CATEGORY CONTINGENT COMPARATIVE JUDGEMENTS

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Abstract

In one experiment, participants compared the size of animals from memory and on congruent trials selected the smaller if both were small and the larger if both were large. On incongruent trials, they selected the larger animal if both were small and the smaller if both were large. In a second experiment, participants compared the lengths of lines and the direction of the comparison was contingent on whether the lines were short or long. Response times (RTs) were increased and semantic congruity effects (SCE) were greatly amplified with the category contingent instructions relative to the conventional non-contingent instructions precisely as predicted by the class of evidence accrual models of decisional processing. These findings are not easily accounted for by the single sample, stage models, of the SCE.

Semantic congruity effects (SCEs) reflect a robust and enduring property of comparative judgments with both perceptual and symbolic comparisons that any complete theory of the comparison process must address. The SCE arises as an interaction between the direction of the comparison and the location of the stimulus pair on the underlying dimension. For example, as in the landmark experiments of Audley and Wallis (1964) who brought the SCE to the attention of contemporary psychophysicists, the time to select the brighter of two relatively bright lights was faster than the time to select the darker. Conversely, the time to select the darker of two relatively dark lights was faster than the selection of the brighter.

In the typical psychophysical comparison experiment, the instructions specifying the direction of the comparison are explicit and defined by the instruction presented. In the present experiment, we made the direction of the comparison dependent on the outcome of a binary categorization. On half of the trials, the direction was semantically congruent with the category and on the other half it was semantically incongruent. In particular, in one experiment, using pairs of line lengths varying from short to long, we required participants to select the shorter line if both lines were short and the longer line if both were long on congruent trials. On incongruent trials, participants selected the longer line in the pair if both lines were short and the shorter line if both lines in the pair were long. We reasoned that the magnitude of the semantic congruity effect when the direction of the comparison was contingent on the category of the stimulus pair relative to the magnitude of the effect with the usual instructions would be theoretically revealing about both the basis for the semantic congruity effect and, more generally, the processes involved in comparative judgments.

Indeed, the Leth-Steensen and Marley (2000) connectionist, instructional pathway interference model is clear in predicting enhanced SCEs with the category contingent instructions. Pathway interference is heightened with the incongruent category contingent instructions primarily because the incongruity is made explicit. Petrusic's (1992) view that the SCE occurs on each pass through the evidence accrual process is also clear in predicting enhanced SCE with the category contingent instructions. On this view, accruals are lengthened with the category contingent instructions on the assumption that binary categorization occurs on each pass through the accrual process. Further, memory access to the relevant instruction is slowed through explicit interference of the category label and the instruction in the category contingent incongruent case and it is assumed that the relevant instruction is accessed and activated on each pass through the evidence accrual process.

Experiment 1

Method

Participants. Nineteen Carleton University students participated in one 40-minute session to satisfy course requirements.

Apparatus. Graphics production, presentation of instructions and stimuli, event sequencing and timing, and the recording of responses and RTs were controlled by a Pentium III computer running under SuperLab control. Stimuli and instructions were presented on a 17 inch (43 cm) ViewSonic video monitor with 800 by 600 pixel resolution. Responses were made using the buttons on an IBM-PC Mouse with the roller-ball disabled.

Stimuli and Design. Six animal names defined the stimulus set. Three names were of relatively small animals (ant, bee, bat), whereas the other three names were of relatively large animals (dog, pig, cow). The animal names were paired within categories resulting in three relatively small animal pairs (ant-bee, ant-bat, bee-bat), and three relatively large animal pairs (dog-pig, dog-cow, pig-cow). Each pair in the design was presented in each of the two possible left-right position orders, resulting in 12 animal names pairs. The two words “Larger”, “Smaller” (usual condition), and the two sentences “small-smaller and large-larger”, and “small-larger and large-smaller” (category contingent condition) served as instructions. The two instructional conditions, and the two forms of comparative instructions in each of the two conditions, occurred equally often and appeared randomly from trial to trial. This factorial combination (the 12 stimulus pairs by two instructions by two conditions) was replicated six times, resulting in 288 experimental trials for each participant, preceded by one replication of practice trials. The order of presentation of the stimulus pairs within blocks was random and different for each participant.

Procedure. Participants were tested individually in a dimly lit room, seated approximately 80 cm from the centre of the video monitor. In the usual instruction condition, participants were told that the presentation of either the word “SMALLER” or “LARGER” served as a warning for the next trial and was an instruction that indicated whether they were to choose either the larger or the smaller animal in the pair. As well, participants were told that the phrase “Small-smaller and large-larger” meant, “if both animals in the pair are relatively small – pick the smaller animal and if both animals are relatively large – pick the larger animals. In addition, the instruction “small-larger and large-smaller” served as an instruction to choose the larger animal in the pair if both animals are relatively small and the smaller animal if both animals are relatively large. After an additional 750 ms, the pair of animal names appeared while the comparative instruction remained on the screen. The participant’s task was to press the left or the right button of a mouse corresponding to the side of the larger (or smaller, respectively) member of the pair of animal names, according the appropriate instruction.

The presentation of the stimuli and the comparative instruction were response-terminated. The next trial began 1000 ms later. Participants were encouraged to respond quickly, but accurately. The 40-minute session included three planned breaks, which ended with the participants’ decision to continue.

Results

The findings are presented in two main sections; the first presents RT analyses and the second focuses on error rates. For each participant, in all analyses, the dependent variables in each cell of the design are the mean RT for all responses and the mean percentage of errors. In each analysis of variance (ANOVA) reported, Huynh-Feldt, epsilon adjustment of degrees of freedom was used. However, the degrees of freedom associated with each value of *F* are defined by the design and the Mean Square Errors provided in the text are those given by the conventional degrees of freedom. Level of significance was set at 0.05 throughout.

RT analyses

Figure 1 (Panel A) provides a view of the main features of the data of this experiment, providing means and error bars for each cell of the design. As is evident from the plots in Figure 1, the category contingent manipulation proved extremely effective in slowing the comparison process. Mean RTs were 1527.7 ms in the category congruent condition and 2414.4 ms in the category in contingent condition. An ANOVA showed this difference to be reliable (F(1, 18)=206.0, MS(Error)=291435.6). The usual lexical markeness effect was also obtained; RTs were 1923.6 ms with the instruction to select the name of the larger animal and 2016.6 ms with the instruction to select the smaller and this markedness effect was statistically reliable (F(1, 18)=8.05, MS(Error)=81790.8). The stimulus pairs also differed in overall RT (F(3, 54)=12.74, MS(Error)=171378.7), reflecting the typically observed end-point effect. As is evident, RTs are longest with the two middle pairs (bee-bat and dog-cow) in both conditions.

The plots in Figure 1 (Panel A) also show the classic crossover pattern of the semantic congruity effect in both instruction conditions and the interaction between stimulus pair and instruction, defining the SCE, is highly reliable (F(3, 54)=29.75, MS(Error)=108016.1). It is also clear from the plots in Figure 1 that the SCE is greatly enhanced with the category incongruent instructions as predicted on the evidence accrual views. Indeed, the three

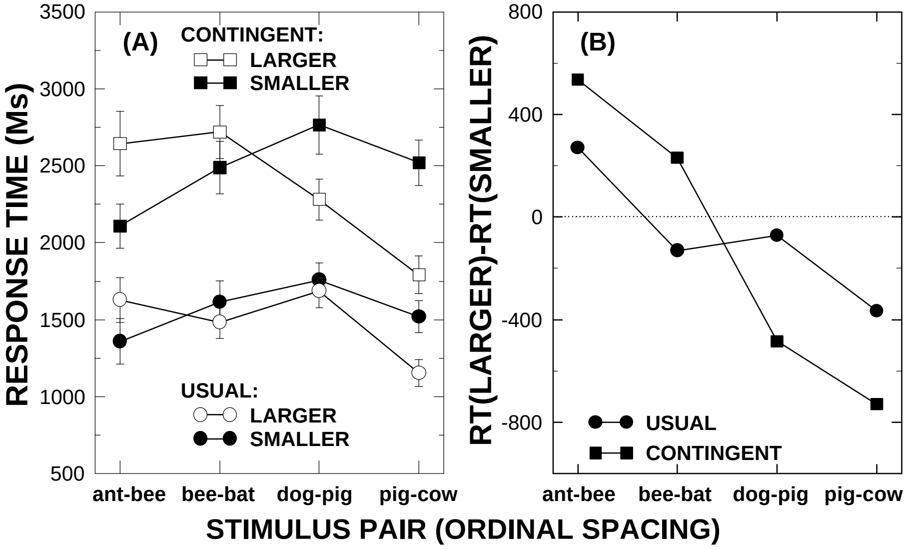

Figure 1. Mean RTs with the category contingent and the usual instructions with each instruction and each stimulus pair (Panel A) in Experiment 1. SCE index for the usual and category contingent instructions with each pair (Panel B).

way interaction involving stimulus pair, instruction direction, and instruction condition is statistically reliable (F(3, 54)=6.83, MS(Error)=115253.5).

The plots in Panel B of Figure 1 provide an alternative way of viewing both the cross-over SCE's in each condition and the enhanced SCE in the category contingent condition. These plots are based on a SCE index, defined by RT with the instruction smaller subtracted from RTs with the instruction larger. The full crossover effect is evident when the SCE is positive (RTs are longer with the instruction longer than with the instruction shorter) for the relatively small animals and the SCE index is negative with the relatively large animals. The enhanced SCE with the category contingent comparisons is evident with the uniformly larger SCE index with each of the small category pairs and each of the large category pairs.

Error analyses

As expected with these symbolic comparisons, error rates were very low. In the usual instruction condition the error rate was 3.95% and it was 4.50% in the contingent instruction condition, and the error rates in these two conditions did not differ reliably (F(1, 18)=1.42, MS(Error)=16.1). Given the these low error rates and the lack of variability in error rates over the 16 cells defined by the factorial combination of instruction condition, stimulus pair, and instruction, it is not surprising that the correlation between error rate and mean RT is minimal (r=0.150, t(15)=0.568, p>0.578). Nevertheless, the lack of a negative correlation is sufficient to rule out a speed-accuracy trade-off.

Experiment 2

The enhanced SCE with the category contingent instructions provides considerable support for the evidence accrual based theoretical positions developed in Leth-Steensen and Marley (2000) and in Petrusic (1992). With a view toward replicating and extending the generality of the findings from Experiment 1, comparisons with perceptual stimuli, visual extents, were required in Experiment 2.

Method

Participants. Eighteen Carleton University students participated in one 50-minute session to satisfy course requirements.

Apparatus. The apparatus of Experiment 1 was used in this experiment.

Stimuli, design and procedure. Three pairs of relatively short lines (10-11, 20-21, 50-51), and three pairs of relatively long lines (147-150, 200-210, 250-252) were used (units are pixels) in each of the two (left-right presentation orders), thus resulting in 12 stimulus pairs. The three short stimulus pairs are defined, in terms of difficulty, by the ratios 1.10, 1.05, 1.02, respectively and the ratios are 1.02, 1.05, and 1.008 for the long pairs, respectively. All lines, drawn by Paintbrush software, were 1 mm wide and appeared in black on a white background. The pairs of lines appeared at the respective centres of the left and right hemi-fields on the monitor.

The two words "Longer", "Shorter" (usual condition), and the two sentences "short-shorter, and long-longer", and "short-longer, and long-shorter" (categorical condition) served as instructions. The instructions were printed in Times New Roman font (size 30, bold), and were displayed at the center of the upper-third of the screen. The two instructional conditions, and the two forms of comparative instructions in each of the two conditions, occurred equally often and appeared randomly from trial to trial. This factorial combination (the 12 stimulus pairs by two instructions by two conditions) was replicated five times for a total of 240 experimental trials, preceded by one replication of practice trials. The order of presentation of the stimulus pairs within blocks was random and different for each participant. The procedure was essentially the same as in Experiment 1.

Results

As in Experiment 1, RT analyses are presented prior to the error data. The ANOVAs are reported in the same way as in Experiment 1.

Response time analyses

As is clear from the plots in Figure 2 (Panel A), and as in Experiment 1, the comparisons with the category contingent instructions are considerably and reliably longer (3052.1 ms) than the comparisons with the usual instructions (1931.1 ms) (F(1, 17)=76.93, MS(Error)=1764276.0). As expected, the stimulus pairs differed reliably (F(5, 85)=7.89, MS(Error)=287101.8), varying systematically with the ratio of the extents. For the three short line-length pairs with ratios 1.1, 1.05, and 1.02, overall mean RTs are 2261.1, 2395.4, and 2570.7 ms, respectively. For the long pairs with ratios 1.05, 1.02 and 1.008, overall mean RTs are 2361.4, 2662.0, and 2698.5, respectively. The interaction between instruction condition and stimulus pair was also reliable (F(5, 85)=3.19, MS(Error)=263741.0) showing generally enhanced effects of stimulus pair a priori ratio defined discriminative difficulty.

In addition, precisely as in Experiment 1, the interaction between stimulus pair and instruction was reliable affirming the clear occurrence of SCEs in both instructional conditions (F(5, 85)=7.37, MS(Error)=213453.2). As well, and critically, affirming the enhanced SCE with the category contingent instructions, the three way interaction involving instruction condition, stimulus pair and instruction was reliable (F(5, 85)=4.01, MS(Error)=158142.8). The plots in Figure 2 in both panels A and B are very clear in showing that the SCE is very substantially enhanced with the category incongruent instructions. Indeed, as the plots in Figure 2 (Panel B) show, the SCE index is larger with each of the relatively short lines and for the relatively long lines.

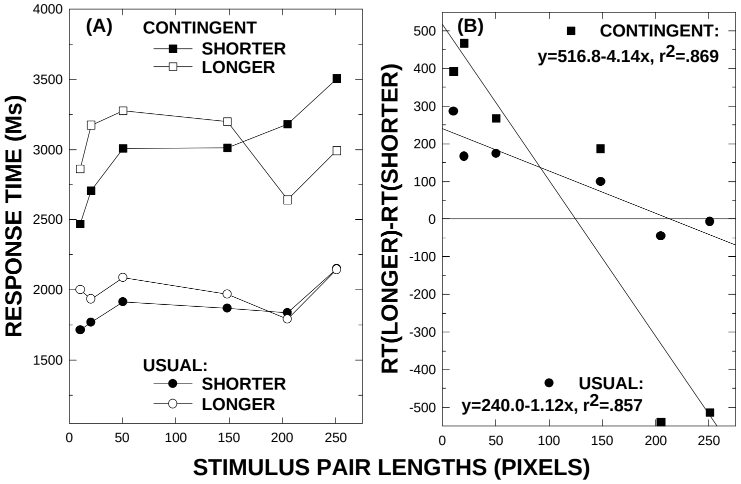

Figure 2. Mean RTs with the category contingent and the usual instructions with each instruction and each stimulus pair (Panel A) in Experiment 2. SCE index for the usual and category contingent instructions with each pair (Panel B).

Error analyses

The correlation of mean RT and mean error rate was positive (r=0.395, t(23)=2.01, p>0.056), thus, ruling out any speed-accuracy tradeoff. As expected with these relatively difficult perceptual comparisons, error rates were high. In the usual instruction condition, errors occurred on 30.94 % of the trials and on 34.11 % of the trials in the category contingent condition and the error rates for these two instruction conditions differed reliably (F(1, 17)=4.85, MS(Error)=223.0).

Discussion and Conclusions

The clear and very substantial increases in the magnitude of the SCE are entirely in accord with the evidence accrual based theoretical positions developed in Leth-Steensen and Marley (2000) and in Petrusic (1992). The single sample, additive stages views, such as Banks' (1977) semantic coding theory, for example, could perhaps account for the present findings, albeit not parsimoniously, with the post-hoc assumption that the increased memory demands in the category contingent incongruent case slowed the code matching process. Moreover, since precisely the same reference points are activated with the usual and the category contingent instructions, the reference point position (e.g., Jamieson & Petrusic, 1975) is not supported. Similarly, since the same expectancies are activated with the two types of instructions, the expectancy view (Marschark & Paivio, 1981) of SCE is also considerably weakened.

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