The role of associative strength and conceptual relations in matching tasks in 4- and 6-year-old children

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The associative strength between target and associates, a factor assumed to be critical but generally not controlled, and the type of conceptual relation (thematic and taxonomic) were manipulated independently in a matching to sample task to determine their respective effects on the matching behaviour of 4- and 6-year-old children. Perceptual similarity between target and associates was controlled and maintained at a low level. A preliminary task was designed to assess the associative strength between targets and several associated pictures. These judgments served to construct for each child the sets of stimuli used in the matching task. Exp. 1 opposed a strong and a weak associate with the target in different configurations: the sets included a target and two thematic associates, two taxonomic associates or one associate of each type. Children were asked to choose the picture that “went well” with the target. Data revealed the role of associative strength on matching choices. This factor interacted sometimes with the greater availability of thematic relations in 4- and 6-year-old children. In Exp. 2, two other configurations were tested. Thematic and taxonomic associates were both either strongly or weakly related with the target. Results replicated those of Exp. 1 and extended them. They showed that younger children were biased towards thematic relations only when these relations corresponded to strong associations. Thus, increasing experience with objects appears to reinforce both associative strength and thematic orientation. Finally, in Exp. 3, instructions orienting toward taxonomic choices modified responses in 6-year-olds only. Altogether, these results show the influence of specific instances and suggest that preschoolers’ matching decisions are partly stimulus driven.
More recently, preference has been shown to vary from 3 to 15 years (Greenfield & Scott, 1986). Others found a thematic preference at all ages (Smiley & Brown, 1979), whereas followed by a taxonomic preference at around 10 years of age (Bauer & Mandler, 1989; Daehler, Lonardo, & Bukatko, 1979; Scott, Serchuk, & Mundy, 1982). Yet some authors reported a thematic preference in children aged from 4 to 6 years (Dunham & Dunham, 1995), and (2) across situations (e.g., Baldwin, 1992; Deák & Bauer, 1995; Golinkoff, Shuff-Bailey, Olguin, & Ruan, 1995; Imai, Gentner, & Uchida, 1994; Markman & Hutchinson, 1984; Waxman & Namy, 1997). Additionally, other research (Osborne & Calhoun, 1998; Walsh, Richardson, & Faulkner, 1993) underlined the influence of the specific exemplars selected by the researcher to instantiate each type of relation (see also Lin & Murphy, 2001, for similar results in adults).

For instance, previous research showed the critical role of perceptual similarity between exemplars. In matching studies in which this factor was not controlled, it was concluded that young children generalized new names on the basis of taxonomic membership (e.g., Markman & Hutchinson, 1984). But in following experiments in which perceptual similarity and taxonomic membership were decorrelated, authors reported that children relied on both factors to generalize new names (e.g., Baldwin, 1992). Analogously, some “category-specific” deficits disappeared when the characteristics of the presented items such as frequency, familiarity, or visual complexity were controlled (e.g., Caramazza & Shelton, 1998).

Taxonomic relations refer to representations of objects of the same kind belonging to a semantic category (e.g., animals, vehicles), whereas thematic relations correspond to an organization of knowledge in terms of familiar scenes or events (e.g., playing football includes elements of different kinds such as a football player, a ball, boots, etc.). In matching to sample tasks contrasting taxonomic and thematic associations, children’s performances have often been interpreted in terms of a “conceptual preference” (Greenfield & Scott, 1986; Smiley & Brown, 1979) for one type of categorical relation. “Conceptual preference” was deduced from the observation of a majority of taxonomic or thematic choices when children were instructed to match one of two objects with a target (“which one goes with the target?”). In fact, it was supposed to reflect the accessibility of one type of relation at a given age.

Taxonomic and thematic relations are available early (Bauer & Mandler, 1989; Daehler, Lonardo, & Bukatko, 1979; Scott, Serchuk, & Mundy, 1982). Yet some authors reported a thematic preference in children aged from 4 to 6 years, followed by a taxonomic preference at around 10 years of age (Smiley & Brown, 1979), whereas others found a thematic preference at all ages from 3 to 15 years (Greenfield & Scott, 1986). More recently, preference has been shown to vary from 3 to 15 years (Greenfield & Scott, 1986).
clustering, recognition, or priming has been previously studied in adults (e.g., Cramer & Eagle, 1972; La-Heij, Dirkx, & Kramer, 1990; Mathews, Maples, & Elkins, 1981) and in children (e.g., Bjorklund & de Marchena, 1984; Frankel & Rollins, 1985; Krackow & Gordon, 1998; McCauley, Weil, & Sperber, 1976; Nation & Snowling, 1999). For instance, Nation and Snowling tried to dissociate pure semantic priming (activation of semantic information only) from “associate” priming for taxonomically and functionally (i.e., thematically) related items in 10-year-olds. Children were presented with a verbal priming task in which prime and target words were either highly associated or not (verbal association task). Results showed that the priming effect depended on the level of associative strength for both relations. Hence, associative strength seems largely involved in automatic priming effects in children for taxonomic and thematic relations (see also McCauley et al., 1976, for priming with pictorial stimuli in 6- and 8-year-olds). Yet its effects in categorization tasks in which less automatic comparison processes are likely to be required remain unexplored.

The aim of this research is to give an account of the influence of associative strength on matching behaviour apart from the conceptual relations shared by the objects. If an associate is more strongly related to the target than to the other object, its activation might be more automatic and might compete or interfere with the more controlled comparison process that is supposedly required when choosing between several associates (Crowley, Shrager, & Siegler, 1997).

Thematic relations among objects come mainly from individual experience with specific episodes in which these objects were involved. Therefore, association strength should be highly variable depending on the specific presented objects. Alternatively, taxonomic relations are likely to be formed on multiple bases: By extracting common properties among objects, perceptual and more abstract ones, and by noticing generic names. Yet, one can assume that the extraction of some common properties also derives from episodic encoding. It might be the case for perceptual properties and for some functional properties that might emerge because objects play the same role in a given event or scene (i.e., slot-filler categories such as things eaten at breakfast; Nelson, 1983; 1986). The potential episodic basis of taxonomic relations was simulated by connectionist networks (Mareschal & French, 2000; Quinn, French, & Mareschal, 2000). With perceptual attributes as inputs, networks performed taxonomic-like categorization, and reproduced categorization behaviour of 3-month-old infants (Quinn, Eimas, & Rosenkrantz, 1993). In simulations like those in infants, extension of categories depended on the level of perceptual similarity. Hence, perceptual similarity might modulate the associative strength between taxonomically related objects in infants. It might also be the case in young children, since perceptual similarity still influences categorization behaviour later in childhood (e.g., Baldwin, 1992; Jones & Smith, 1993; Landau, Smith, & Jones, 1988). The direct consequence is that associative strength should probably depend on the hierarchical level of categories, exemplars from basic-level categories being more strongly associated than exemplars from superordinate ones because of their greater perceptual similarity (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976). Even perceptually dissimilar objects are likely to be more strongly associated when they belong to a basic-level category because they also share more nonperceptual common properties than exemplars from superordinate categories (Rosch et al., 1976). It is assumed that exemplars from slot-filler categories should be associated at an intermediary level: As superordinate categories, they share few common properties with the target, but unlike them they belong to a common context, which should increase associative strength.

In a very different theoretical framework, Nelson’s conception also illustrates the experiential (or episodic) basis of taxonomic categories, which might derive from event schemas (Nelson, 1983, 1986). Taxonomic categories would first appear as contextualized groupings with a limited extension—slot-filler categories are composed of objects of the same kind that belong to a given schema—before becoming decontextualized groupings, i.e., superordinate categories. Hence, associative strength between taxonomically related objects might vary depending on whether they share thematic relations or not. It should be the case in both children and adults because schemas still play an important role in categorization later in life (Lin & Murphy, 2001; Ross & Murphy, 1999; Vallée-Tourangeau, Anthony, & Austin, 1998). All these arguments contribute to emphasize the link that might exist between taxonomic representations and episodic encoding in all individuals.

As previously noted, performances in matching tasks are generally reported as mean percentages of taxonomic or thematic choices computed across subjects and items. From these means, conclusions are drawn regarding the accessibility of taxonomic and thematic relations as a function
of age and/or situation. But associative strength between targets and associates are never controlled. Some authors checked by mean of a control group that children properly identified the presented associations (Blaye & Bonthoux, 2001; Waxman & Namy, 1997), but this might be insufficient since it is unlikely that (1) two associates would be equivalently related to a given target, (2) all the associates of a same type (taxonomic or thematic) would be equivalently related across targets, and (3) the associative strength of a given associate would be judged equivalent by different children. Altogether, these considerations lead us to study the relative effects of associative strength and type of relation, taxonomic or thematic, in determining children’s matching choices.

In the following experiments, associative strength between target and associates, a factor assumed to be critical but which is generally not controlled, and type of relation (thematic and taxonomic) were manipulated independently to determine their respective effects in matching tasks; perceptual similarity was controlled and maintained at a low level.

**EXPERIMENT 1**

Performances of 4- and 6-year-old children were assessed in a matching task after they had judged, in a previous session, the associative strength between targets and several associated pictures. These judgments served to construct the sets of stimuli used in the matching task for each child. It is worth noting that in memory studies, associative strength corresponded to the production frequency of words in verbal association or exemplar generation tasks, and thus was a measure of lexical association. Here, since the matching task involved pictorial stimuli, judgments of associative strength were made on pictures.

To show the influence of associative strength and conceptual relation on matching, each target was presented along with two associated pictures of opposite associative strength in two types of configurations. In homogeneous configurations, both associates shared the same conceptual relation with the target (i.e., a strong and a weak thematic associate, Th+ and Th−, or a strong and a weak taxonomic associate, Ta+ and Ta−). In heterogeneous configurations, conceptual relations differed (i.e., a strong thematic and a weak taxonomic associate, Th+ and Ta−, or a strong taxonomic and a weak thematic associate, Ta+ and Th−). Children were required to choose the best match with the target (“which one goes best with?”). This instruction was selected because it was nonconstrained. Since it does not specify whether the child must choose an object of the same kind as the target (taxonomically related) or an object of a different kind, which belongs to the same event or scene as the target (thematically related), it allows us to observe how children spontaneously interpreted the task (Deák & Bauer, 1995).

Hence, if matching choices under nonconstrained instructions were predominantly guided by associative strength, strong associates should be more frequently chosen than weak associates in all configurations. Alternatively, if both associative strength and conceptual relation had an influence on matching choices, this pattern should still be observed in homogeneous configurations but not in heterogeneous configurations. More precisely, because in previous research young children demonstrated thematic preference in conditions of nonconstrained instructions (i.e., “best match,” see, for example, Smiley & Brown, 1979), they might choose thematic associates even when these associates are weakly related to the targets.

**Method**

**Participants**

Twenty-two French children participated in the main study: eleven 4-year-olds (second year in nursery school, mean age 4;9 years; range 4;4 to 5;2) and eleven 6-year-olds (first grade in primary school, mean age 6;11 years; range 6;7 to 7;2). Written parental consent for the children’s participation was obtained. Two children (one 4-year-old and one 6-year-old) were not included in the analyses due to poor understanding of the associative strength judgment task.

Twelve additional children (six from each age group) participated in a pretest phase. They were administered a verbal association task which helped to choose items. Ten adults rated the perceptual similarity between the targets and their corresponding associates.

**Stimuli**

Seventy-seven black-and-white drawings of objects included in a 7 x 9 cm rectangle were used as stimuli: There were 11 targets and, for each target, 3 taxonomic and 3 thematic associates (see Appendix A). Perceptual similarity between each associate and its corresponding target was low. Fourteen targets were initially
selected but three of them were excluded because the mean similarity rating of at least one pair of target and associate exceeded 4 on a scale from 1 (perceptually dissimilar) to 9 (perceptually similar).

The three taxonomic and the three thematic associates of a given target were chosen to correspond a priori to three levels of associative strength (strong, medium, and weak, see Appendix A). Taxonomic associates corresponded to three hierarchical levels. For instance, for the target “dog,” the supposedly strongest associate (Ta1) was another dog, i.e., an exemplar from the same basic-level category; the supposedly medium associate (Ta2) was a guinea-pig, i.e., an exemplar from the same slot-filler category of pets; and the supposedly weakest associate (Ta3) was a snake, i.e., an exemplar from the same superordinate category of animals.

Thematic associates were selected from a verbal association task. During a pretest phase, children were asked to say the first words that came to their mind in response to target names. The most frequent names produced at the beginning of the task were considered a priori as the strongest associates (Th1), the least frequent names produced later as the weakest associates (Th3), and the medium associates (Th2) chosen from names that meet neither of these criteria. It was expected that children would judge Ta1, Ta2, Ta3, and Th1, Th2, Th3 as being sufficiently different in associative strength to be able to extract a strong (+) and a weak (−) associate for each target and type of relation (Ta and Th) for each child.

Procedure

Children were run individually in a quiet room of their school. All of them participated in two successive sessions separated by a 1-week delay. First, they judged the associative strength of all the pairs targets and associates. Ratings were then analysed to extract for each child and each target a strong and a weak thematic associate (Th+ and Th−) and a strong and a weak taxonomic associate (Ta+ and Ta−). Second, children performed a matching task in which strong and weak associates were contrasted.

Session 1: Judgments of associative strength

Children made two successive series of judgments. They first judged the associative strength on a scale from 0 to 10 for all the pair targets and associates (6 judgments—Ta1, Ta2, Ta3 and Th1, Th2, Th3—for each of 11 targets). The target was presented above the associate. To adapt the task for young children, the scale was analogous to the pain scale used by physicians. The child was asked: “show me with the little hand (the cursor) if both pictures go together very strongly (showing the highest levels at the top of the scale), moderately strongly (showing the levels at the middle of the scale) or not strongly (showing the lowest levels at the bottom of the scale).” At the start of the session, an example of judgment was provided: details were added as to the differentiation even degrees for each level—strongly, moderately strongly, and not strongly associated items. Then, the child made a series of 12 judgments (2 targets × 6 associates) to learn to use the scale. During these familiarization trials (see Appendix A), which are not included in the analyses, additional explanations were sometimes given. Finally, the child judged the remaining pairs (9 targets × 6 associates), which were presented in a fixed pseudorandom order (a given target never appeared on two successive trials).

This spontaneous judgment phase was followed by a more constrained one to ensure that a strong and a weak associate could be extracted for each child, target, and type of relation. The three taxonomic or three thematic associates were shown simultaneously with each corresponding target. The child was required to order the three pictures as a function of their associative strength with the target.

Spontaneous associative strength judgments were analysed first. For each child, when the three judgments (three taxonomic or three thematic associates for a given target) differed between each other by at least 1 point, weak and strong associates were chosen on the sole basis of the spontaneous judgments. Alternatively, constrained judgments were used (1) when the three associates were judged to be equivalent and (2) when two associates were judged to be equivalent and the third was clearly distinct. In this case, if both spontaneous and constrained judgments indicated the same strong or weak associate, constrained judgments served to select among the two others. If, however, spontaneous and constrained judgments were not consistent regarding the distinct associate, the spontaneous judgment was retained for it and the choice between the two others was made at random (this last method concerned less than 10% of the judgments at each age). From these analyses, a strong and a weak taxonomic associate (Ta+ and Ta−) and a strong and a weak thematic associate (Th+ and Th−)
were selected for each child and each target to be used in the following matching task.

**Session 2: Matching task**

A week later, children performed a picture-matching task. On each trial, the target was shown first, followed by two comparison pictures associated to the target. Associates were placed side by side below the target. After pointing to the target (saying “see this one?”), the experimenter asked, pointing successively to the two comparison pictures: “which one goes best with it?” (in French: “lequel va le mieux avec?”)

Children were asked to choose among two associates, one strongly and the other weakly associated to the target. They were shown four configurations for each target. In two configurations, called homogeneous, either two taxonomic associates (Ta+Ta−) or two thematic associates (Th+Th−) were contrasted. In two other configurations, called heterogeneous, a taxonomic and a thematic associate were contrasted (Th+Ta− and Ta+Th−). As in the judgment session, two targets served in familiarization trials and nine targets in test trials (four configurations for each). There were therefore 8 familiarization triads and 36 test triads; half were homogeneous and half were heterogeneous configurations. The nine test targets appeared in a different random order in each of four blocks with the four types of configurations roughly counterbalanced across the blocks. The spatial position of the two associates (strongly and weakly related, and taxonomic and thematic for heterogeneous configurations) was counterbalanced across items in each block.

**Results**

As judgment of associative strength is an original methodology, the first analyses are intended to validate the scale. The following analyses are aimed at testing the effects of associative strength and type of relation in the matching task.

**Judgments of associative strength**

At a descriptive level, mean judgments of associative strength reflected fairly the degrees established prior to the experiment. For taxonomic associates, associative strength covaried with category level: 66% of the strong taxonomic associates (Ta+) were basic-level associates (Ta1) and 66% of the weak taxonomic associates (Ta−) were superordinate associates (Ta3); slot-filler associates (Ta2) corresponded equally often to strong and weak associates (respectively, 24% and 23%). For thematically related pictures, associative strength was more variable but reflected roughly the levels established during the pretest: strongly related pictures (Th+) were predominantly Th1 associates (59%) and weakly related pictures (Th−) were predominantly Th3 associates (54%). This means that the task was generally well understood and that judgments of associative strength appeared to be valid. To check that strong and weak associates were well differentiated, mean judgments for each configuration of the subsequent matching task were compared (Ta+ vs. Ta−, Th+ vs. Th−, Th+ vs. Ta−, and Ta+ vs. Th−). All t-tests comparisons were significant in 4- and in 6-year-old children (p < .001).

**Matching task**

The following analyses concerned the matching task. The dependent variable was the number of strong associates (“+choices”) chosen by age (4 vs. 6 years) and configuration (Th+Th−, Ta+Ta−, Th+Ta−, Ta+Th−, see Table 1). To test the global effect of associative strength, t-tests were first performed against chance for homogeneous configurations (Th+Th− and Ta+Ta−) at each age. As indicated in Table 1, all percentages significantly exceeded 50%. These results show that associative strength reliably influenced choices in young children. Then, two alternative hypotheses about the importance of associative strength could be differentiated. If associative strength was the main determinant of matching performances, then “+choices” should be still predominant in heterogeneous configurations. Alternatively, if both associative strength and type of conceptual relation influenced choices, then “+choices” should vary in heterogeneous configurations depending on which associate was the most strongly related to the target. Because it has been shown that young children preferred thematic relations under nonconstrained instructions (Greenfield & Scott, 1986; Smiley & Brown, 1979; Waxman & Namy, 1997), their “+choices” might be predominant in Th+Ta− configurations but not in Ta+Th− configurations.

Results are not consistent with the first hypothesis and they support the alternative one, since “+choices” were predominant in Th+Ta− configurations (t-tests against 50% were significant at both ages), but did not differ from chance level in Ta+Th− configurations (Table 1). Hence, associative strength is not the only factor affecting
young children’s performances in the matching task; conceptual preference also plays a role.

An analysis of variance was then performed on the number of “+choices” with age (4 vs. 6) as a between-subjects factor, configurations (homogeneous vs. heterogeneous) and type of relation of the strong associate (Th vs. Ta) as within-subjects factors. There was a main effect of age, F(1, 18) = 9.91, p < .01, and an interaction between age and type of relation, F(1, 18) = 5.21, p < .05. The “+choices” produced by 6-year-old children exceeded those of 4-year-olds (89% and 71%, respectively) but the superiority of 6-year-olds’ “+choices” was greater when the strong associate was thematic rather than taxonomic. The analysis also revealed main effects of configuration, F(1, 18) = 21.13, p < .01, and type of relation, F(1, 18) = 6.47, p < .05, and an interaction between both factors, F(1, 18) = 39.73, p < .01. Homogeneous configurations led to more “+choices” than heterogeneous ones and “+choices” were more often thematic than taxonomic. More importantly, regarding the influence of associative strength and conceptual relation, the strong associate was more frequently chosen in homogeneous than in heterogeneous configurations when it was taxonomic, HSD Tukey test, p < .05, but equivalently chosen in both configurations when it was thematic, HSD Tukey test, p > .10.

**Discussion**

The original methodology used here revealed that valid assessments of associative strength could be collected in 4- and 6-year-old children and that this factor played an important role in matching tasks.

Judgments of associative strength were collected for taxonomically and thematically related pairs of pictures for which perceptual similarity was low. Regarding taxonomic relations, strong associations corresponded mainly to basic-level pairs (e.g., a dog with the target “dog”) and weak associations to superordinate pairs (e.g., a snake with the target “dog”). Hence, the order of associative strength between picture pairs reflected roughly taxonomic hierarchies in 4- and 6-year-old children, independently of perceptual similarity. Concerning thematic relations, stimuli were selected from a verbal association task since no a priori hierarchy could be established apart from the children’s experience with objects. Here too, children’s estimates reflected the predicted association levels. Hence, associative strength between pictures covaried with hierarchical levels for taxonomic relations and with verbal associations for thematic relations. These results contribute to validate the judgment scale of associative strength in young children.

Individual judgments were then used to build triads in which a target was presented along with a strong and a weak associate. Results in homogeneous configurations (two thematic or two taxonomic associates) indicated that decision was based on the associative strength at both ages since “+choices” were always predominant. However, associative strength was not the unique decision basis because “+choices” varied in heterogeneous configurations depending on whether the strong associate was taxonomically or thematically related to the target: thematic “+choices” were predominant (Th+Ta− configurations) whereas taxonomic “+choices” were not (Ta+Th− configurations).

Finally, at the developmental level, effects of both associative strength and thematic preference seem to increase with age, as revealed by (1) the superiority of older children’s “+choices”

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**TABLE 1**

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<tr>
<th>Experiment 1</th>
<th>Experiment 2</th>
<th>Experiment 3</th>
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<td>Homogeneous configurations “goes best” instructions</td>
<td>Heterogeneous configurations “goes best” instructions</td>
<td>Heterogeneous configurations “same kind” instructions</td>
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<td><strong>4-year-olds</strong></td>
<td><strong>6-year-olds</strong></td>
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<td>Th+Ta−</td>
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<td>5.90 (66%)</td>
<td>4.70 (52%)</td>
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<td>(9) = 2.32</td>
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**Note:** Mean number of “+choices” (mean percentages in parentheses) observed in Experiments 1 and 3 as a function of configurations and age; values of F-tests against 50% and corresponding p levels are indicated below the corresponding means.
in homogeneous configurations and (2) the interaction between age and type of relation, which showed that “+choices” were even more frequent in 6- than in 4-year-old children for thematic rather than for taxonomic associates. In accordance with the results of Smiley and Brown (1979) and Greenfield and Scott (1986), these data suggest that thematic preference does not disappear between 4 and 6 years of age. On the contrary, it is assumed that increasing experience with objects reinforces both associative strength and thematic links.

To test further the influence of associative strength and type of conceptual relation with age, complementary data were collected. The goal was to directly observe the variation of a given choice as a function of the associative strength level of the alternative option (e.g., the variation of thematic choices as a function of the associative strength level of taxonomic associates). Therefore, the performances obtained in heterogeneous configurations (ThTa) of Experiment 1, in which the associates were of opposed strength (+ and −), were compared to those of equivalent strength (+ and + or − and −) in identical instructions conditions.

**EXPERIMENT 2**

Experiment 1 revealed the role of associative strength on matching performances. This factor interacted sometimes with the greater availability of thematic relations in 4- and 6-year-old children. To further support this interpretation and to better qualify the processes that might underlie choices, performances obtained in the heterogeneous configurations (ThTa) of Experiment 1, in which the associates were of opposed strength (+ and −), were compared to those obtained in the heterogeneous configurations of Experiment 1, where the two associates had different associative strengths (Th+Ta and Ta+Th−).

If associative strength was the main determinant of choices, then “+choices,” either thematic or taxonomic, should increase when the associative strength of the alternative option decreases. In contrast, no variation of “+choices” with associative strength of the alternative option would be observed if this factor had no impact. In addition, a difference between age groups would show developmental differences in the weighting of associative strength and conceptual relations in this situation.

**Method**

**Participants**

The participants were twenty children: ten 4-year-olds (second year in nursery school, mean age 4;9 years; range 4;8 to 5;0) and ten 6-year-olds (first grade, mean age 6;11 years; range 6;7 to 7;4). They came from schools located in the same neighbourhood as those of Exp. 1. A written parental consent was required. Each child performed the tasks individually in a quiet room of his/her school.

**Stimuli**

The pictures were those used in Experiment 1 (see Appendix A).

**Procedure**

The procedure was almost identical to the one used in Exp. 1: Children made two successive series of judgments of associative strength and, 1 week later, performed a matching task with “goes best” instructions. As previously, the triads used in the matching task were constructed for each child as a function of his/her preceding judgments. The only difference with Exp. 1 was that each target appeared only twice in the familiarization and test trials of the matching task since only two heterogeneous configurations (Ta+Th+ and Th−Ta−) were proposed. There were therefore 4 familiarization triads (2 targets) and 18 test triads (9 targets). The nine test targets appeared in a different pseudorandom order in each of two blocks with the two configurations roughly counterbalanced across the blocks. The spatial position of taxonomic and thematic associates was counterbalanced across items in each block.

**Results**

**Judgments of associative strength**

Results were similar to those of Exp. 1. For judgments of associative strength. For taxonomic associates, associative strength covaried with category level: 56% of the strong taxonomic associates were basic-level associates (Ta1) and 55% of the weak taxonomic associates (Ta−) were superordinate associates (Ta3); slot-filler associates (Ta2) corresponded equally often to strong and weak associates (respectively, 28.5% and 25.5%). For thematic associates, responses correspond roughly at the levels established during the pretest: Strongly related pictures
were predominantly Th₁ associates (54.5%) and weakly related pictures were often Th₃ associates (47%).

**Matching task**

In the matching task, thematic choices were predominant in Th⁺Ta⁺ configurations: 66% and 63% in 4- and 6-year-olds, respectively. The comparison with chance level (i.e., 50%) was significant in both groups, respectively, \(t(9) = 4.02, p < .01\), and \(t(9) = 2.32, p < .05\). Thematic choices were also predominant in Th⁻Ta⁻ configurations in 6-year-olds (76%), \(t(9) = 7.04, p < .001\), but not in 4-year-olds (53%), \(t(9) = 1.03, p > .10\).

Performances in heterogeneous configurations when both options were differently associated (Exp. 1) or equivalently associated (Exp. 2) were then compared first on taxonomic choices and second on thematic choices. Taxonomic choices, either strongly or weakly associated, were expected to be more frequent when they were opposed to weak rather than to strong thematic associates (i.e., in Ta⁺Th⁻ than in Ta⁺Th⁺ configurations and in Ta⁻Th⁻ than in Ta⁻Th⁺ configurations). To test these comparisons, an analysis of variance was performed on the number of taxonomic choices, with age (4 vs. 6 years) and type of configuration (different or equivalent strength) as between-groups factors, and with strength of Th (+ and −) as a repeated measure. The planned comparisons contrasting types of configurations (different and equivalent strength) for Ta⁺ and Ta⁻ confirmed the predictions. Taxonomic choices decreased from Ta⁺Th⁻ to Ta⁺Th⁺ configurations (parts a1 and a2 of Figure 1), \(F(1, 36) = 4.16, p < .05\) and \(F(1, 36) = 3.66, p = .06\) at 4 and 6 years, respectively, and from Ta⁻Th⁻ to Ta⁻Th⁺ configurations (parts b1 and b2 of Figure 1), \(F(1, 36) = 4.21, p < .05\), and \(F(1, 36) = 13.93, p < .001\).

An analogous prediction was made for thematic choices: It was expected that they would be modified as a function of the associative strength level of the corresponding taxonomic associates. The analysis of variance performed on thematic choices revealed the expected effects in 6-year-olds: Thematic choices were more frequent in Th⁺Ta⁻ than in Th⁺Ta⁺ configurations, \(F(1, 36) = 24.89, p < .001\) and in Th⁻Ta⁻ than in Th⁻Ta⁺ configurations, \(F(1, 36) = 13.10, p < .01\).
p < .001 (Figure 1). However, 4-year-olds’ thematic choices (either strongly or weakly related to the target) did not vary as a function of associative strength of the corresponding taxonomic associate (Fs < 1): They were predominant when strongly associated (in Th+Ta+ and Th+Ta configurations) but did not differ from chance level when weakly associated (in Th-Ta and Th-Ta configurations), independent of the associative strength of the taxonomic associate.

Discussion

Regarding the associative strength judgment session, results closely replicated those obtained in Experiment 1, in which the procedure was identical. Therefore this experiment adds further validity to the rating scale of associative strength used with 4- and 6-year-old children.

As to the matching task, data provide further evidence that children’s performances were dependent on associative strength. In Exp. 1, this conclusion was essentially drawn from the predominance of “+choices” in both homogeneous configurations, Th+Th− and Ta+Ta−. This conclusion can now be extended since taxonomic associates were chosen more or less frequently as a function of the associative strength level of the corresponding thematic associates at both ages. A similar pattern of results was observed for thematic choices in 6-year-olds, but not in 4-year-olds. Except for this last issue, which will be commented on later, these data confirm the influence of associative strength in matching tasks.

Data of Exp. 2 also support the role of young children’s conceptual orientation in this task. Although the associative strength of the two associates was equated at the individual level (two strong or two weak associates), thematic choices were predominant in 6-year-old children in both configurations (Th+Ta and Th−Ta−) and in 4-year-old children in Th+Ta configurations. In summary, further evidence is provided that associative strength and greater availability of thematic relations interacted in young children’s choices, as was already shown in the first experiment.

Returning to developmental differences, the performances obtained by 4-year-old children differed from those of 6-year-olds on two aspects: (1) there was no variation of thematic choices as a function of associative strength of the corresponding taxonomic associates, and (2) there was no preference in Th−Ta configurations. In fact, whatever the associative strength of the taxonomic associates, children chose predominantly the thematic associates when they were strongly associated to the target but they distributed their choices equivalently when these associates had a low associative strength. The first result suggests that younger children relied less consistently on associative strength than older ones, as was already found in Exp. 1. The second result shows that they were biased towards thematic relations only when these relations corresponded to strong associations, whereas responses were at chance in the case of weak thematic associations.

In other matching studies using identical instructions (i.e., “goes best”), a thematic preference was observed in 4- and 6-year-olds (Smiley & Brown, 1979, 4- and 6-year-olds; Waxman & Namy, 1997, 4-year-olds). Yet this preference disappeared with “goes with” instructions and reversed totally when children were required to find “another one” (Waxman & Namy, 1997). Analogously, instruction effects were observed in a matching task contrasting two associates, one perceptually and the other taxonomically related to the target (Deák & Bauer, 1995): 4-year-old children produced predominant perceptual choices when they were asked to choose “the most like” as the target but predominant taxonomic choices were observed when children were asked to choose “the same kind of thing” as the target. These findings show that instructions can orient children towards taxonomic choices and that the expression of conceptual preference is context-dependent.

Consequently, the effect of instructions was studied in the case of strong thematic links, in which matching seems to be predominantly stimulus-driven. If it were the case, constrained instructions orienting children towards taxonomic relations would conflict with associative strength in Th+Ta− configurations and the thematic preference would disappear. Additionally, this type of instruction should act in the same direction as associative strength and reinforce its effect in Ta+Th− configurations. These predictions were tested in the following experiment.

EXPERIMENT 3

To determine whether children’s matching behaviour was modified by instructions, another group of 4- and 6-year-old children performed the same tasks as in Exp. 1 and 2 (judgments of associative...
strength and matching). The matching task was proposed in a constrained condition of instructions intended to orient towards taxonomic relations. Children were required to choose the picture that was the “same kind” as the target (Deák & Bauer, 1995). Only heterogeneous configurations with contrasted associative strength (Th+Ta− and Ta+Th−) were presented. It was expected that the “same kind” instructions would lead to increased taxonomic choices as compared with the “goes best” instructions used in Exp. 1. Moreover, comparing instruction conditions might also reveal developmental differences and help to specify the basis of matching behaviour in 4- and 6-year-old children.

**Method**

**Participants**

Twenty children participated in the experiment: ten 4-year-old (second year in nursery school, mean age 4;7 years; range 4;4 to 4;11) and ten 6-year-old children (first grade, mean age 6;11 years; range 6;7 to 7;4). They came from schools located in the same neighbourhood as those of Exp. 1 and 2. Written parental consent was required. Each child performed the tasks individually in a quiet room of his/her school.

**Stimuli**

The stimuli were those used in Exp.1 and 2.

**Procedure**

The procedure was the same as in the previous experiments: Children made two successive series of judgments of associative strength and, 1 week later, performed a matching task in which the presented triads were constructed for each child as a function of his/her preceding judgments. The main difference with Exp. 1 and 2 concerned the instructions used in the matching task: Children were asked to choose among two associates “the same kind of thing” (i.e., in French “la même sorte de chose”) as the target (instead of the “goes best” picture). Each target appeared twice in familiarization and test trials since only two heterogeneous configurations with associates of contrasted strength (Ta+Th− and Th+Ta− configurations) were presented. There were therefore 4 familiarization triads (2 targets) and 18 test triads (9 targets). The nine test targets appeared in a different pseudorandom order in each of two blocks with the two configurations roughly counterbalanced across the blocks. The spatial position of both associates was counterbalanced across items in each block.

**Results**

The results obtained in the judgment session replicated fairly those of Exp.1 and 2. Regarding the matching task, “+choices” (Table 1) were still predominant in Th+Ta− configurations at both ages (70% and 73% in 4- and 6-year-old children, respectively); despite the “same kind” instructions, which were intended to orient choices toward taxonomic relations, t-tests against chance were at least marginally significant (Table 1). By contrast, in the Ta+Th− configurations, taxonomic “+choices” became largely predominant in 6-year-olds (87%) as predicted, but remained at chance in 4-year-olds (53%). These results are similar to those obtained in Exp. 1.

Performances in this instruction condition (“same kind”) were then compared with those obtained in Exp. 1 (“goes best” instruction) for the configurations that were presented in both experiments (Th+Ta− and Ta+Th−). An analysis of variance was performed on the number of “+choices,” with age (4 vs. 6 years) and instruction as between-groups factors and type of configuration (Th+Ta− vs. Ta+Th−) as a repeated measure. The difference between instruction conditions was significant in 6-year-olds for both configurations, $F(1, 36)=7.07, p<.05$, and $F(1, 36)=8.91, p<.01$, in Th+Ta− and Ta+Th− configurations, respectively. As predicted, the “same kind” instruction as compared to the “goes best” instruction increased “+choices” in Ta+Th− configurations (from 53% to 87%) and lowered them in Th+Ta− configurations (from 98% to 73%). However, this was not the case in 4-year-olds ($F$ values <1 for both configurations). Instructions did not modify younger children’s choices.

**Discussion**

The main result was that the “same kind” instructions, as compared with the “goes best” instructions, modified choices in 6-year-olds only: As expected, “+choices” in this group increased with “same kind” instructions in Ta+Th− configurations and decreased in Th+Ta− configurations. Hence, the taxonomic orientation stemming from instructions conflicted successfully
with the spontaneous thematic orientation observed under nonconstrained instructions. Percentages of taxonomic choices were particularly high (87%) when associative strength acted in the direction of instructions, as in Ta+Th− configurations. However, instructions were not fully successful when they were in conflict with both associative strength and thematic orientation, since in Th+Ta− configurations, taxonomic choices did not differ from thematic ones. Finally, data show again the greater availability of thematic relations, at least in the case of strong associations in 6-year-old children.

Contrary to the findings of Waxman and Namy (1997), the modification of instructions did not alter the matching behaviour of 4-year-old children. Several factors might explain this discrepancy. First, the instructions that were intended to orient towards taxonomic relations differed between experiments: Children were asked to “find another one” in the Waxman and Namy study and to find “the same kind of thing” in this experiment. The first instructions might be more efficient than the others because they refer more directly to the category name. More importantly, Waxman and Namy’s procedure began with three pretest trials aimed at showing the two different kinds of relations: For thematic relations, the experimenter performed an action with both objects, whereas for taxonomic relations, he/she only tapped them together. In contrast, children’s attention was not drawn to both conceptual relations. Familiarization trials were identical to test trials and served only as a warming-up phase. One might consider that the Waxman and Namy demonstration helped children to discover that both choice options were differently related to the target. This procedure is likely to have increased the activation level of taxonomic relations, leading to the observed difference between experiments. Finally, these results might also result from a linguistic difficulty. “The same kind of thing” which is a usual form in English, was translated by “la même sorte de chose,” which is less usual in French. It is thus possible that some 4-year-old children did not properly understand this form.

**GENERAL DISCUSSION**

The goal of these experiments was to examine the impact of associative strength and conceptual preference in young children’s matching behaviour in the absence of perceptual similarity. To this end, 4- and 6-year-old children first rated the associative strength between perceptually dissimilar picture pairs, and then performed a matching task in which associative strength and type of conceptual relation were manipulated.

The first contribution is to show that valid assessments of associative strength can be collected in young children. The data revealed that associative strength covaried with the hierarchical level for taxonomically related associates, independently of perceptual similarity, and with verbal association for thematically related associates. Due to the consistency across experiments, these results justify the collection of association norms between pictures of objects as a function of age. These norms will allow improvement of the control of the stimuli used in young children’s categorization studies, particularly when studying categorical flexibility (Blaye & Bonthoux, 2001; Bonthoux, Blaye, Cannard, Petit, & Séraphin, 2001). However, individual variability was quite high, which has at least two implications: (1) it seems necessary to include, besides the group results, individual patterns of performances when studying categorization skills in young children, as, for example, did Golinkoff et al. (1995) or Waxman and Namy (1997), and (2) diverse individual patterns in a given situation support pluralistic developmental models rather than unitary ones (Lautrey, in press).

The most important result is the evidence showing the role of associative strength in matching tasks. Results of Experiments 1 and 2, in which nonconstrained instructions were used (“goes best”), support this claim. In Exp. 1, young children reliably selected the most strongly associated picture when both associates were related to the target in the same way (either taxonomically or thematically). In Exp. 2, the choices of strong taxonomic associates varied as a function of the associative strength of the thematic alternatives at both ages (the analogous effect for strong thematic associates was significant in 6-year-olds only). Hence, young children’s matching behaviour depends on associative strength of both choice options and, thus, seems partly stimulus driven. These results add further evidence for the impact of specific instances in matching tasks, as has already been shown by other researchers either indirectly (Walsh et al., 1993), or directly (Osborne & Calhoun, 1998). Although this issue has rarely been raised in the developmental literature on categorization, it is not surprising since adult judgments of similarity
and thematic relatedness are still influenced by stimuli characteristics (Wisniewski & Bassok, 1999).

Associative strength conflicted with thematic orientation (Exp. 1 and 2) since at both ages (1) choices were equivalently distributed among strong taxonomic and weak thematic associates (Exp. 1), and (2) strong thematic choices exceeded strong taxonomic choices (Exp. 2; weak thematic choices also exceeded weak taxonomic choices but only in 6-year-olds). This means that the processing of conceptual relations was biased towards thematic associates in this task. This result was already reported by others (Smiley & Brown, 1979; Waxman & Namy, 1997) with the same instructions (“goes best”). However, data additionally revealed a greater availability of thematic relations even when the associative strength of both thematic and taxonomic associates was controlled.

However, because of the thematic bias observed with nonconstrained instructions, the data suggest a stronger activation of thematic than taxonomic relations. For instance, when the strong associate was thematically related to the target, “+ choices” were equally frequent in Th+Th− configurations in which the associative strength was the unique basis of choice and in Th+Ta− configurations in which both associative strength and type of relation could influence choices (Exp. 1). When the strong associate was taxonomically related to the target, however, “+ choices” dominated only in Ta+Ta− configurations, not in Ta+Th− configurations; in these latter configurations, the taxonomic associate strongly related to the target was selected as frequently as the thematic associate weakly related to it. This factor leads us to consider that the activation threshold required to select one associate would be reached earlier for thematic than for taxonomic associates, independently of the level of associative strength.

The effects of both associative strength and thematic orientation were greater in 6- than in 4-year-old children. This implies that the weighting of choice criteria used in matching tasks change during development, with older children relying more consistently than younger ones on associative strength and showing a stronger preference for thematic relations. One can assume that, because of their greater experience with objects, 6-year-old children are more likely than 4-year-olds to judge the pairs target and associate as strongly related and to identify the thematic associates quickly.

Moreover, older children were affected by the modification of instruction whereas younger children were not (Exp. 3). The “same kind” instructions, intended to bias responses towards taxonomic matching, successfully modified choices in 6-year-olds only. This latter result suggest that when the instructions required it, these children were more capable than 4-year-olds of modifying their spontaneously activated choice and choosing the other associate. Given the instruction effects observed by other researchers in 4-year-old children (Waxman & Namy, 1997), it is assumed that the wording used and the absence of any demonstration of both conceptual relations were not sufficient to modify 4-year-olds’ selection criteria.

In summary, these experiments emphasize the influence of associative strength and they could help to reconcile some divergent findings. More specifically, a lack of homogeneity in associative strength across items and/or individuals could partly explain the inter- and intra-individual variability frequently mentioned in matching tasks. According to this logic, various patterns of responses among children (Dunham & Dunham, 1995) might partially result from individual differences in the judgments of associative strength of a given pair of objects, whereas within-children variability (Osborne & Calhoun, 1998; Walsh et al., 1993) would stem from differences across items.

References


### APPENDIX A

Stimuli used in Experiments 1, 2, and 3 (targets 1 and 2 served in familiarization trials)

<table>
<thead>
<tr>
<th>Targets</th>
<th>Basic-level (T1)</th>
<th>Slot-filler (T2)</th>
<th>Superordinate (T3)</th>
<th>Thematic (Th1)</th>
<th>Thematic (Th2)</th>
<th>Thematic (Th3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Saucepan</td>
<td>Frying pan</td>
<td>Colander</td>
<td>Glass</td>
<td>Stove</td>
<td>Milk</td>
<td>Matchbox</td>
</tr>
<tr>
<td>Rabbit 1</td>
<td>Rabbit 2</td>
<td>Bear</td>
<td>Scorpion</td>
<td>Carrot</td>
<td>Rabbit hutch</td>
<td>Tractor</td>
</tr>
<tr>
<td>Dog 1</td>
<td>Dog 2</td>
<td>Guinea pig</td>
<td>Snake</td>
<td>Bone</td>
<td>Kennel</td>
<td>Shotgun</td>
</tr>
<tr>
<td>Cake</td>
<td>Pie</td>
<td>Chocolate</td>
<td>Sausage</td>
<td>Candle</td>
<td>Present</td>
<td>Flour</td>
</tr>
<tr>
<td>Seagull</td>
<td>Eagle</td>
<td>Ostrich</td>
<td>Dolphin</td>
<td>Egg</td>
<td>Nesting box</td>
<td>Scarecrow</td>
</tr>
<tr>
<td>Ball</td>
<td>Rugby ball</td>
<td>Roller-skates</td>
<td>Card</td>
<td>Soccer player</td>
<td>Basketball board</td>
<td>Whistle</td>
</tr>
<tr>
<td>Bee</td>
<td>Fly</td>
<td>Butterfly</td>
<td>Cat</td>
<td>Beehive</td>
<td>Flower 2</td>
<td>Sting</td>
</tr>
<tr>
<td>Lamp</td>
<td>Chandelier</td>
<td>Torch</td>
<td>Headlight</td>
<td>Light bulb</td>
<td>Plug</td>
<td>Desk</td>
</tr>
<tr>
<td>Flower 1</td>
<td>Rose</td>
<td>Houseplant</td>
<td>Tree</td>
<td>Vase</td>
<td>Snail</td>
<td>Rake</td>
</tr>
<tr>
<td>Suit jacket</td>
<td>Casual jacket</td>
<td>Tie</td>
<td>Swimming costume</td>
<td>Coat hanger</td>
<td>Suitcase</td>
<td>Reel of thread</td>
</tr>
<tr>
<td>Axe</td>
<td>Chain saw</td>
<td>Saw</td>
<td>Pliers</td>
<td>Wood</td>
<td>Play house</td>
<td>Carpenter</td>
</tr>
</tbody>
</table>