Choosing Category or Complementary Relations: Prior Tendencies Modulate Instructional Effects

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Abstract Concepts in semantic memory are associated with other categorically (e.g., dog-horse) and complementarily (e.g., dog-bone) related concepts. Although complementary relations produce more robust priming (e.g., Lupker, 1984), categorical responding is more common in preference tasks where participants choose directly between categorical and complementary relations (e.g., Smiley & Brown, 1979). Three experiments examined the effects of instructions and individual differences on adult preferences. Experiment 1 demonstrated that category preferences were infrequent, and that "most similar" instructions produced modestly more category responses than "goes together" instructions. In Experiments 2 and 3, emphasizing key words enhanced the instructional effect, and "similar" instructions produced especially large increases in category preferences for participants predisposed to categorical relationships. These preference experiments demonstrate that complementary advantages are similar to those for priming, and that instructions and prior tendencies can have subtle influences on semantic memory.

Semantic networks consist of diverse kinds of relations between concepts, one fundamental distinction being that between categorical and complementary relations. Categorical pathways specify taxonomic relations and link concepts that tend to be similar in appearance, have equivalent purposes or behaviour, share the same functions, and have similar defining properties (Keil, 1989). For example, "dog" may be linked to the superordinate category "animal," and through that node to "horse" and other concepts that share defining and characteristic features of animals. Categorical relations have played a central role in hierarchical models of semantic memory (Collins & Loftus, 1975), and are also called taxonomic, conceptual, or nominal relations.

Complementary links reflect spatial, temporal, and causal relations between concepts, including joint involvement in the same scene or event (Mandler, 1979; Markman, 1989). For example, complementary links connect "dog" to such experientially related concepts as "bone" and "leash." Complementary relations characterize schemas and scripts, central cognitive structures in the episodic memory literature, and have also been called syntagmatic, associative, thematic, or functional relations.

The relative strength or accessibility of categorical and complementary relations has important implications for theories of semantic memory (Collins & Loftus, 1975; Reed, 1988; Siegler, 1991). For example, an advantage for complementary over categorical relations could indicate that complementary relations are mediated by direct links, whereas categorical relations involve indirect links. Alternatively, a complementary advantage could indicate that such relations exist in a more readily available lexical network, whereas categorical relations exist in a conceptual network that is post-lexical and hence slower to access. The distinction is also important for hierarchical models of semantic memory (Rosch, Mervis, Gray, Johnson, & Boyes-Braem, 1976), because these models emphasize categorical relations over complementary relations.

The issue of which relation type is stronger has been explored using several standard cognitive paradigms, notably semantic priming (e.g., Fischler, 1977; Lupker, 1984), but also episodic memory tasks (e.g., Rabinowitz & Mandler, 1983). Although the results have been somewhat inconsistent, a number of studies have demonstrated that complementary relations may have an advantage or are at least as strong as categorical relations.

With respect to semantic priming, studies have consistently reported strong priming effects for complementary (i.e., associative) relations (e.g., Gellatly, Parker, Blurton, & Woods, 1994; Lupker, 1984; McNamara, 1992; Meyer & Schvaneveldt, 1971; Seidenberg, Waters, Sanders, & Langer, 1984; Tweedy, Lapinski, & Schvaneveldt, 1977; Williams, 1996). Findings are more inconclusive for categorical relations. Some studies have demonstrated categorical priming effects in lexical decision tasks (Neely, 1977), standard word and picture naming tasks (e.g., Irwin & Lupker, 1983; Lupker, 1988; Lupker & Williams, 1989; Sperber, McCauley, Ragain, & Weil, 1979), category identification and verification tasks (e.g., Bajo, 1988; Irwin & Lupker, 1983; Reinitz, Wright, & Loftus, 1989), facial recognition (e.g., Brennen & Bruce, 1991) and semantic matching tasks (e.g., Whitlow, 1986). But category priming effects obtained in these

studies may be at least partially attributed to complementary priming since the categorically related target and prime were often complementary associates (e.g., dog-cat). Few studies have shown that category relations benefit priming when complementary associations are controlled (Chiarello, 1985; Fischler, 1977; Lupker, 1984; Williams, 1994; Williams, 1996).

Other studies have found that categorical priming only occurs under some testing conditions. For example, category primes have been shown to facilitate performance on picture naming (Huttenlocher & Kubicek, 1983), lexical decision (Lupker, 1984; Williams, 1996) and pronunciation tasks (only when the to-be-pronounced target word was degraded) (Williams, 1996); but category priming was not as effective on a word naming task (Lupker, 1984; Huttenlocher & Kubicek, 1983). Category primes were also found to have no effect on bilingual naming (Kroll & Stewart, 1994) and lexical decision tasks (Shelton & Martin, 1992), and negatively affected performance using these tasks in other conditions (Kroll & Stewart, 1994; Becker, 1980). Finally, several studies have shown that categorical priming is most effective when the primes are highly typical and dominant categorical exemplars (Balota, Black, & Cheney, 1992; Coltheart & Evans, 1981; Neely, Keefe, & Ross, 1989; Nelson, LaLomia, & Canas, 1991; Pusen, Erickson, Hue, & Vyas, 1988), whereas less familiar category primes interfere with responding (La Heij, Dirkx, & Kramer, 1990).

Episodic memory tasks have similarly shown that recall is enhanced when participants organize items using either category clustering (e.g., Ellis & Hunt, 1989; Schwartz & Reisberg, 1991) or complementary (i.e., script and schema) relations (Alba & Hasher, 1983; Bower, Black, & Turner, 1979; Mandler, 1979; Yerkovich & Walker, 1986). Although the two bases for organization have been compared less frequently than in priming studies, Rabinowitz and Mandler (1983) reported that free recall was superior for words organized on a complementary basis (i.e., schematically) than for the same list of items organized categorically. Kahn and Paivio (1988), however, found equivalent recall when conditions for complementary and categorical lists were closely matched (i.e., participants received labels for both the categorical and schematic clusters).

These cognitive studies, and the priming studies in particular, suggest either that complementary relations may be stronger than category relations, or that neither relation has a particular advantage. This conclusion appears to be contradicted, however, by preference studies of conceptual development (e.g., Denney & Moulton, 1976; Greenfield & Scott, 1985; Smiley & Brown, 1979), which indicate that categorical relations become dominant over complementary relations in adolescence and early adulthood.

In preference tasks, participants choose between alternatives related to a target by categorical or complementary relations. Studies have generally reported that young children make complementary choices, whereas older children and adults make more categorical choices (Annett, 1959; Denney, 1974; Denney & Lennon, 1972; Ervin, 1961; Smiley & Brown, 1979). Evidence for this developmental shift has also been obtained using other tasks: forced choice recognition tasks (Scott, Scott, & Serchuk, 1980; Scott, Serchuk, & Mundy, 1982), free association (Bjorklund & Jacobs, 1985; Ervin, 1961; Lucariello, Kyratzis, & Nelson, 1992; Rossi, 1964), free recall (Bjorklund & Jacobs, 1985; Bjorklund & Zeman, 1982; Rossi, 1964), oddity tasks (Ricco, 1989), sorting and recall (Bjorklund & de Marchena, 1984; Denney & Ziobrowski, 1972; Frankel & Rollins, 1985), word definition (Johnson & Anglin, 1995; Watson, 1985), and even semantic priming (McCauley, Weil, & Sperber, 1976).

However, the shift to category choices has not been supported in all conditions nor across all studies (Greenfield & Scott, 1985; Imai, Gentner, & Uchida, 1994; Walsh, Richardson, & Faulkner 1993). Using a picture preference task, Greenfield and Scott (1985) and Walsh et al. (1993) found that participants from the preschool to intermediate school years made more complementary than categorical choices. Likewise, Imai, et al. (1994) demonstrated that even adults produced higher levels of complementary than categorical responding in a preference task, using standard task instructions.

Further complicating the picture, other studies have shown that children ranging in age from 19 months to six years appear to be capable of (and sometimes prefer) making responses based on category membership (Bauer & Mandler, 1989; D'Entremont & Dunham, 1992; Gelman & Coley, 1990; Gelman & Markman, 1986, 1987; Fenson, Vella, & Kennedy, 1989; Markman, Cox, & Machida, 1981; Ricco, 1989; Scott et al., 1982; Waxman & Kosowski, 1990). Daehler, Lonardo, and Bukatko (1979) even found that two year olds were more accurate at identifying categorical than complementary relations, and suggested that awareness of complementary relations did not emerge until after three years of age.

These disparate findings suggest that other factors are contributing to the relative predominance of categorical and complementary responding. Task instructions are one such factor that may account for some discrepant findings, especially since they have not been systematically controlled across studies. For example, several researchers have reported high levels of complementary responding when they used variations of "goes together" instructions (i.e., "Find one that *goes with* this one," "Put all the items into groups that *go together* in some way," "I'm going to show you some pictures and you can tell me if you think they *go together*," "Which one of these pictures *goes best* with this one") (Bjorklund & de Marchena, 1984; Imai et al., 1994; Lucariello et al., 1992; Scott et al., 1982; Walsh et al., 1993).

Conversely, other studies have demonstrated high levels of categorical responding, or have obtained shifts to category choices using wordings that encouraged responses of similarity (i.e., "Select those that were *alike*

in some way") (Jahandarie, 1986) or sameness (i.e., "Find the two pictures that are the *same kind* of thing," "Can you find another one that is the *same as* this one for Teddy") (D'Entremont & Dunham, 1992; Lucariello et al., 1992; Ricco, 1989). Similarly, Scott et al. (1980) found that participants could choose category relations when instructions emphasized category membership (i.e., "Select the picture that goes with ... and *belongs to the same family* as the one you just saw").

Some preference studies have shown directly that participants are sensitive to differences in instructions. For example, instructions that direct participants to focus on identical features and make responses based on category membership (e.g., See this *fep*? Can you find another one just like this *fep*?) increase categorical responding compared to other instructions (Bauer & Mandler, 1989; Imai, et al., 1994; Markman & Hutchinson, 1984; Waxman & Gelman, 1986; Waxman & Kosowski, 1990). These findings provide support that task instructions account for some variability in preferences.

In contrast to the preference task, the priming and memory paradigms do not require explicit instructions about the kind of relations that participants should use. Priming instructions focus on the processing of the target (e.g., make a word versus nonword judgement in lexical decision, or read a word in naming), and generally do not mention a specific prime-target relation. Although not explicitly instructed, participants may nonetheless adopt mental sets that selectively emphasize complementary or categorical relations, perhaps as a function either of individual differences in semantic networks or of experimental exposure to varying proportions of prime-target pairs that represent identifiable kinds of semantic relations (e.g., category members). Similar factors could operate in memory tasks and in preference tasks using neutral instructions.

The present study used the preference task to examine more closely the relative advantage of categorical versus complementary relations for adults. Adult performance on this task has previously been examined solely as a comparison point for children, rather than specifically for what it reveals about adult semantic memory, the focus of the present study.

We specifically examined the contribution of instructions and individual differences to adult selection of category and complementary choices on the preference task. Instructions that theoretically should activate categorical pathways (i.e, similar to) or complementary pathways (i.e., goes together) in semantic memory, were used to increase category and complement choices, respectively. We also attempted to identify a neutral wording that would be more comparable to priming and memory studies than instructions that favour one type of relation.

Experiment 1

Experiment 1 compared five instructions. Categorical relations that connect members of the same taxonomic group should be selectively activated by instructions that include the words "most similar" (Medin, Goldstone, & Gentner, 1990, 1993), resulting in more category choices on the preference task. The phrase "goes together," on the other hand, should activate complementary pathways and produce fewer category and more complement choices. We examined several possible neutral wordings, specifically "related to" and counterbalanced combinations of "goes together and most similar" instructions. Neutral instructions should either activate both relations equally or fail to stimulate a specific type of semantic path, in either case producing intermediate levels of category choices.

A supplementary prediction concerned incidental recall following the preference task. If instructions cause participants to focus on certain relations, then the increased activation and more elaborate processing of those pathways should result in enhanced recall of items compatible with the choice instructions. Thus, category words should be recalled more often under "most similar" instructions and less often under "goes together" instructions. The reverse pattern should be observed for recall of complementary words, and the three neutral instructions should fall between these extremes.

We further hypothesized that "similar to" instructions and category choices might be mediated by superordinate concepts (e.g., animal for dog-horse), whereas "goes together" instructions and complement choices might be mediated by concrete mental images of the objects and scenes characteristic of scripts and schemas. To measure these possible mediators of instructions, participants were asked to rate their experience of superordinate labels and concrete images of the objects during the preference task.

METHOD

Participants

A total of 120 introductory psychology students (93 females) from the University of Winnipeg completed the experiment for course credit. Participants were from 18 to 48 years old (M = 20.65). An additional 10 participants were replaced: 5 who used English in less than 40% of home and social conversations, 3 who did not follow instructions, and 2 who had participated in an earlier pilot experiment.

Materials

The preference task consisted of 60 stimulus triads, each containing a target word, a category item from one of 27 superordinate categories (e.g., animals, insects), and a complementary item. The target items and their categorical and complementary relations are presented in the Appendix. Most triads were obtained or adapted from previous developmental studies (Bjorklund & de Marchena, 1984; Frankel & Rollins, 1985; Greenfield & Scott, 1985; Markman & Hutchinson, 1984; McCauley et al., 1976; Smiley & Brown, 1979).

The classification of the relations was assessed by twelve judges who independently identified the item in

each triad that belonged to the same category as the target word and the item that was associated with the target word but did not belong to the same category. It was not necessary that the raters give one category rating and one complementary rating for each word triad. Agreement with the intended classification was almost perfect: 97.64% correct for category judgements and 98.47% correct for association judgements. These ratings of the category and complementary items are also included in the Appendix.

To reduce contiguous repetition of categories in the test booklets, the 60 stimulus triads were divided into six sets, each set containing 10 triads from 10 different categories. The six sets and the triads within sets were randomized to create six lists. For each list, category alternatives occurred on the right for half of the items in each set, and on the left for the other half (targets always appeared on the far left), yielding a total of 12 lists.

Procedure

Participants were tested in small groups. They completed the preference task, the incidental recall task, and the mediator rating task in that order. The preference task required participants to select one of the two alternatives listed to the right of each target word. The alternatives were numbered one and two, and participants wrote the number for their choice in an answer booklet. Participants were randomly assigned to one of the 12 lists and one of five instructional conditions.

The instructions required participants to choose the alternative that (1) "was most similar," (2) "went together," (3) "was most related," (4) "was most similar and went together," or (5) "went together and was most similar" to the target word.

For incidental recall, the participants were given a booklet containing the target words in the same order as they had appeared in the preference task and they attempted to recall (in any order) both of the words that had been paired with each target. Once they could recall no additional words, participants used five-point scales to rate for each triad two kinds of possible mediators of their choices, namely, the extent to which they had experienced a mental image and the extent to which they had thought of a superordinate label during the preference task. Participants who experienced low imagery or category labels for items on the task were asked to give low ratings of one. Conversely, participants who experienced many mental images or thought of category labels for the items were asked to assign high ratings of five.

Participants then recalled the instructions from the preference task, commented on strategies they had used in selecting alternatives (e.g., "In general, what was your reason for choosing the words that you did?", "Did you group the words in any particular way?"), and indicated whether they had anticipated the recall task. A final self-report language questionnaire measured proficiency at speaking, reading, and writing English, and obtained information about native language, age of English acquisition, and use of English in various settings.

Scoring

The number of category choices on the preference task was determined for each participant (maximum of 60). Given two alternatives, the number of complement choices equals the total number of responses (i.e., 60) minus the number of category choices, so we analyzed and report only the category choice scores.

Recall responses were scored correct if they matched the category and complement items presented during the preference task. Participants could recall a maximum of 60 category and 60 complement items on the recall task. Obvious misspellings, plurals, and some close synonyms (e.g., stop light for traffic light, bunny for rabbit, postman for mailman) were scored as correct.

For the imagery and category rating tasks, the ratings were tallied across test items. Mean imagery and mean category ratings were then calculated for each participant.

The memory-for-instructions protocols were rated on a three point scale by an experimenter who was blind to the actual instructional condition. A rating of three indicated that the memory-for-instructions protocol showed a "most similar" (i.e., category) tendency, two indicated a "neutral" tendency, and one indicated a "goes together" (i.e., complement) tendency.

RESULTS

The dominance of category and complement responses on the preference and recall tasks was assessed by mean overall category choices and mean recall of the two alternatives. Initial analyses examined the deviation of mean category choices from 50% and differences between recall of category and complement alternatives. Subsequent analyses of variance and planned contrasts examined the effect of instructions on categorical choices, recall, and imagery/category ratings. A final analysis of variance compared ratings of the memory-for-instructions protocols across instructional conditions.

Table 1 illustrates the mean percentage of category responses produced in the preference and recall tasks, overall and as a function of the five instructional conditions. (Complementary response means may be obtained by subtracting the category response mean from 60.) On the preference task, participants made many fewer category choices than complement choices, $t(119) = 7.57$, $p < .001$, for the comparison against 50%. Furthermore, only the "similar" instruction group failed to produce significantly fewer category choices compared to the 50% criterion, $t(23) = 1.43$, $p = .165$ (two-tailed). Participants also recalled fewer category ($M = 39.57\%$) than complement ($M = 68.32\%$) alternatives, $F = 433.42$, $MS_e = 114.43$, $p < .001$, and this was true for all five instructions.

Responding on the preference task was influenced by instructions in the predicted manner. Participants made the most category choices with "similar" instructions and the fewest with "goes together" instructions, while the three neutral instructions (i.e., "related," "similar and goes together" and "goes together and similar") fell

TABLE 1
Experiment 1: Mean Percentage of Category Responses in the Preference and Recall Tasks as a Function of Task Instructions

	Task			
	Preference		Recall	
Task Instructions	*M*	*SD*	*M*	*SD*
Similar	41.39	29.41	41.04	13.74
Related	32.99	24.41	38.33	12.78
Similar + Goes Together	33.26	24.63	41.60	15.92
Goes Together + Similar	34.79	23.92	40.07	17.57
Goes Together	23.89	15.13	36.81	11.76
Combined Total	33.26	24.20	39.57	14.37

between these extremes. However, due to the large variation among participants within conditions (*SD*'s ranged from 29.41 for the "similar" condition to 15.12 for the "goes together" condition) and the three neutral conditions being treated as distinct groups, the omnibus main effect of instructions was not significant, $F(4, 115) = 1.64$, $MS_e = 573.58$, $p = .170$. The predicted ordering was confirmed, however, by a planned comparison contrasting the "most similar" (coded 1), the three neutral (coded 0), and the "goes together" (coded −1) instructions, $F(1, 115) = 6.41$, $p = .013$.

Recall also varied across instructions. As demonstrated in Table 1, participants recalled fewer categorical alternatives from a comparison against 50%. Recall of category alternatives declined from "most similar" to neutral to "goes together" instructions, whereas recall of complement alternatives increased. The overall interaction was not significant, $F(4, 115) = 1.47$, $MS_e = 114.43$, $p = .216$, but a planned contrast revealed that the predicted interaction between instructions (coded +1, 0, and −1) and type of relation was significant, $F(1, 115) = 4.08$, $p = .046$. However, this instructional effect is complicated by the fact that participants tended to recall the items they chose on the preference task. When prior preferences were accounted for, participants still recalled more complementary than categorical responses, but the instructional effect was not significant.

Participant ratings of imagery and category experiences during the preference task did not differ across conditions, $F(4, 112) = 0.24$, $MS_e = .17$, $p < .914$, and a planned comparison revealed no pattern corresponding to that in the preference and recall data, $F(1, 112) = 0.01$, $MS_e = 0.01$, $p < .903$. Participants were relatively consistent in their ratings of both category labels ($M = 3.15$) and experiences of mental images ($M = 3.35$), although higher on the latter, $F(1, 112) = 4.56$, $MS_e = 0.54$, $p = .035$. The general questions did not reveal any obvious differences between groups.

Memory-for-instructions ratings varied across instructional conditions, $F(4, 115) = 6.50$, $MS_e = .35$, $p < .001$. The mean rating for the "most similar" condition ($M = 2.21$) was slightly toward the category end of the scale (i.e., three), the mean rating for the "goes together" condition ($M = 1.46$) was toward the complement pole (i.e., one), and the neutral conditions fell in the middle (M's = 2.08, 1.96 and 1.79 for subjects in the "related," "similar and goes together," and "goes together and similar" instructional conditions, respectively).

DISCUSSION

The results clearly demonstrated an advantage for complementary relations in the neutral conditions, and even somewhat under conditions that were expected to favour categorical relations. Participants produced more complement than category responses on both the choice and recall tasks, and they also gave somewhat higher ratings for the use of imagery (hypothesized to be associated with complementary relations) than for the use of superordinate labels.

The high overall level of complementary responding in our experiment is related to evidence in the semantic priming literature that associative relations are more reliable and effective primes compared to categorical relations (e.g., Lupker, 1984; Shelton & Martin, 1992; Young, Flude, Hellawell, & Ellis, 1994; Williams, 1996). With respect to development, the advantage for complement items is also consistent with previous studies that have reported strong complement preferences on choice and recall tasks, even with adolescent and adult participants (e.g., Blewitt & Toppino, 1991; Greenfield & Scott, 1985; Imai, Gentner, & Uchida, 1994; Rabinowitz & Mandler, 1983), and contrary to the traditional developmental model of a shift from complementary to categorical relations well before adulthood.

As predicted, the relative dominance of complement responses was affected somewhat by instructions, with participants making more category choices under "similar" instructions than under "goes together" instructions, and the three neutral conditions producing intermediate levels of categorical responding.

Although significant by planned comparisons, the effects of instructions were surprisingly modest and variable, especially when one considers that explicit instructions to identify the categorical and complementary item produced almost perfect performance in the pre-experimental check of the items. It is unlikely that these weak effects resulted from participants simply responding haphazardly to vague instructions, or from the between-subject manipulation of instructions in the experiment proper. The significant deviation from chance responding on the choice task, the reliable effect of instructions, and the differences in memory for the instructions all indicate that participants attended to the task and performed differently across the conditions. Experiments 2 and 3 sought to enhance the instruction effects and to examine the substantial variability among participants within experimental conditions.

Experiment 2

To enhance the modest instruction effects of Expe-

riment 1, we emphasized the critical words in Experiment 2; specifically, key words in the instructions were enlarged, underlined, and written in bold. This manipulation was expected to increase the likelihood that participants would attend to and remember the relevant aspects of the instructions, leading to stronger instructional effects on preferences and on memory for instructions than were observed in Experiment 1.

Experiment 2 also investigated the variability among participants and the overall high levels of complementary responding observed in Experiment 1. Most semantic network models permit connections of different types (e.g., complementary and categorical) to vary in strength across individuals and conditions (Gitomer & Pellegrino, 1983; Keil, 1989; Vygotsky, 1986). Such individual differences have been demonstrated empirically (Chiarello, Burgess, Richards, & Polluck, 1990; Coltheart & Evans, 1981; Hines, Czerwinski, Sawyer, & Dwyer, 1986). For example, in priming research Chiarello et al. (1990) and Hines et al. (1986) found that category primes presented to the left visual field were most effective for participants with slowest reaction times. These researchers did not find any such relation between participant reaction time and processing speed for complementary primes. This significant correlation between processing speed and amount of priming for categorical (but not complementary) relations suggests that category concepts are activated more slowly than complementary concepts and provides support for the important role of individual differences in semantic memory research.

A free association task was used in Experiment 2 to measure spontaneous tendencies to produce category responses. Individual differences on this associative measure were expected to predict category choices on the preference task and possibly to interact with instructions. The modest effect of instructions in Experiment 1 could indicate that "similar" instructions evoke category choices only in participants who are predisposed to category responses.

The association task also provided an independent test of the dominance of complementary and categorical relations. Inasmuch as participants in Experiment 1 chose and recalled more complementary than categorical items, we expected associations to be related to stimuli more by complementary than by categorical relations.

METHOD

Participants

Seventy-two introductory psychology students from the University of Winnipeg participated in the experiment for course credit. Participants ranged in age from 18 to 47 years (M = 21.52). All participants could read and write English well. Four additional participants who did not complete the tasks within the scheduled time were replaced.

Materials

The preference task contained the same 60 stimulus triads that were used in Experiment 1. The association measure was based on 36 concrete words (Paivio, 1974) with a mean familiarity rating of 6.00, a mean imagery rating of 6.63 (both on 7-point scales), and a mean length of 5.80 letters. These 72 words (which are available from the authors) were not used in the preference task. An additional 36 abstract words appeared as fillers. The association stimuli were randomly ordered and divided into four sets. The sets were then randomized to create four booklet orders.

Procedure

Participants were tested in small groups and first completed the preference task as described in Experiment 1. Only three instructional conditions were used: (1) "is most similar to," (2) "goes together with," or (3) "is related to" the target word. Since Experiment 1 showed that all three of our hypothesized neutral instructions were effective in producing intermediate levels of categorical and complementary responding, we eliminated redundant testing conditions by using only one neutral wording (i.e., "is related to"). The critical phrases of the instructions were underlined, enlarged, and highlighted in bold. Participants were randomly assigned to one of the three instructions and to one of 12 lists (see Experiment 1 for details).

Participants were then asked to recall the instructions for the preference task and to comment on their strategies for choosing between the category and complement alternatives. Next, participants completed the free association task, generating two related words for each target word or marking an "X" if they did not know the meaning of the stimulus word. Lastly, participants completed an English language questionnaire.

Scoring

Category and complement responses on the preference task and memory for instructions were scored as in Experiment 1. Due to time constraints and the unanticipated number of unique word associations produced by the participants, only the first 18 concrete words were judged for categoricalness. Four raters independently coded the 1237 unique stimulus-response pairs on a five-point scale. High ratings were assigned to pairs with strong categorical relations (e.g., blue-yellow) and low ratings to pairs related in a non-categorical way (e.g., blue-sky). Blank spaces, X's, and unreadable responses were not scored. The categoricalness ratings were reliable (alpha = .80) and were averaged to produce a mean for each word pair. Pair means were then averaged across pairs to obtain a mean categoricalness rating for each participant. The final score was based on an average of 35.39 ratings (out of a possible of 36) for each participant.

RESULTS

As in Experiment 1, a t-test compared the mean percentage of category choices to 50% and analyses of variance examined instructional effects and memory-for-instructions. Regression analyses determined whether individual

TABLE 2
Experiment 2: Mean Percentage of Category Responses on the Preference Task and Mean Categoricalness Ratings on the Free Association Task as a Function of Task Instructions

	Task			
	Preference		Free Association	
Instructions	*M*	*SD*	*M*	*SD*
Similar	55.42	32.23	2.73	0.42
Related	30.21	19.15	2.53	0.30
Goes Together	26.53	21.76	2.48	0.36
Combined Total	37.38	27.85	2.58	0.36

differences in category tendencies, as measured by the free association task, predicted choices on the preference task and interacted with instructions.

The mean percentage of category responses produced overall and as a function of the three instructional conditions is presented in Table 2. Overall, participants again produced fewer category choices than complement choices on the preference task, $t(71) = 3.84$, $p < .001$, for the deviation from 50%. There was also a significant main effect of instructions on preferences, $F(2, 69) = 9.48$, $MS_e = 626.21$, $p < .001$. Although still relatively low in absolute terms, category responses became the dominant choice with "similar" instructions and were twice as probable as with "goes together" instructions. "Related" instructions again produced intermediate levels of category responses.

The rated categoricalness of the reported preference instructions varied more dramatically than in Experiment 1 across instructional conditions, $F(2, 69) = 51.72$, $MS_e = .25$, $p < .001$. The mean rating was 2.83 for the "similar" group (much closer to the perfect category rating of three than in Experiment 1), 1.88 for the "related" group, and 1.38 for the "goes together" group (closer to the perfect complementary rating of one than in Experiment 1).

Free associations tended to be complementary rather than categorical ($M = 2.58$ versus a mid-point of 3 on the category rating scale). Categoricalness ratings correlated significantly with the degree of category responding in the preference task, $r = .49$, $p < .01$. Participants who chose many category alternatives in the preference task were likely to give category responses in the association task.

The relation between category preferences and category associations varied with instructions, and was examined separately for the three conditions. To obtain meaningful intercepts at average levels of category associations as recommended by Aiken and West (1991), category association ratings were converted to deviation scores about the grand mean of 2.58. The regression equations were $Y' = 48.03 + 48.49 \times C$ for the "similar" group, $Y' = 31.10 + 17.80 \times C$ for the "related" group, and $Y' = 27.42 + 8.64 \times C$, for the "goes together" group, where Y′ refers to the predicted score on the preference

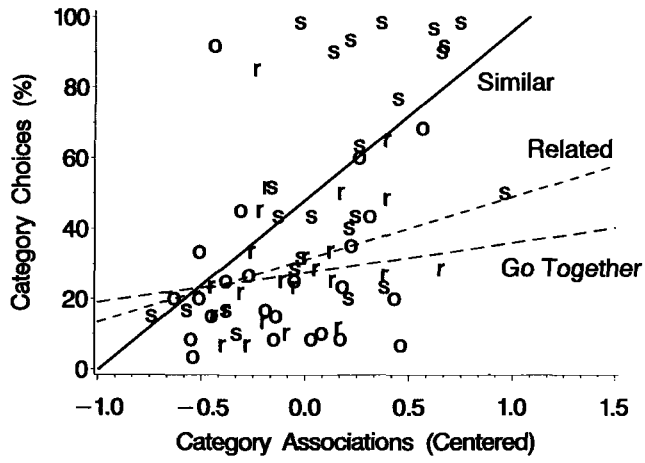

Figure 1. Category choices in Experiment 2 as a function of categoricalness ratings and similar (s), related (r), or go together (o) instructions.

task and C refers to the deviation category score from the association task. The slope was highly significant for "similar" instructions, $t(22) = 3.82$, $p < .001$, tended toward significance for related instructions, $t = 1.35$, $p < .19$ (two-tailed), and did not approach significance for "goes together" instructions, $t = 0.69$, $p = .50$. The separate equations and the raw scores appear in Figure 1.

Differences between intercepts and slopes were tested for significance using multiple regression. The predictors were rated categoricalness of associations (centered at the mean), linear and quadratic indicator variables for instructions, and linear and quadratic terms for the interaction ($R^2 = .40$). A significant linear effect for the y-intercepts of the three equations, $t(66) = 3.04$, $p = .003$, confirmed that instructions affected preferences at the average category association value (i.e., at the mean used for centering). The regression coefficient for the predictor representing the overall categoricalness rating on the free association task was significant, $t = 3.26$, $p < .002$.

These main effects were qualified by a significant interaction between the linear effect of instructions and categoricalness, $t = 2.36$, $p = .021$. The interaction reflects significant differences among the slopes of the simple equations for the three groups. The major finding was that category choices increased with category associations only for participants who received "similar" instructions, as is clearly shown in Figure 1.

Unexpectedly, category association scores were affected by instructions, $F(2,69) = 3.29$, $MS_e = .13$, $p < .04$. Category associations were highest for participants with "similar" instructions in the preference task, intermediate for "related" instructions, and lowest for "goes together" instructions.

DISCUSSION

Participants in Experiment 2 again made more complement than category choices overall, with the exception of participants who received "most similar" instructions.

Free associations also tended to be complementary rather than categorical. These results support the view that participants have strong biases for complementary relations, as reported in Experiment 1 and in the priming studies cited earlier.

These complementary tendencies were partly overridden by instructions that emphasized similarity. The effect of instructions was stronger than that observed in Experiment 1, and the enhanced effect was due primarily to increased category responses by participants given "similar" instructions. In the "similar" condition, the percentage of category choices increased by more than 10% from Experiment 1 to Experiment 2, and participants remembered the categorical nature of the instructions more accurately.

The free association measure revealed substantial individual differences in tendencies to retrieve category and complement responses. These tendencies predicted the number of category choices in the preference task, although only the slope for the "similar" condition was significant. The interaction between instructions and tendencies is consistent with a model in which instructions can prime pre-existing category relations, but have little effect when such relations are weak.

Interpretation of the observed relation between the association and preference tasks is complicated somewhat by the fact that the association task was done second and was susceptible to the instruction manipulation for the prior preference task. Preference instructions appear to have either influenced interpretation of the common instructions to generate "related" associations or operated indirectly by priming specific superordinate nodes during the choice task. To replicate Experiment 2 and to eliminate possible carryover effects from the preference task to the free association task, free association was performed first in Experiment 3.

Experiment 3

Experiment 3 again examined the effects of enhanced instructions and individual tendencies to give category associations. Participants free associated *before* the preference task, to eliminate any possible influence of preference instructions. If order of the association and preference tasks is irrelevant, individual variation in spontaneous category associations should still predict choices on the preference task and moderate the effects of instructions.

METHOD

Participants

The participants were 72 introductory psychology students (49 females) from the University of Winnipeg. They ranged in age from 18 to 47 years (M = 24.25). All participants could read and write English well; an additional 12 participants who did not meet this criterion or failed to complete the tasks were replaced.

Materials and procedure

The three enhanced instruction conditions of Experiment 2 were used and testing was again done in groups. One set of 18 concrete words was randomly chosen from the association words used in Experiment 2. These words did not appear on the preference task, and had a mean familiarity rating of 5.30, a mean imagery rating of 6.65, and a mean length of 5.50 letters. All participants completed the association task, the preference task, a revised imagery/category rating task with highlighted instructions, and a language questionnaire, in that order. The same four judges rated the categoricalness of the 789 unique free association stimulus-response pairs that had not occurred in Experiment 2 (alpha = .71). Other materials and scoring procedures for Experiment 3 were identical to those used in Experiments 1 and 2.

TABLE 3
Experiment 3: Mean Percentage of Category Responses on the Preference Task and Mean Categoricalness Ratings on the Free Association Task as a Function of Task Instructions

	Task			
	Preference		Free Association	
Instructions	*M*	*SD*	*M*	*SD*
Similar	52.50	32.26	2.70	0.57
Related	27.36	22.86	2.63	0.50
Goes Together	18.19	9.38	2.54	0.34
Combined Total	32.69	27.35	2.62	0.48

RESULTS

The results of the preference, free association, and imagery/category rating tasks were analyzed according to procedures described in Experiments 1 and 2. Table 3 illustrates the mean percentage of category responses on the preference task and the mean categoricalness ratings on the free association task overall, and as a function of instructions.

On the preference task, participants once again produced fewer category than complementary choices, $t(71) = 6.91$, $p < .001$, for comparison with 50%. There was also a main effect of instructions, $F(2, 69) = 13.76$, $MS_e = 550.31$, $p = .001$, with "similar" instructions producing the most category choices, followed by "related" and "goes together" instructions. The pattern is very similar to that observed in Experiment 2.

The categoricalness-of-association scores for individual participants were based on mean ratings across an average of 35.43 stimulus-response pairs (out of a possible 36). Associations again tended to be complementary rather than categorical (M = 2.62 on a 5-point scale) and, as expected given the changed order of the association and preference tasks, preference instructions were now unrelated to the association scores, $F = .63$, $MS_e = 0.23$, $p = .53$. As in Experiment 2, category associations were positively correlated with category choices on the preference task, $r = 0.26$, $p < .05$.

The relation between the association and preference tasks varied across instructions. Category association

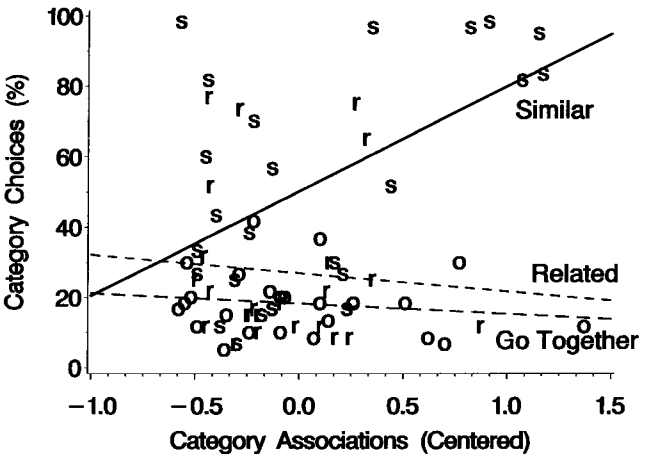

Figure 2. Category choices in Experiment 3 as a function of categoricalness ratings and similar (s), related (r), or go together (o) instructions.

scores were converted to deviation scores about their grand mean (M = 2.62) for the regression analyses. The regression equations were: $Y' = 50.28 + 29.73 \times C$ for the "similar" condition, $Y' = 26.94 - 5.26 \times C$ for the "related" condition, and $Y' = 18.21 - 2.94 \times C$ for the "goes together" condition. The pattern was similar to that observed in Experiment 2, and again only the slope for the "similar" instruction condition was significant, $t(22) = 2.91$, $p = .008$. Indeed, equations for the other two groups had (nonsignificant) negative slopes. The best-fit lines and raw scores appear in Figure 2.

Multiple regression ($R^2 = .41$) revealed a linear effect of test instructions, $t(66) = 2.016$, $p < .05$, and an interaction between the linear component of the instructions and the category association ratings, $t = 2.99$, $p < .004$. The main effect of category scores was not significant, $t = 1.20$, $p = .23$. Category choices were particularly frequent for participants who produced category associations spontaneously and received "similar" instructions on the preference task.

As in Experiment 1, the post-experimental questionnaires were uninformative about the specific mediators of choices on the preference task, perhaps because the cognitive processes involved in these tasks are not available to consciousness.

DISCUSSION

Experiment 3 replicated the effects of instructions in the preference tasks of Experiments 1 and 2, and the interaction between categoricalness ratings and preference task instructions observed in Experiment 2. These findings confirm that choices on the preference task were influenced by test instructions, by individual response tendencies, and by the interaction between these variables. Furthermore, our concern that the free association data was confounded by instructions on the preference task in Experiment 2 proved unfounded. Whether the association task was first (Experiment 3) or second (Experiment 2), category association ratings moderated the effects of choice instructions. The "similar" instructions were most effective for participants who had category predispositions, and had little effect on participants with weak category tendencies.

General Discussion

The present experiments have demonstrated a consistent preference for complementary choices, a significant yet moderate effect of instructions on baseline preferences, and a replicable interaction between instructions and individual tendencies to give category associations. These effects support findings from other semantic memory paradigms, provide a tentative explanation for apparent inconsistencies in results across and within the various paradigms, and highlight the importance of several fundamental issues in semantic memory.

ADVANTAGE FOR COMPLEMENTARY RELATIONS

One clear conclusion is that adults generally demonstrate an overall preference for complementary relations. Although adults produced both complement and category responses in preference tasks, complement responses were more common with most instructions, notably with the neutral "related" instructions. Even "similar" instructions only raised mean category preferences to the 55% range.

Other supplementary observations supported this conclusion. Free associations tended to be complementary rather than categorical, the neutral "related" instruction wording produced only marginally more category choices than the "go together" instructions and many fewer category choices than the "similar" instructions, and participants reported higher levels of imagery than use of category labels during the preference task.

The present findings are consistent with priming and episodic memory studies in which complementary relations show stronger effects than category relations (e.g., Lupker, 1984; Rabinowitz & Mandler, 1983; Shelton & Martin, 1992; Young, Flude, Hellawell, & Ellis, 1994; Williams, 1996). These findings suggest that the semantic links between concepts sharing a complementary relations are generally stronger or more readily accessible than are categorical relations. One general implication of this conclusion is that the past emphasis on taxonomic, hierarchical relations in models of semantic memory may need to be balanced by greater attention to complementary relations based on schemas and episodic events.

APPARENT CONTRADICTIONS BETWEEN PARADIGMS

The results of the present experiments and previous research on priming also challenge the dominant developmental view of a complementary to category shift. However, instructions alone seem an unlikely explanation for the observed differences. The "similar," "related," and "go together" instructions did modulate preferences, but only modestly, and probably not enough to produce the very strong category preferences reported in some preference studies. Even with the

emphasized "similar" instructions of Experiments 2 and 3, category choices averaged over all participants at best matched or slightly exceeded complementary choices.

Although "similar" instructions did not produce uniformly high levels of category choices, instructions did interact with individual tendencies for category responses. Participants with pre-existing category tendencies were strongly influenced by the "similar" instructions and demonstrated a high degree of preference for category choices, as reported in other studies with adults. Figures 1 and 2 show almost 100% category choices for participants who received the similar instructions *and* had high category scores on the association task.

These findings show that suitable instructions and participants can produce high levels of category choices, both of which may have occurred in preference studies demonstrating a shift to category choices. Predispositions to categorical organization may also explain evidence that category preferences correlate with schooling (Jahandarie, 1986) and social class (Sigel, Anderson, & Shapiro, 1966), both of which have been implicated in understanding of taxonomic relations.

INCONSISTENCIES WITHIN PARADIGMS

Instructions, predispositions, and their interaction may also contribute to the variable results for priming and related semantic memory paradigms. Using different tests and a range of stimuli (e.g., words, pictures, names of famous people), category primes have produced inconsistent effects: strong facilitation (Fischler, 1977, Williams, 1996), weak facilitation (Lupker, 1984), no effect (Huttenlocher & Kubicek, 1983; Shelton & Martin, 1992), and even interference (Becker, 1980). As noted previously, variable results have also been reported with the preference task, for example, as a function of instructions (Markman & Hutchinson, 1984). The present research suggests that participants, materials, or other subtle factors that vary unsystematically across experiments may have affected the benefit of category relations in semantic memory tasks.

Analogous to the present instructional effects, exposure to pairs or groups of words that exemplify certain types of relations (e.g., taxonomic) could prime general classes of responding. Such indirect context effects have been demonstrated in free association and semantic priming paradigms. Wynne, Gerjuoy, and Schiffman (1965), for example, found that antonym-evoking stimuli placed early in a free association list increased the frequency of antonym responses for later items. Similarly, enhanced priming effects occur when primes and targets share a semantic relation (e.g., Fischler, 1977; Meyer & Schvaneveldt, 1971; Neely, 1977) or are highly related (Balota, Black, & Cheney, 1992; Coltheart & Evans, 1981; Neely, Keefe, & Ross, 1989; Nelson, LaLomia, & Canas, 1991; Pusen, Erikson, Hue & Vyas, 1988).

In memory tasks, mental sets could also be influenced by the actual presentation of taxonomic (Khan & Paivio, 1988) or complementary (Blewitt & Toppino, 1991) labels. Such labels would make specific kinds of relations particularly prominent.

The present results also demonstrate the sometimes critical role of individual differences in semantic memory tasks. Only by measuring participants' pre-existing sensitivity to category relations were we able to identify the locus of the instruction effect. It appears that some people have weak or otherwise inaccessible category pathways, a state that could result from education, from differential familiarity with specific categories, and/or from other personal experiences that contribute to the underlying organization of concepts in semantic memory (Chiarello et al., 1990; Coltheart & Evans, 1981; Hines et al., 1986; Gitomer & Pellegrino, 1983; Keil, 1989; Koivisto & Laine, 1995; Vygotsky, 1986).

With respect to cognitive development, the variability of preferences across instructions supports the argument made by others that age-related changes reflect a shift in subjective preferences (Scott et al., 1982) or in predominant strategy (Siegler, 1994; Bjorklund, 1995), rather than a fundamental change in semantic memory. Markman (1989) and Scott et al. (1980), for example, concluded that young children can group objects categorically, but simply attend more to spatial (i.e., complementary) relations between objects. One way to influence attention to different relations is by instructions.

ISSUES FOR SEMANTIC MEMORY RESEARCH AND THEORY

The effects of instructions and individual differences on the distinct kinds of relations studied here, as well as in other semantic memory paradigms, have several implications for research on semantic memory. One fundamental issue is how to model the preference for complementary relations. The advantage can be explained by several possible and somewhat overlapping mechanisms (Chiarello et al., 1990; Hines et al., 1986). Complementary pathways (e.g., dog-bone) may be more direct than category relations, which would be mediated by intervening superordinate nodes (e.g., dog-animal-horse). It is not obvious, however, that complementary relations are necessarily direct, as opposed to mediated by propositional structures (e.g., dog-chews-bone). It is possible that complementary relations reside in a more readily-activated lexical (i.e., nonsemantic) system, whereas categorical relations reside in a deeper and more slowly activated semantic system (Chiarello et al., 1990). Alternatively, complementary items may simply be stronger or more easily activated because of repeated experiences or recent priming. The present experiments do not distinguish these alternatives, but the preference paradigm offers an additional method for investigating the organization of these distinct relations in semantic memory.

The effect of instructions requires some cognitive mechanism by which specific relations are selectively primed. One hypothesis is that remembered words and phrases from the instructions modulate the spread of activation from the nodes corresponding to stimulus words. The instruction "similar" and the stimulus "cow," for example, may converge on relevant category path-

ways and nodes (e.g., cow-animal), and/or inhibit irrelevant pathways and nodes in semantic memory (e.g., cow-milk). Instructions that allow other choices (e.g., "related"), would not bias the spread of activation toward category associations and/or away from non-category associations. The emphasis of key words in the instructions of Experiments 2 and 3 produced stronger contextual priming effects, thereby increasing category choices under "similar" wordings.

The observed effects of individual differences may require some adjustment of standard approaches to semantic memory research and theory. Preference, priming, and other measures of semantic relatedness would benefit from individual difference measures of relevant dimensions, such as the association measure of category sensitivity used in the present research. Theorists may also need to consider varied and dynamic models, rather than a single associative network to accommodate all participants as in most current simulations.

More generally, our findings are relevant to both cognitive and developmental approaches attempting to understand the organization of semantic memory. The present work has revealed important contributions of instructions and individual differences to choice performance, and suggested several mechanisms by which these variables might affect processing in semantic memory. Some of these mechanisms (e.g., inhibition of alternative relations) have already been implicated in research on children's knowledge of category relations (e.g., Clark & Johnson, 1994).

In conclusion, category and complementary preferences were influenced by an interaction between instructions and spontaneous tendencies to produce category associations. The experiments confirmed an overall advantage for complementary relations, demonstrated the fundamental importance of individual differences in semantic structures, and identified several factors that should be considered in cognitive and developmental research on category preferences, episodic memory, and semantic priming. The preference task provides one additional paradigm for further study of the cognitive mechanisms that underlie such semantic judgements and the dynamic, adaptive nature of semantic memory.

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APPENDIX

Target, Category (CTG), and Complementary (COMP) Items Used in the Preference Task, and Classification Ratings of the Category and Complementary Items in Percent.

Target Item	CTG Item	COMP Item	CTG % rating	COMP % rating
1) banana	cherry	monkey	100	100
2) baseball-cap	shoe	head	100	100
3) bed	table	pyjamas	100	100
4) bee	butterfly	honey	92	92
5) birthday-cake	chocolate-cake	birthday-present	75	75
6) brush	comb	hair	100	100
7) cactus	ivy	desert	100	100
8) car	airplane	tire	100	100
9) carrot	onion	rabbit	100	100
10) chair	couch	sitting-man	100	100
11) chimney	roof	brick	83	100
12) cow	pig	milk	100	100
13) crown	hat	king	100	100
14) cup	saucer	coffee	100	100
15) doctor	mailman	syringe	100	100
16) dog	elephant	bone	100	100
17) door	window	key	100	100
18) dress	sweater	hanger	100	100
19) duck	blue-jay	pond	100	100
20) farmer	butcher	tractor	100	100
21) fire-engine	truck	fireman	100	100
22) guitar	bagpipe	pick	100	100
23) gun	arrow	bullet	67	92
24) hammer	chisel	nail	100	100
25) hand	ear	ring	100	100
26) hockey	soccer	puck	100	100
27) horse	lion	saddle	100	100
28) kitchen	bedroom	refrigerator	100	100
29) motorcycle	bus	traffic-light	100	92
30) mouse	goat	cheese	100	100
31) necklace	earring	neck	100	100
32) needle	pin	thread	100	100
33) net	rope	fish	100	100
34) ocean	stream	whale	100	100
35) paintbrush	crayon	easel	92	92
36) pen	pencil	paper	100	100
37) piano	violin	music	100	100
38) pie	ice-cream	apple	67	83
39) policeman	teacher	jail	100	100
40) record-player	stereo	record	100	100
41) red	green	rose	100	100
42) river	lake	boat	100	100
43) robin	penguin	nest	100	100
44) running-shoe	slipper	foot	100	100
45) sailor	pilot	ship	92	92
46) saw	screwdriver	board	100	100
47) sheep	cat	wool	100	100
48) shirt	pants	iron	100	100
49) spider	grasshopper	web	92	92
50) spoon	fork	soup	100	100
51) sprinkler	watering-hose	flowers	100	100
52) stove	toaster	pan	100	100

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APPENDIX (*continued*)

53) sword	knife	pirate	100	100
54) teeth	eye	toothbrush	100	100
55) tennis	golf	racket	100	100
56) tiger	kangaroo	circus	100	100
57) train	taxi	tracks	100	100
58) tulip	tree	watering-can	100	100
59) watermelon	blueberry	seeds	100	100
60) yellow	blue	sun	100	100

Sommaire

Les concepts de la mémoire sémantique sont reliés à des concepts connexes de multiples façons y compris les liens catégoriels (chien-cheval par exemple) et les liens complémentaires (chien-os, par exemple). Plusieurs recherches sur les paradigmes ont étudié la force et l'accessibilité relatives de ces liens catégoriels et complémentaires dans la mémoire sémantique. Des recherches sur l'amorçage sémantique ont démontré que, bien que l'amorçage catégoriel puisse se produire dans certaines circonstances, les liens complémentaires sont plus constants (Lupker, 1984, par exemple). Par contre, les tests de préférences (Smiley et Brown, 1979, par exemple) qui demandent aux participants de choisir un mot relié à une cible par des liens catégoriels ou complémentaires produisent généralement plus de réponses catégorielles, particulièrement chez les adultes. Les instructions et d'autres facteurs cognitifs pourraient avoir provoqué ces différents résultats. Trois études, réalisées auprès d'adultes, ont examiné l'influence des instructions et des préférences individuelles sur les réponses catégorielles et complémentaires lors d'un test de préférences. Au cours de la première expérience, les choix de catégories étaient, dans l'ensemble, relativement peu communs et se faisaient le plus souvent à la suite d'instructions de type «le plus similaire» et le moins souvent avec des instructions de type «relié». Comme nous l'avions prévu, les instructions neutres de types «connexe», «similaire» ou «relié» ont produit des niveaux intermédiaires de réponses par catégorie. L'effet des instructions a augmenté lors des deuxième et troisième expériences lorsque les mots clés des instructions ressortaient. Des instructions de type «le plus similaire» ont provoqué des choix plus catégoriels que complémentaires, particulièrement chez les participants prédisposés à associer spontanément des catégories aux mots. Ces résultats confirment les recherches déjà existantes sur l'amorçage en révélant que nos participants avaient des préférences nettement complémentaires. De plus, les préférences des participants peuvent changer à la suite de modifications subtiles dans le libellé des instructions ou des tendances antérieures à catégoriser.