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Title	Concrete and abstract concepts in school age children
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Publication date	2004-01-01
Original Citation	Caramelli, N., Setti, A. and Maurizzi, D.D. (2004) 'Concrete and abstract concepts in school age children', Psychology of Language and Communication, 8(2), pp. 19-34.
Type of publication	Article (non peer-reviewed)
Link to publisher's version	http://www.plc.psychologia.pl/plc/plc/contents/vol_8-2.htm, http://www.degruyter.com/view/j/plc
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Download date	2026-11-07 04:43:04
Item downloaded from	https://hdl.handle.net/10468/2707

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Psychology of Language and Communication 2004, Vol. 8, No. 2

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CONCRETE AND ABSTRACT CONCEPTS IN SCHOOL AGE CHILDREN*

The aim of this study is to highlight what kind of information distinguishes abstract and concrete conceptual knowledge in different aged children. A familiarity-rating task has shown that 8-year-olds judged concrete concepts as very familiar while abstract concepts were judged as much less familiar with ratings increasing substantially from age 10 to age 12, according to literature showing that abstract terms are not mastered until adolescence (Schwanenflugel, 1991). The types of relation elicited by abstract and concrete concepts during development were investigated in an association production task. At all considered age levels, concrete concepts mainly activated attributive and thematic relations as well as, to a much lesser extent, taxonomic relations and stereotypes. Abstract concepts, instead, elicited mainly thematic relations and, to a much lesser extent, examples and taxonomic relations. The patterns of relations elicited were already differentiated by age 8, becoming more specific in abstract concepts with age.

Introduction

Concrete concepts refer to perceivable and spatially embedded entities, while abstract concepts refer to entities that "are neither purely physical nor spatially constrained" (Barsalou & Wiemer-Hastings, in press). Although the difference between concrete entities, such as 'dog', and abstract ones, such as 'peace', is evident on intuitive grounds, their difference is not so evident in conceptual knowledge development and organization.

Traditionally, the concrete vs. abstract distinction has been dealt with mainly on linguistic grounds. Analyzing a corpus of nouns and verbs produced by school age children, Roger Brown (1957, reported in Schwanenflugel, 1991) found that 75% of the most frequently produced words were of the concrete

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type. More recently, Schwanenflugel (1991) checked the Rinsland (1945) corpus of children's language, used by Brown (1957) for the presence in children's language of nouns most frequently used by adults. Assuming that children knew the word if it was present at least twice in the corpus for that age group, Schwanenflugel (1991) found a striking difference between younger and older children. While first graders had already mastered a large majority of the concrete nouns most frequently used by adults, only adolescents had mastered the majority of the abstract nouns. A similar trend was found in the acquisition of reading. Yore and Ollila (1985, reported in Schwanenflugel, 1991) have shown that in learning to read children run into difficulties more often with abstract than with concrete words. Accordingly, there is evidence that children acquire abstract words later than concrete words and have more difficulty in reading abstract than concrete words. Moreover, in a lexical decision task, 9-year-olds showed the concreteness effect (Schwanenflugel & Akin, 1994),i.e. a processing difference between abstract and concrete terms. Interestingly, in the same study, 11-year-olds did not show the concreteness effect when the stimuli were paired in regard to context availability, an effect already found in adults.

Studies on the different processing of concrete and abstract words in adults have shown that words referring to concrete entities are processed faster, learned and remembered better than abstract words (Paivio, 1971, 1986; Paivio, Yuille, & Madigan,1986; Schwanenflugel, 1991; Schwanenflugel & Shoben, 1983; Schwanenflugel & Stowe, 1989). Moreover, abstract and concrete words obtain different ratings in imageability and context availability tasks (e.g. Altarriba, Bauer & Benvenuto, 1999).

This asymmetry between concrete and abstract words has been explained by Paivio (1971, 1986) with the Dual Code theory. Words referring to concrete referents are accessed more easily than those referring to abstract referents because the information they convey rests on both a verbal and an imagery code, while that conveyed by abstract words rests only on the verbal code. In a different perspective, studying word context availability Schwanenflugel and Shoben (1983) have shown that it is more difficult to find an appropriate context for abstract than for concrete words. In fact, when abstract and concrete words were preceded by an appropriate context, no difference between them was found in reading time. Moreover, context availability ratings were shown to correlate with those on concreteness (Schwanenflugel & Shoben, 1983; Altarriba et al., 1999) and to be a good predictor of lexical decision performance (Schwanenflugel, Harnishfeger, & Stowe, 1988).

On conceptual grounds, Keil (1989) has highlighted the distinction between natural kind, artefact and nominal kind concepts in children's conceptual development. Despite stress on the continuity between children's concrete and abstract nominal kind concepts, researchers' interest has focused

mainly on the acquisition of the distinction between natural and artefact kinds, i.e. concepts referring to objects, (e.g., Mandler, 1992; Mandler, Bauer, & McDonough, 1991; Mandler & McDonough, 1993, 1996; Markman, 1989) and on their characteristics (e.g., Keil, Smith, Simons, & Levin, 1998). The relative lack of interest in abstract conceptual knowledge development has been probably triggered by the widely held assumption that abstract knowledge is a late acquisition due to the so-called 'thematic to taxonomic shift' (Lucariello, Kyratzis, & Nelson, 1992; Lucariello & Nelson, 1985; Nelson, 1977, 1986). According to this view, early conceptual knowledge organization is thematic in nature as it rests on scripts derived from the events which children take part in. Taxonomic conceptual knowledge organization, instead, has been conceived of as the result of further development in the acquisition of the abstract hierarchical relations, which shape conceptual knowledge, according to the so-called 'cognitive economy principle'. This assumption, however, has been widely questioned on several grounds (e.g. Sloman, 1998). Recent research has shown that, when properly interviewed, even pre-school children are able to deal with taxonomic information which is abstract in nature (Waxman & Namy, 1977).

Few recent studies on adults have highlighted the continuity between concrete and abstract concepts. Both concrete and abstract conceptual knowledge elicit situational information, i.e. thematic information (Barsalou & Wiemer-Hastings, in press). In fact, abstract concepts were shown to yield information more often on the settings and events in which they can occur than on the kind of thing they refer to, i.e. their superordinate category. For example, the concept 'sadness' elicits information on the events and situations that make people sad, i.e. on its antecedents, more than on the taxonomic information that 'sadness' is an emotion (Wiemer-Hastings & Graesser, 2000; Wiemer-Hastings, Krug, & Xu, 2001).

Wiemer-Hastings, Barnard, & Faelnar (2003) have shown that nouns referring to abstract concepts elicit a lower number of exemplars than concrete concepts. In addition, both intra- and inter- category similarity ratings were lower for abstract than for concrete concepts, i.e. the exemplars, and the categories as well, of abstract concepts were less differentiated than those of concrete concepts. They have suggested that the superordinate level of abstract concepts can be equated to 'ad hoc' categories, which depend on task requirements, even if they have also acknowledged that the stable core of abstract concepts is grounded on thematic information.

However, to our knowledge, no systematic investigation has been carried out to highlight the kinds of information that characterize the development of abstract and concrete conceptual knowledge in children. This study was aimed at filling this gap by comparing the pattern of information elicited by concrete and abstract concepts in school age children. A written association production

task was selected to verify whether, and if so, when and how, concrete and abstract conceptual knowledge become distinguishable. The association production task has been frequently used in research on children's knowledge organization of object concepts, as it allows the assessment of both stable and the variable aspects of conceptual knowledge (see Borghi & Caramelli, 2003). In fact, concepts are not isolated units, but are deeply inter-related by different types of information that can be assessed through the types of relations linking children's associations to the given concept nouns.

According to the theoretical framework just described, the following hypotheses were advanced:

1. Familiarity evaluation. If abstract concept nouns are acquired later than concrete concept nouns, the shift in the age of acquisition should affect familiarity evaluations more of abstract than of concrete concept nouns. Thus, with age, judged familiarity of abstract concepts should increase more than that of concrete concepts.
2. Difference between concrete and abstract concepts in the association production task.
   (a) Number of productions. A higher production frequency is expected for concrete than for abstract concepts, due to the higher familiarity of concrete concept nouns.
   (b) Types of production. According to the literature on concrete concept development it is widely acknowledged that the production of thematic relations by far outnumbers that of taxonomic relations (e.g., Borghi & Caramelli, 2003). Children should produce thematic relations more frequently than taxonomic relations at all the considered age levels. However, abstract concepts, which convey contextual information on the situations and events they can fit into (Wiemer-Hastings & Graesser, 2000; Barsalou & Wiemer-Hastings, in press), should elicit thematic relations more often than concrete concepts. Moreover, the latter should elicit more taxonomic and attributive relations than abstract concepts, as they are characterised by perceptual properties and refer to objects which belong to well defined categories (Wiemer-Hastings, Barnard, & Faelnar, 2003).
3. Developmental trend.
   (a) Number of productions. Due to the differences in age of acquisition, with age the overall productions elicited by abstract concepts should increase more than those elicited by concrete concepts as children improve their mastery of the abstract conceptual domain.
   (b) Types of production. With age, abstract concepts should elicit more thematic and less attributive information than concrete concepts, due to the increasing differentiation between the abstract and the concrete conceptual domains.

Method

Participants

A sample of 120 middle class children took part in the study, out of which 40 aged 8 (M = 8.5), 40 aged 10 (M = 10.4) and 40 aged 12 (M = 12.6). All the children were Italian native speakers.

Materials

The materials were 80 concept nouns, of which 40 were concrete, e.g. 'baboon', and 40 abstract concept nouns, e.g. 'duty'. In order to have a representative sample of both concrete and abstract knowledge domains, the set of concrete concept nouns included 20 concept nouns referring to artefacts, 10 to animals and 10 to plants so that both animate and inanimate kinds were balanced. The set of abstract concept nouns included 20 referring to both emotions, e.g. 'happiness ', and affective states, e.g. 'boredom', and 20 belonging to the 'moral' domain referring to both conventional, e.g. 'freedom', and ego-related concept nouns, e.g. 'duty'. All the selected concept nouns were assumed to be familiar to the children for two reasons. The first was that all the selected concept nouns occur very often in standard tales and stories children of this age are acquainted with. The second was age, as 8-year-olds already have a good level of competence in both speaking and reading as assessed by their teachers.

Procedure

The total set of 80 concept nouns was divided into 4 lists of 20 concept nouns each in which the different types of concepts were balanced. The lists were presented to the children by their teachers in 4 different sessions, at school. On each list, below each concept noun there was a blank line for the children's productions and, below it, another line on which there was a seven-point scale. For each concept noun the children had to write the first thing that came to their mind and, then, to rate on the scale how familiar the noun was to them (1 meaning not familiar/unknown and 7 meaning very familiar/very well known). The task was introduced as an ordinary educational activity not to be evaluated.

Data analysis and results

Analysis on familiarity ratings

Both concrete (CC) and abstract (AC) concept nouns obtained a mean rating higher than 4 in all the considered age groups (8-year-olds AC (M = 4.4) and CC (M = 6) , 10- year-olds AC (M = 4.6) and CC (M = 6), 12- year-olds AC (M = 5.2) and CC (M = 6.3). Thus, on the whole it was confirmed that the selected concept nouns were familiar to the children.

In order to verify the first hypothesis, on the familiarity ratings a two way ANOVA (Age X Type of concept) was performed with participants as random factor, and another with materials as random factor. Both the main factors, i.e. Age and Type of concept, were significant (respectively Fp (2,117) = 8.50, MSe = .76, $p < .001$; Fm(2,234) = 157, MSe = .78, $p < .001$ and Fp (1,117) = 385.35, MSe = .28, $p < .001$; Fm(2,234) = 11.4, MSe = .78, $p < .001$). The Age X Type of concept interaction was significant only in the analysis with participants as random factor [Fp (2,117) = 3.36, MSe = .28, $p < .05$]. Post hoc analysis (Newman-Keuls, $p < .01$) performed on the factor Age showed that overall 8- and 10- year-olds' ratings were lower (respectively M = 5.2 and M = 5.3) than those for 12-year-olds (M = 5.7). Thus, concept noun familiarity increased between the age 10 and 12.

Considering the factor Type of concept, concept nouns referring to concrete entities were considered more familiar (M = 6) than those referring to abstract ones (M = 4.7). The post hoc analysis carried out on the interaction (Newman-Keuls, $p < .01$) showed that 8-year-olds' familiarity ratings of both abstract and concrete concepts (respectively M = 4.4 and M = 5.9) did not significantly differ from 10-year-olds' (respectively M = 4.6 and M = 6.1). But the familiarity ratings of abstract concepts produced by10-year-olds were significantly lower than those produced by 12-year-olds (respectively M = 4.6 and M = 5.2), while no difference was found in concrete concepts (respectively M = 6.1 and M = 6.3). Thus, on the whole, while the familiarity ratings of concepts referring to concrete entities, which were higher than those referring to abstract entities, did not change with age, the familiarity ratings of concepts referring to abstract entities increased from 10 to 12 years of age.

Thus the first hypothesis was verified. In fact, concepts referring to concrete entities were judged as more familiar than those referring to abstract entities, the familiarity of which increased between the ages 10 and 12, while no increase was found in concrete concept familiarity.

Analyses on the association task

Children's productions were transcribed and coded according to the type of relation linking the produced associations to the given concepts. The following types of relations were coded:

1. Taxonomic relations, which establish the hierarchical structure of conceptual knowledge. They include: the Superordinate level, e.g. *baboon* – 'animal', the Subordinate level, e.g. *bicycle* – 'mountain-bike', and the Coordinate level, e.g. *hamster* – 'mouse'.
2. Thematic relations, which link objects co-occurring in the same situation or event. They include: spatial relations, e.g. *camel* – 'desert', temporal relations, e.g. *rose* – 'at St. Valentine's day', modality relations, e.g. *eagle* – 'in dive', means-end relations, e.g. *harmony* –'guitar', cause relations,

e.g. *medal* – 'victory', function relations, e.g. *watch* – 'time', action relations, e.g. *guitar* – 'to play', event relations, which refer to complex situation, e.g. *medal* – 'I received it at the prize ceremony'.

3. Attributive relations, which refer to the physical characteristics or qualities of objects. They include: property relations referring both to perceptual object properties like shape, color, size, etc, e.g. *camel* –'it is tall', and to object qualities, e.g. *dog* – 'domestic animal', and partonomic relations referring to object parts, e.g. *camel* – 'it has a lump'.
4. Stereotypes. This code was used for both conventional, e.g. *peace* – 'children', and idiosyncratic associations, e.g. *tulip* – 'sea'.
5. Examples. This code was used when the children instantiated the given concept, e.g. *Marco* – 'mosquito' (see Barsalou and Wiemer-Hastings, in press).

Children's productions that could not be included in the preceding codes were coded as 'Other'. As they amounted to only 3% of the total productions, they were not further analyzed. The coding procedure was carried out independently by two judges, one of them was blind to the hypotheses. The judges agreed on 94% of the codes, and cases of disagreement were solved after a brief discussion. In order to properly analyze the data, the proportion of each relation produced by each child was calculated and arcsin transformed in order to normalize the variance (see Barsalou & Wiemer-Hastings, in press for the use of this procedure on data of the same type).

The analyses on the children's productions will be presented in the following order:

A. Overall analysis of the production frequencies for each type of concept and age level (hypotheses 2a., and 3a.);
B. Analysis on the coded relations in abstract and concrete concepts (hypotheses 2a., 2b., and 3a.);
C. Analyses on the coded relations in each age group (hypothesis 3b.).

A. *Overall analysis on the production frequencies for each type of concept and age level (hypotheses 2a., and 3a.).*

Overall, 8 year old children produced 2354 associations, i.e. they responded to 73% of the items, (M = 59.5), 10-year-olds produced 2678 associations, i.e. they responded to 84% of the items (M = 67.5) and 12-year-olds produced 3023 (M = 76.5) associations, i.e. they responded to 94% of the items. In particular, the percentage of the productions calculated on the attended responses per type of concept, i.e. AC and CC, (N =1600 each), showed that 8-year-olds responded 56% of the times to AC and 92% of the times to CC, 10-year-olds responded 72% of the times to AC and 97% of the times to CC , and 12-year-olds responded 92% of the times to AC and 99% of the times to CC. Therefore, the overall production was higher for concrete than for abstract concepts, as children responded on aver-

age to 96% of CC, while they responded on average to 73% of AC (hypothesis 2a, see the following inferential statistics). Moreover, while the frequency of the responses to AC increased with age from 56% to 92%, no such increase was found in CC (hypotheses 3a, see the following inferential statistics).

Due to the high frequency of non-responses, the reliability of the associations produced was checked by performing correlation analyses between the familiarity ratings and the number of non-responses. The rationale behind these analyses was that, if a negative correlation between non-responses and familiarity ratings was found, then we could confidently assume that children did not respond to the concept nouns which they judged as unfamiliar to them. When abstract concepts which obtained the lowest familiarity ratings were analyzed, in all the age groups the number of non-responses was negatively highly correlated with familiarity ratings (8-year-olds: R Spearman = -.72, $p < .001$; 10-year-olds: R Spearman = -.74, $p < .001$; 12-year-olds: R Spearman = -.68, $p < .001$). No correlation analyses were performed on concrete concepts due to ceiling effects (overall there were high familiarity ratings and 3.5% of non-responses only in 8-year-olds). This means that children produced their associations only when they were familiar with the concepts, i.e. they knew their meanings, and thus we can reliably assume that children's productions mirrored their conceptual knowledge.

B. *Analysis of the coded relations for each type of concept (hypotheses 2a, 2b, and 3a)*

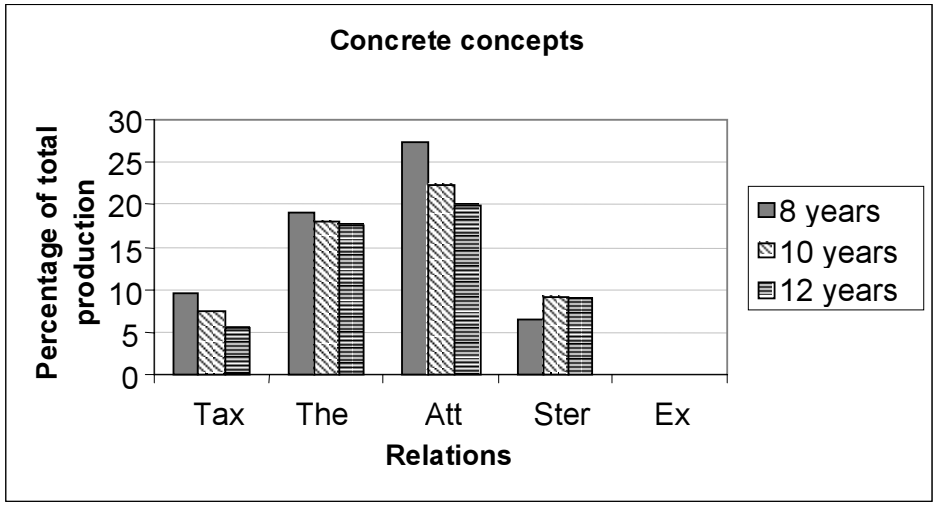
The arc-sin transformed the proportion of each relation produced by children, excluding the responses in the Other category, was entered into by participants ANOVA with Age (8,10,12) as a between factor, and Type of Concept (AC vs CC) and Type of Relation (taxonomic, thematic, attributive, stereotypes and examples) as within factors. A further by materials ANOVA was run as well, with Age and Concept Type as between factors and Type of relation as a within factor.

All the main factors reached significance in both the analyses (Age: $Fp(2,117) = 13.98$, MSe = .005, $p < .001$; $Fm(2,234) = 4.24$, MSe = .005, $p < .02$; Type of relation: $Fp(4,468) = 294$, MSe = .02, $p < .001$; $Fm(4,936) = 143$, MSe = .07, $p < .001$ Type of concept $Fp(1,117) = 126.3$, MSe = .007, $p < .001$; $Fm(1,234) = 17$, MSe = .005, $p < .001$).

All the interactions were significant in the analysis with participants as random factor (Age X Type of relation: $F(8,468) = 1.97$, MSe = .014, $p < .05$; Age X Type of Concept: $F(2,117) = 17.86$, MSe = .007, $p < .001$; Type of relation x Type of concept: $F(4,468) = 491$, MSe = .008, $p < .001$; and the three-way interaction: $F(8,468) = 3.23$, MSe = .008, $p < .01$), while only the Type of relation X Type of concept interaction was significant in the analysis with materials as random factor ($F(1,936) = 119$, MSe = .07, $p < .001$).

The total production increased between ages 8 and 10 and did not significantly differ between ages 10 and 12 (post hoc Newman-Keuls analysis on the

Figure 1. Percentage of type of relations produced with concrete concepts relative to the total production.

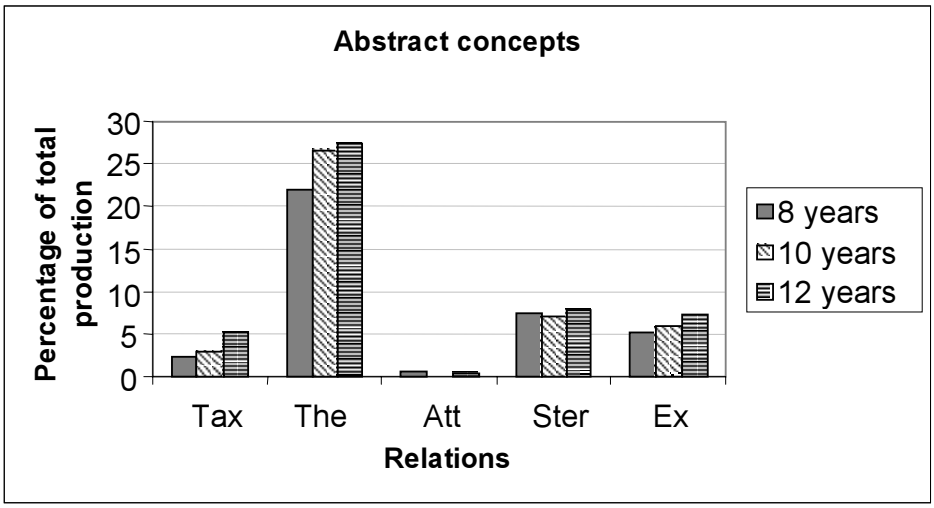


factor Age, $p < .001$]. It was higher for concrete than for abstract concepts (57% vs. 43% of the total production) (hypotheses 2a. and 3a.). Post hoc Newman-Keuls analysis ($p < .01$) run on the factor Type of relation confirmed that the difference between thematic relations and all the other types of relations was significant (hypothesis 2a.). Namely, thematic relations were produced most frequently and amounted to 44% of the total production in all the age groups studied.

Post hoc Newman-Keuls analysis ($p < .01$) performed on the interaction between Type of concept and Type of relation confirmed that abstract concept nouns elicited thematic relations and examples (respectively 25% and 6%) significantly more frequently than concrete concept nouns (respectively 18% and 0.1%). Concrete concept nouns elicited attributive and taxonomic relations (respectively 23% and 7.4%) significantly more frequently than abstract concept nouns (respectively 0.4% and 3.6%) (hypothesis 2b.). Thus, abstract and concrete concepts differed in the kinds of conceptual information they elicited with abstract concept nouns yielding mainly thematic relations (25%) and concrete concept nouns yielding mainly attributive relations (23%). Moreover, this result, i.e. that abstract concepts elicited more thematic relations than concrete concept nouns, which was already found in research on adults (e.g., Barsalou & Wiemer-Hastings, in press; Setti, Borghi, Caramelli, submitted) was replicated in children as well.

With age, a shift was found in the types of relations elicited by abstract and concrete concept nouns as shown by the post hoc analysis (Newman-Keuls, $p < .001$) performed on the three-way interaction. While the production of thematic relations elicited by concrete concept nouns did not change with age (see Figure 1), that elicited

Figure 2. Percentage of type of relations produced with abstract concepts relative to the total production.



by abstract concepts increased between 8 and 10 years of age (respectively 21% and 27% of the total production) (post hoc Newman-Keuls, $p < .001$) (see Figure 2). Moreover, while the production of taxonomic relations elicited by concrete concepts did not change with age, that elicited by abstract concept nouns increased between 8 and 10 years of age (respectively 2% and 3% of the total production) and between 10 and 12 years of age as well (respectively 3% and 5% of the total production) (post hoc Newman-Keuls, $p < .001$). Finally, while the production of examples elicited by concrete concepts did not change with age, that elicited by abstract concepts increased between age 8, 10 and 12 (respectively 5%, 6% and 7% of the total production) (post hoc Newman-Keuls, $p < .01$). Thus, it can be concluded that, while concrete concepts elicited thematic and taxonomic relations and examples in a stable proportion in the considered age groups, abstract concepts, on the other hand, elicited more thematic and taxonomic relations and examples with age.

C. *Analyses on the coded relations in each age group (hypothesis 3b.)*

In order to better disentangle the pattern of relations elicited by abstract and concrete concepts during development, three separate ANOVAs were performed, one on each age group.

On 8-year-old productions two ANOVAs were performed, one with participants and the other with materials as random factors, with Type of relation and Type of concept as within factors. In both analyses the main factor Type of relation and the interaction between Type of relation and Type of concept were significant. The factor Type of concept reached significance in the analysis with

participants as random factor showing only a trend toward significance in the analysis with materials as random factor (Type of relation: $Fp(4,156) = 79$, MSe = .02, $p < .001$; $Fm(4,312) = 34$, MSe = .08, $p < .001$; Type of concept $Fp(1,39) = 91$, MSe = .008, $p < .001$; $Fm(1,78) = 3.4$, MSe = .006, $p = .07$; Type of relation x Type of concept: $Fp(4,156) = 137$, MSe = .009, $p < .001$; $Fm(4,312) = 37$, MSe = .08, $p < .001$). Overall the number of productions was higher for concrete than for abstract concepts, and children produced mainly thematic relations followed by attributive relations (respectively 41% and 28% of the total production). More precisely, the post hoc analysis of the interaction Type of Relation X Type of concept (Newman-Keuls, $p < .001$) showed that abstract concepts elicited mainly thematic relations (22% of the total production), while concrete concepts elicited mainly attributive and thematic relations (respectively 27% and 19% of the total production). Moreover, the latter elicited more taxonomic relations (9.5%) than did abstract concepts (2%). Abstract concepts elicited a very small number of attributive relations (0.6%) and more examples (5%) than concrete concepts (respectively 27% and 0.04). Thus, at age 8 the pattern of the relations elicited by concrete concepts already differed from that elicited by abstract concepts. In fact, concrete concepts were characterized mainly by attributive as well as by thematic relations and, to a lesser degree, also by taxonomic relations, while abstract concepts were characterized by thematic relations and to a lesser degree by stereotypes and examples. Interestingly, however, the number of thematic relations elicited by abstract and concrete concepts did not yet differ.

On 10-year-old productions two ANOVAs were performed, one with participants and the other with materials as random factors, each of which with Type of relation and Type of concept as within factors. Both the main factors and their interaction were significant (Type of relation: $Fp(4,156) = 102$, MSe = .014, $p < .001$; $Fm(4,312) = 51.2$, MSe = .007, $p < .001$; Type of concept $Fp(1,39) = 33$, MSe = .011, $p < .001$; $Fm(1,78) = 17.3$, MSe = .004, $p < .001$; Type of relations X Type of concept: $Fp(4,156) = 161$, MSe = .008, $p < .001$; $Fm(4,312) = 39$, MSe = .007, $p < .001$).

Overall, concrete concepts elicited more productions than did abstract concepts. Children produced mainly thematic relations (45% of the total production) followed by attributive relations and stereotypes (respectively 22% and 16% of the total production). Post hoc analysis of the interaction (Newman-Keuls, $p < .001$) showed that abstract concepts elicited mainly thematic relations (27% of the total production), while concrete concepts elicited both attributive and thematic relations (respectively 22% and 18% of the total production). Moreover, thematic relations were elicited more often by abstract than by concrete concepts, which, in turn, elicited more taxonomic relations than abstract concepts (respectively 7.5% and 3%). Abstract concepts elicited more examples than concrete concepts, while the number of stereotypes did not differ across the two kinds of concepts. Thus, at age10 the pattern of relations elicited by abstract and concrete concepts is

much more differentiated than that produced by 8-year-old children since, in particular, abstract concepts elicited more thematic relations than concrete concepts.

On 12-year-old productions two ANOVAs were performed, one with participants and the other with materials as random factors, each of which with Type of relation and Type of concept as within factors. Both the main factor Type of relation and the interaction were significant in the ANOVA with participants and materials as random factors. The factor Type of concept, however, reached significance only in the analysis with participants as random factor but not in that with materials as random factor (Type of relation: $Fp(4,156) = 123$, MSe = .01, $p < .001$; $Fm(4,312) = 64.6$, MSe = .056, $p < .001$; Type of concept $Fp(1,39) = 14$, MSe = .002, $p < .00$; Type of relation X Type of concept: $Fp(4,156) = 215$, MSe = .006, $p < .001$; $Fm(4,312) = 47.3$, MSe = .05, $p < .001$).

Again, overall, concrete concepts elicited more productions than did abstract concepts. Children produced mainly thematic relations (45% of the total production) followed by attributive relations and stereotypes (respectively 20% and 17% of the total production). The post hoc analysis (Newman-Keuls, $p < .001$) run on the 2 way interaction showed that abstract concepts elicited more thematic relations than concrete concepts (respectively 27% and 17.6% of the total production), while taxonomic relations were elicited equally frequently (respectively 5% and 5.7%) by the two kinds of concepts. Moreover, the same number of stereotypes was produced for concrete and abstract concepts, while the latter elicited significantly more examples than did the concrete concepts.

Thus, the main results of the analyses on children's productions at the different age levels showed that concrete and abstract concepts elicited a different pattern of relations already at age 8. Concrete concepts were characterized mainly by attributive and thematic relations, as well as, to a much lower extent, by taxonomic relations. This result replicated that found by Borghi & Caramelli (2003) in younger children. Abstract concepts, instead, were characterized mainly by thematic relations, and, to a lesser extent, by examples and taxonomic relations. Accordingly, while concrete concepts were mainly characterized by attributive relations, i.e. by the properties of the objects they refer to, abstract concepts were mainly characterized by thematic relations, i.e. by the situations that exemplify their reference. This was also supported by their eliciting an increasing number of examples, the production of which was practically absent when elicited by concrete concepts.

The hypotheses advanced were verified. Concrete concepts were acquired and mastered before abstract concepts as, overall, they were judged as more familiar than abstract concepts by children at all the age levels, and their familiarity did not increase with age. Abstract concept familiarity, instead, increased between 10 and 12 years of age (hypothesis 1). In the association production task the overall production was higher for concrete than for abstract concepts, even if that elicited by the latter increased with age (hypotheses 2a and 3a). As expected, both

concrete and abstract concepts elicited mainly thematic relations. However, while concrete concepts were characterized by attributive relations, almost absent in abstract concepts, these last were characterized by examples, almost absent in the former (hypothesis 2b). Over development the overall amount of productions increased due to the increased familiarity of abstract concepts (hypothesis 3a) and the pattern of relations elicited by the two kinds of concepts became more differentiated. In fact, while the pattern of relations elicited by concrete concepts was almost stable with age, that elicited by abstract concepts showed an increase in thematic relation production.

Discussion and conclusions

The main concern of this study was the development of abstract and concrete conceptual knowledge as assessed by the kinds of relations elicited by abstract and concrete concepts. In line with some recent studies on adults (Barsalou & Wiemer-Hastings, in press; Wiemer-Hastings et al., 2001) abstract and concrete concepts displayed the activation of a specific pattern of relations also in school age children. Concrete concepts elicited a large number of attributive and thematic relations. Hence, concrete concepts conveyed information mainly related to the properties of the objects they refer to, such as shape or parts. This finding is in line with previous studies showing the relevance of an object's perceptual characteristics in children's conceptual knowledge (Tversky & Hemenway, 1984). In the same vein, Borghi & Caramelli (2003) found an increasing number of attributive relations produced from age 5 to age 8 in an association production task. On the other hand, abstract concepts elicited thematic relations and were characterized by information referring to the situations and events they are experienced in. Overall, the information elicited by concrete concepts rests on a wider range of relations than that elicited by abstract concepts (see Wiemer-Hastings et al., 2003). Concrete concepts elicit attributive and thematic relations as well as a smaller number of taxonomic relations, i.e. information on categories. For example, the concept 'dog' could elicit attributive information about dogs having four legs and a tail, thematic information about dogs running in a meadow and eating bones and information about dogs being animals and, more specifically, domestic animals. The pattern of relations characterizing concrete concepts is already well established in 8 year old children as it does not change with age. Abstract concepts, instead, not referring to perceivable objects, do not seem to be organized in conventional taxonomic categories (Wiemer-Hastings et al., 2003) nor display features as distinctive as those displayed by concrete concepts. Hence, they are characterized mainly by the contextual information that defines the events which they are experienced in. Thus, for example, the concept 'duty' could elicit mainly situational information and examples such as 'at school' and 'to do the homework'. This specific kind of information that abstract concepts are made up from, already

present in 8-year-old children, becomes more specific with age due to children's mastery wider domains of abstract concepts, resulting in the increase of thematic relation production.

More generally, it is concluded that the different relations that differentiate the activation of information in abstract and concrete concepts can be framed within the distinction between 'extrinsic' and 'intrinsic' features (Barr & Caplan, 1989). Abstract concepts elicit extrinsic features, i.e. information about the relation between the referent of the concepts and other entities, while concrete concepts elicit both extrinsic and intrinsic features, i.e. object's properties. Furthermore, these findings fit nicely with theories that underline the role of contexts and situations in accounting for the concrete/abstract distinction, such as the Context Availability (Schwanenflugel & Shoben, 1983) and the Contextual Constraints (Wiemer-Hastings et al., 2001) theories. According to the former, abstract concepts, being less defined, can be embedded in a greater variety of contexts than concrete concepts. According to the latter, abstract concepts differ from concrete concepts in the kinds of constraints in the situations they can fit into. Although the present results cannot directly test these assumptions, showing that abstract concepts are characterized by thematic relations, i.e. information on situations and events, and examples clearly support both of them. Further research is needed in order to check for differences in the thematic relations elicited by abstract and concrete concepts.

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