptual to taxonomic responses as a function of the co-occurrence of category information and socio-pragmatic support. We tested two sorts of category information, comparative and conceptual information. Each aimed at triggering one of the conceptual capacities that highlight taxonomic relations: comparison or conceptual-based inference. The socio-pragmatic support was designed in an interactive format in which the information was provided by an adult (experimenter) who gauged the child's performance, providing contingent category information and explicit feedback.

The experiment consisted in a word-extension and forced-choice task with three phases: pretest, process, and posttest. The pretest measured spontaneous choices (perceptual vs. taxonomic); also, it was a way of showing children the kind of task they were going to be involved in. The process examined children's categorization as a function of training. The posttest assessed the influence of the different kind of trainings in children's unaided choices.

We defined four training conditions:

Conditions 1 and 2: *Socio-pragmatic conditions*. Children were presented with contingent category information, either *Comparison* (1) or *Conceptual-based* (2), + feedback. In these conditions both, the feedback and the category information represented the socio-pragmatic support since the adult's role was aimed at operating on the children's conceptual basis.

Conditions 3 and 4: *No-sociopragmatic conditions*. (3) *Information-only condition*: The adult provided children with the relevant conceptual criteria, but no feedback was given; in consequence, the children did not receive information concerning whether their response was correct. (4) *Feedback-only condition*: The adult's intervention was meant to provide a generic evaluation of the children's behavior but not specifically linked to the conceptual basis.

Method

Participants

Fifty-six 3-year-old children participated in this experiment (age range=2.7–3.5 years, 24 girls and 32 boys); they were randomly assigned to one of the four conditions. Seventeen were included in the comparison, 16 in the conceptual-based, 18 in the information-only, and

14 in the feedback-only conditions. An additional six children were not included, three because they refused to complete the task and three due to experimenter error.

Materials

In this experiment, we used the materials employed in the nine trials of "Experiment 1." The trials of the same category were put together in three sets: Animal, Vehicle, and Fruit. Three more trials were added to each set, resulting in the three sets with six trials each. The items of the trials are listed in Appendix A. Figure 2 displays a sample of the stimuli. In this experiment, we also used W.P. to engage the children in the task.

Procedure

In each condition, children were randomly assigned to one of the three categories. A total of 21 children were tested with the Animal set, 22 with the Vehicle set, and 22 with the Fruit set. In concordance with previous research (e.g., Waxman and Gelman 1986; Gentner and Namy 1999), we found no differences in the performance of the children in the different categories, so no further analyses were performed in this sense.

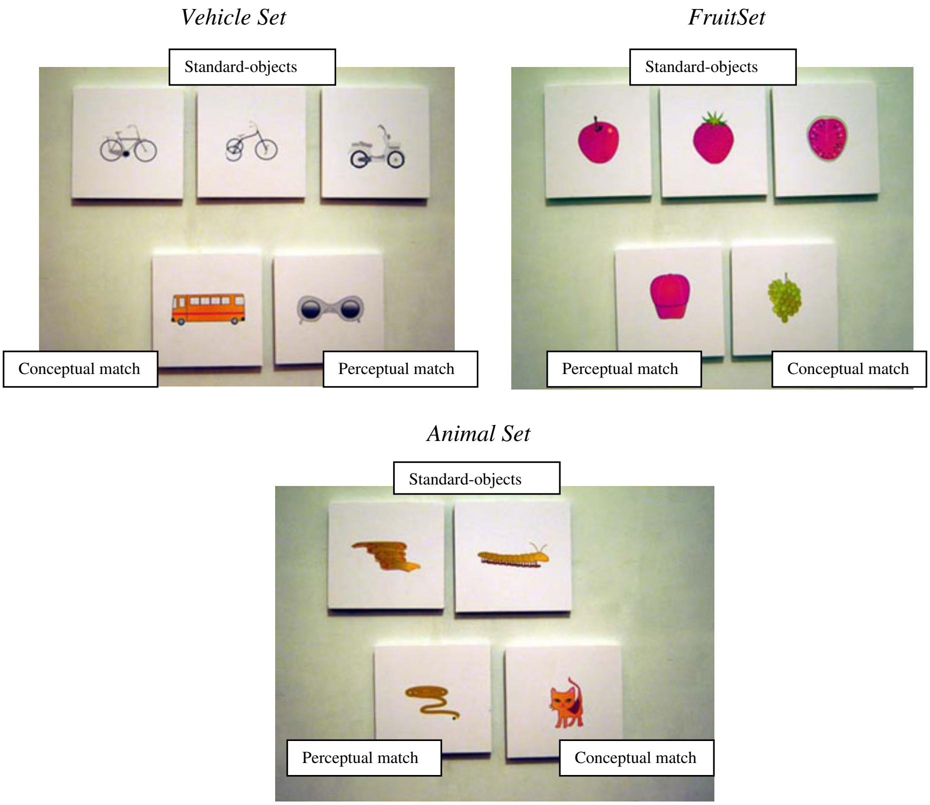

Fig. 2 Sample stimuli used during training in "Experiment 2" (note that, in *conceptual-based condition*, only the first standard-object was employed in each set because children in this condition did not receive comparisons, but conceptual properties)

In the *pretest* (one trial), all children were asked to extend a novel label applied to an object of a given category to another member.

In the *training* (four trials), we manipulated children's ability to switch from a perceptual to a taxonomic choice in response to the co-occurrence of category information and socio-pragmatic support. In the experimental training conditions (comparison and conceptual-based conditions), we provided category information (comparative or conceptual-based) contingently to the child's response: If children categorized perceptually, a new piece of category information (comparative or conceptual-based) was given for the next trial. If children extended the name taxonomically, the same amount of support (same comparison or conceptual information) was maintained for the next trial. During the four training trials, we offered a maximum of three comparisons or conceptual information and a minimum of no information (no comparisons or conceptual information were given).

In the *Information-only*, condition children were simply exposed to both types of information (comparative + conceptual-based) at the beginning of each trial, but neither contingent information during the trials, nor feedback were provided. In the *feedback-only condition*, children received corrective or confirmative feedback after each trial but no contingent information. These two conditions allowed us determine whether it was the co-occurrence of information and socio-pragmatic support that lead to category changes, or if either information or feedback alone were the responsible for the changes.

Finally, children were presented with a *posttest* (one trial). Here, the procedure was identical to the one of the pretest except for the particular items included in the category under evaluation.

The specific procedures were as follows. As in "Experiment 1," all sessions began with the presentation of the materials and the familiarization; afterward, children were told that they were going to learn Winnie the Pooh's special names for things.

Pretest The experimenter presented the first standard item (e.g., apple) saying: "This is a *Bliket* in W.P. talk," requesting the child to repeat the novel word. She then laid the pictures of the two alternatives, the taxonomic choice (grape) and the perceptual choice (balloon) asking the child: "Can you tell W.P. which one of these is also a *Bliket?"* After the child chose one alternative, the experimenter said: "Now I am going to ask W.P. if this (child's choice) is a *Bliket."* If children categorized *perceptually*, the experimenter corrected them saying: "W.P. told me that this is the *Bliket*," handing over the taxonomic choice. If children categorized *taxonomically*, the experimenter said: "W.P told me that it is a *Bliket*," pointing to the children's choice. Children were not given any other feedback.

Training process: four conditions

1. *Comparison*. The experimenter added a standard-object to the one already displayed in the pretest (apple + strawberry) saying: "Look at these, this is a *Bliket* and this is also a *Bliket*, see how both are *Blikets*?" (pointing to both objects). The purpose was to provide category information highlighting conceptual commonalities in a form of a comparison in order to engage to the child in the comparison. Then the experimenter presented the first trial and asked the child to extend the word to one of the alternatives displayed saying: "Can you tell W.P. which one of these is also a *Bliket?"* After the child response, the experimenter provided contingent feedback:

   If children choose the *perceptual match*, the experimenter said: "W.P. told me that it is not a *Bliket* (pointing the child's choice). He told me that this is a *Bliket* (pointing the taxonomic one). Now I am going to help you find another *Bliket*." Immediately after, the experimenter presented the second piece of category information adding a new standard-object (apple + strawberry + watermelon) in order to make more explicit the taxonomic commonalities saying: "This is a *Bliket* (apple), this is a *Bliket* (strawberry), and this is also a *Bliket* (watermelon), see how these are *Blikets*?" (pointing to the three objects).Then, she presented the second, third, and forth trials, one by one following the same procedure, and children had to extend the word to one of the alternatives displayed. The experimenter offered comparisons contingently with the child's response and feedback.

If children extended the novel word to the *taxonomic match*, the experimenter said: "Very good! W. P. told me that it is a *Bliket*. Let's go to find another one." Since the child categorized taxonomically, the same piece of information (one comparison) was maintained. Then, she presented the second, third, and forth trials with new items, one by one, like in the first trial, offering contingent category information and feedback. In each trial, children had to extend the word to one of the alternatives displayed.

2. *Conceptual-based*. The experimenter presented the standard-object already displayed in the pretest within the context of a short *vignette*. A vignette consisted in a brief piece of information to verbally describe the conceptual status of the object named. Its objective was to invite the child to infer the category-kind on the basis of the conceptual-property given. Living-thing properties were given for animals and fruits, artifact properties for vehicles (Appendix B). For example, the experimenter said: "Look at this, this is a *Bliket* (apple), I will tell you something special about *Blikets*: *Blikets* like this one are born from a seed and grow up in plants, did you know that?" Then, the experimenter asked the child to repeat what she had just said. Next, pointing to the standard-object, said: "So, now you know that this is a *Bliket* and that *Blikets* … (repeating the *vignette*)." Then, she laid down pictures of the conceptual (grapes) and perceptual (balloon) alternatives asking: "Can you tell me which one is also a *Bliket*?" Children had to extend the word to one of the alternatives displayed. As in the comparison condition, the experimenter provided contingent category information, now in a form of conceptual properties, and feedback.
3. *Information-only*. After the pretest, the experimenter added a standard-object to the one already displayed in the pretest (e.g., apple + strawberry). Children were simply exposed to both kinds of object information (comparison + conceptual properties) at the beginning of the test, but no further contingent information or feedback was provided. For example, the experimenter labeled two standard-objects saying: "Look at these, this is a *Bliket* (apple) and this is also a *Bliket* (strawberry). Can you see how both are *Blikets*? (pointing to both objects). I will tell you something else very special about *Blikets*: *Blikets* like these are born from a little seed and they grow up in plants. Did you know that?" Then, she asked the child to repeat what she had just said. Next, she laid down the two alternatives (conceptual and perceptual) asking the child: "Can you tell me which one is also a *Bliket*?" Four consecutive trials followed.
4. *Feedback-only*. With the standard-object of the pretest already displayed, the experimenter said: "Look at this; this is a *Bliket* (apple)." Then, she laid down pictures of the two alternatives (taxonomic and perceptual) and asked: "Can you tell me which one is also a *Bliket*?" As in the other conditions, children had to extend the word to one of the alternatives displayed. If children extended the novel word *perceptually*, the experimenter said: "W.P. told me that it is not a *Bliket* (pointing the child's choice); he told me that this is a *Bliket* (pointing the taxonomic one)". Immediately after, the experimenter presented the next trial. If children extended the novel word *taxonomically*, the experimenter said: "Very good! W. P. told me that it is a *Bliket*." If they extended the novel

word perceptually, she corrected them saying: "No, Winnie the Pooh says that it is not a *Bliket"* (pointing the perceptual match). After each trial and during the whole process, the experimenter gave explicit feedback to the child, but no category information was provided.

Posttest Immediately after the training, children's category performance was assessed following the same general procedure of the pretest. The experimenter presented the standard item (e.g., apple) saying: "This is a *Bliket* in W.P. talk," requesting the child to repeat the novel word. She then laid the pictures of the two alternatives, the taxonomic choice (banana) and the perceptual choice (ball) asking the child: "Can you tell W.P. which one of these is also a *Bliket?"*

During the entire task and for all conditions, the order of presentation of the trials was counterbalanced across subjects. The location (left–right) of each of the two choices (conceptual, perceptual) relative to the child was counterbalanced within each individual.

The predictions were: First, 3-year-old-children will be more likely to categorize perceptually in their initial spontaneous choices (pretest). Second, children who receive either comparison or conceptual-based information in co-occurrence with socio-pragmatic support will be more likely to make the shift to a taxonomic categorization. In contrast, children who either are exposed only to category information or feedback will continue categorizing perceptually. Finally, the analyses inside the comparison and conceptual-based conditions will reveal differences in the amount of assistance required for the children to complete the task.

Results

Effects of the training conditions on the conceptual response rate

Analyses were performed on the number of conceptual responses; percentages are also informed for clarity purposes. First we analyzed the rate of conceptual responding in the pretest and posttest as a function of condition (Fig. 3). In the pretest of all conditions, children made

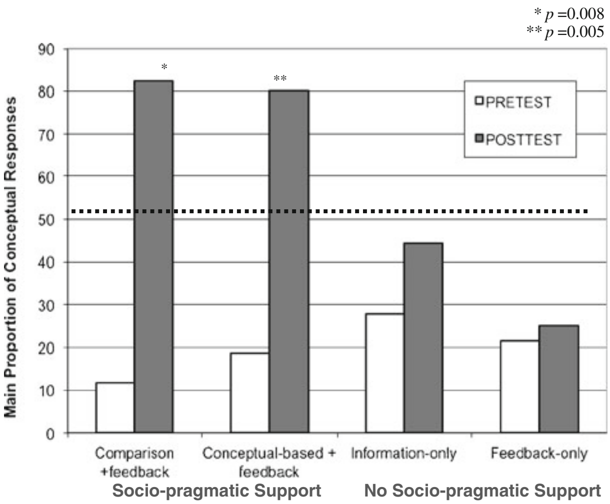

Fig. 3 Rate of conceptual responses in the pretest and posttest as a function of condition (*p=0.008, **p=0.005)

less conceptual responses than expected by chance (0.50). Comparison condition, 2 /17 (11.8 %), $x^2_{(17)}$=9.9, gl. 1, p<0.002; conceptual-based condition, 3/16 (18.8 %), $x^2_{(16)}$=6.2, gl. 1, p<0.01; feedback-only condition, 3/14 (21.4 %), $x_{(14)}{}^2$=4.5, gl. 1, p<0.03; information-only condition, 5/18 (27.8 %) $x_{(18)}{}^2$=3.5, gl. 1, p=0.06).

In the posttest, only the children in the comparison or conceptual-based condition made more taxonomic responses than expected by chance. Comparison-condition, 14/17 (82.4 %), $x_{(17)}{}^2$=7.1, gl. 1, p<0.008; conceptual-based condition, 14/16 (81.3 %), $x_{(16)}{}^2$=8.04, gl. 1, p< 0.005. In contrast, in the information-only and feedback-only conditions, children's taxonomic responses continued at chance levels. Information-only condition, 8/18 (44.4 %), $x_{(18)}{}^2$=0.2, gl. 1, 35, p=0.63; feedback-only condition, 5/14 (35.7 %), $x_{(14)}{}^2$=1.1, gl. 1, p=0.28.

To test whether the proportion of taxonomic responses increased and the proportion of perceptual responses decreased from pre- to posttest in each condition, we first compared the proportion of taxonomic responding before training. All children in the pretest selected the same proportion of taxonomic choices when extending a novel word to an object, x^2=1.4, gl. 3, p=0.60.

Then, we compared the proportion of taxonomic responding between pretest and posttest in each condition. Given that the data were nominal (perceptual/taxonomic) and the distribution of scores was not symmetrical, the McNemar test for related samples was considered appropriate for statistical analyses.

After training, children in the comparison condition selected more taxonomic responses (82.4 %) than in the pretest (11.8 %), McNemar, p<0.001, and so did children in the conceptual-based condition—posttest 81.3 % vs. pretest 18.8 %, McNemar, p<0.002. In contrast, no significant increase in taxonomic responses from pre- to posttest were found either in the information-only (27.8 % vs. 44.4 %, McNemar, p=0.3) or in the feedback-only condition (21.4 % vs. 35.7 %, McNemar, p=0.5).

These results reflect that, even though most children formed perceptual categories in the pretest, only the groups who were trained with category information and socio-pragmatic support were more likely to override their preference to categorize perceptually and to form taxonomic categories in the posttest. In contrast, the groups who solely received category information or feedback continued categorizing on the basis of perceptual relations. These results also show that, both kind of trainings, comparison and conceptual based, were effective.

Effects of the training process as a function of the trial number

Given the considerable conceptual advances made by children in the instruction conditions, at which point in the training process did they improve the most? To address this question, we compared the proportion of conceptual responses between the pretest and each of the four trials of the training process (Fig. 4). In the conceptual-based condition, children progressed between the pretest and each one of the four trials—pretest (18.8 %)–trial 1 (68.8 %), McNemar p<0.008; pretest (18.8 %)–trial 2 (75 %), McNemar p<0.012; pretest (18.8 %)–trial 3 (81.3 %), McNemar p<0.002; and pretest (18.8 %)–trial 4 (93.8 %) McNemar p<0.001. However, only in the third and fourth trials did they select taxonomic responses reliably above chance: trial 3, x^2=6.2, p< 0.002; trial 4, x^2=12. 2, gl 1, p<0.001.

In the comparison condition, the progresses took place between the pretest and the second trial (pre-test 11 %–trial 2, 58.8 %, McNemar, p<0.05) and between the pretest and the fourth trials (pre-test 11 %–trial 4, 76.4 %, McNemar, p<0.003), but only in this last trial children selected conceptual responses above chance (x^2=4.7, p<0.05).

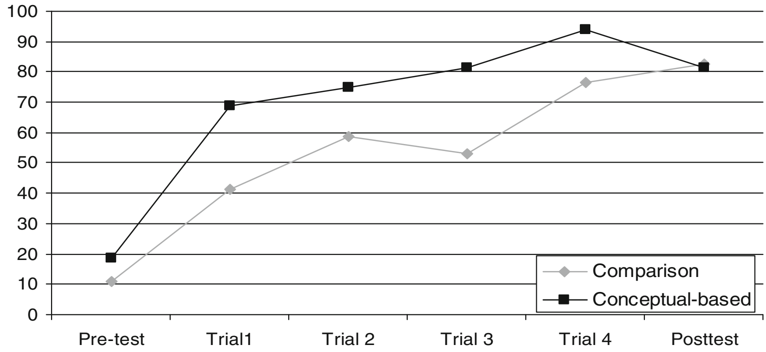

Fig. 4 Proportion of conceptual responses during the training process by conditions

Effects of the training as a function of the amount of category information

We also analyzed the amount of pieces of information (comparisons or conceptual information) children required during the training process by condition. In the *comparison condition*, 17 children needed a total of 39 comparisons (11 children required three, two required two, and two children one) while, in *conceptual-based condition*, 16 children required a total of 24 conceptual properties (two required three, six required two, six required one, and two, none). The amount of pieces of category information the children required differed between conditions (Mann–Whitney U test, $z=2.4$, $p<0.013$).

These results show that the group who was trained by conceptual-based condition needed less category information than the group who was trained with comparisons. In the conceptual-based condition, children's performance improved along the four trials, and the assistance was gradually reduced. In the comparison condition, children's progression was irregular, and they needed more help to succeed.

Discussion

This study was designed to assess the role of cognitive capacities in combination with socio-pragmatic support in young children taxonomic categorization. The results clearly show the necessity of the co-occurrence of both sorts of support. Initially, most children categorized familiar objects perceptually. However, when they were provided with contingent category information and feedback in an interactive process, they detected taxonomic relations and used this new criterion in their categorizations.

It seems unlikely that the taxonomic-shift found in the comparison and conceptual-based conditions could have been driven solely by the information children were exposed to. If that were the case, we should have found such shift in the information-only condition as well. It also seems improbable that the results might have stemmed exclusively from the corrective feedback. In the feedback-only condition, children were given feedback, but they did not make significant progresses.

It appears that children needed something more than solely category information or corrective feedback to refine their conceptual understanding. Rather, children needed to be engaged in a dynamic process with an adult gauging their performance, indicating what entities must be compared or what properties must be inferred, and taking responsibility for the management of the interaction.

The results of this experiment also show that, even though both kinds of instruction led to a conceptual shift, there were differences in the course of children's learning depending on the sort of training received. The learning process was gradual when children’s performance was supported by conceptual properties, and they needed less help to succeed. In contrast, when children’s execution was guided with comparative information, their progress was irregular and required more prompts.

General discussion

The present research aimed at presenting an integrative approach to the development of categorization focusing on the type of information that children might be sensitive to and the social context in which that information is provided. Results indicate that the provision of comparative or conceptual information along with explicit corrective feedback can support taxonomies, while providing information (of both types) or feedback alone cannot.

Specifically, our findings show that, although 3-year-olds did not focus on taxonomic relations on their own, they detected them after being trained in collaborative contexts. This conceptual shift was the result of the co-occurrence of young children conceptual capacities and the socio-pragmatic support.

The evidence presented is particularly relevant for taxonomies in which the linguistic–propositional format codes and transmits categorization properties allowing young children go beyond the object’s perceptual appearance they tend to rely on. It is consistent with the idea that taxonomic formation depends on the experience with the shared representational format of language in interactive contexts (Nelson 1996; Nelson and Nelson 1990; Yu and Nelson 1993).

In a broader perspective, this research is in line with a conception of cognitive development as a construction of representational systems (in which taxonomic thinking is one of the most powerful), thanks to the children's experiences with more competent adults and a conventional language. Cognitive development, then, is the result of a collaborative construction in which the child’s individual activity is as crucial as the interaction with the social world (Nelson 1996).

Although children do possess certain cognitive skills that enable them to form categories (e.g., comparison, conceptual-based inferences), the acquisition of the taxonomies of a given cultural and linguistic community is a result of exposure to and experience with the socio-pragmatic support and the language used to formulate them. As conceptual structures are linguistic organizations, in order to understand the ways in which language categorizes the surrounding world, it is necessary for the child to be exposed to social interactions with others. This may explain why taxonomies become refined rather late in development, as many studies have shown (e.g., Benelli 1988; Greene 1994; Imai et al. 1994; Winer 1980; “Experiment 1” in this paper).

The differences found in the speed at which children adopted taxonomic categorization may be explained within the frame of the mechanisms involved. Comparison promotes taxonomic commonalities as a result of a structure–alignment inferential mechanism based on implicit processes. Conceptual-based input leads directly to the specific category domain providing an explicit, articulated, and culturally reliable piece of knowledge. Furthermore, the comparison mechanism simply compares two pictorial representations which probably do not have a particular meaning beyond themselves, while the conceptual vignettes open up a representational world probably more interesting and more linked to the child's experience. This issue seems particularly relevant to the theoretical debate concerning the role of perceptual versus conceptual information in guiding early categorization and word learning and might explain why conceptual-based training resulted to be more rapid and stable across trials.

Altogether, the results can be interpreted in terms of the notion of rate of change as a function of training put forward by Opfer and Siegler (2004), who stated that it is possible to induce category changes in experimental contexts. According to Keil (1999), children and adults often come to new insights not because of underlying conceptual revolutions (Kuhn 1982) but rather because they place an already present explanatory system in a new set of phenomena. The perceptual-to-taxonomic shift observed in this research might be explained in the context of this notion of category change. When 3-year-olds started the task, they categorized objects relying mostly on perceptual properties. When they were guided with cues aimed at making explicit the conventional taxonomic relations, they went beyond object perceptual similarities and adopted a new criterion according to taxonomic relations. The perceptual-to-taxonomic-shift observed in this work parallels patterns found in other cognitive fields: such as the perceptual–functional shift (Bruner et al. 1956), the characteristic-to-defining shift (Keil 1989; Keil and Batterman 1984), and the relational shift (Gentner 1988).

To conclude, the research presented underscores the importance of considering the powerful relation between children's conceptual categories and the socio-pragmatic support in order to explain the underlying mechanisms that shape category understanding. Mastering taxonomies and using them at a young age seem to require of an explicit guidance aimed at highlighting the conceptual status of the taxonomies that encode our knowledge of the world.

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Appendix A

Table 2 List of items in "Experiment 2"

Pretest			
	Fruit ("Bliket")	Animal ("Dax")	Vehicle ("Nec")
Standard	Apple	Snake	Bike
Alternatives			
Perceptual	Balloon	Belt	Glasses
Conceptual	Black grapes	Cow	Skate

Training			
Comparison/information-only conditions			
Standards	Apple, strawberry, watermelon	Snake, caterpillar, snail	Bike, motorbike, tricycle
Alternatives			
Trial 1			
Perceptual	Lollipop	Lace	Dumbbell
Conceptual	Tangerine	Butterfly	Lorry
Alternatives			
Trial 2			
Perceptual	Light-bulb	Hose	Binoculars
Conceptual	Peach	Cat	Car
Alternatives			
Trial 3			
Perceptual	Peaked cap	Scarf	Sunglasses
Conceptual	Green grapes	Rabbit	Bus
Alternatives			
Trial 4[a]			
Perceptual	T-shirt	Umbrella	Shoe
Conceptual	Plum	Pig	Plane
Conceptual-based/feedback-only conditions			
Standard	Apple	Snake	Bike
Alternatives			
Trial 1			
Perceptual	Lollipop	Lace	Dumbbell
Conceptual	Tangerine	Butterfly	Lorry
Alternatives			
Trial 2			
Perceptual	Light-bulb	Hose	Binoculars
Conceptual	Peach	Cat	Car
Alternatives			
Trial 3			
Perceptual	Peaked cap	Scarf	Sunglasses
Conceptual	Green grapes	Rabbit	Bus
Alternatives			
Trial 4			
Perceptual	T-shirt	Umbrella	Shoe
Conceptual	Plum	Pig	Plane
Posttest			
Standard	Apple	Snake	Bike
Alternatives			
Perceptual	Ball	Rope	Glasses
Conceptual	Banana	Dog	Scooter

[a] The fourth trial was designed as a control. As in each triad, it consisted in the standards and two matches; however, neither *was perceptually similar* to the standards. For example, the *Fruit Set* had a target (apple) and two alternatives: one conceptual (plum) and one neither conceptual nor perceptual (e.g., T-shirt). This trial was designed to identify participants whose responses during the training were biased to select the match that was not perceptually similar to the target, independently of any understanding of taxonomic category

Appendix B

Table 3 List of vignettes in "Experiment 2"

Fruit-kind	
Prompt 1:	*"Blikets like this one were born from a little seed and grow up in plants."*
Prompt 2:	*"If we give water to Blikets they grow up and become taller."*
Prompt 3:	*"Blikets like this are used to eat and W. P. loves eating Blikets!"*
Animal-kind	
Prompt 1:	*"Daxs like this one have babies to whom they look after every day."*
Prompt 2:	"*When babies Daxs miss their Moms, they run quickly and give them a lot of kisses."*
Prompt 3:	*"Daxs like this one are very little at first, but then they grow up and become older."*
Artifact-kind	
Prompt 1:	"*W.P. uses Necs like this one to go around."*
Prompt 2:	"*W.P. uses Necs like this one to drive to the beach in Summer time."*
Prompt 3:	*"W.P .gets on Necs like this to fly away from home."*

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