SOME EFFECTS OF NEGATIVE DELAYS UPON THE PERCEPTION OF CAUSAL RELATEDNESS

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ABSTRACT

We examined the effects of negative delays on the perception of causality using a variation of the paradigm originated by Michotte (1954) and as an extension to similar work conducted by Kanizsa and Vicario (1968). In our design, on some trials a second Object B started to move prior to collision with the launching Object A Given that contact A B was made we expected reports .akin to 'A launched B' following some negative delays. However, rather than obtaining unequivocal measures related to launching, with variations in reportage over the range of negative delays, Experiment 1 revealed a tendency for subjects to adjust their pattern of responses following positive delays as a function of their reportage following negative delays. In fact observers tended to equilibrate their pattern of causality and no causality responses such that the different proportions of responses were symmetrical across negative and positive delays. In Experiment 2, which introduced a further report alternative aiming to better describe causality reportage by means of metaphor, report equilibration was found to equilibrate across the different classes of causality reports and one alternative class of no causality report. The two experiments described here strongly suggest that causality reportage may be governed by a tendency for subjects to try to balance the number of reports they make such that each response alternative is equally represented.

The 'launching effect' described by Michotte (1954) illustrates the perceptual conditions under which the motion of an originally stationary object (B) is seen to be 'caused' by collision with a moving object (A). The perception of A 'launching' B into motion was argued to be qualitatively dissimilar from other modes of casual relatedness: For example, Michotte (1956) described the circumstances under which A may be seen to 'trigger' the motion of B when the velocity of B is higher than that of A. An effect considered to be related to the launching effect was described by Michotte as a 'relay effect'. The relay effect (i.e. the transition of motion energy from A to B) occurs when the velocity of A is substantially faster than B. The relay effect described by Michotte is paradigmatically isomorphic with the launching effect. In these instances, the difference between the two effects is such that relay effects are described when the velocity of A is faster than the velocity ordinarily associated with the launching effect. Nonetheless relative to the launching effect, the relay effect describes a set of circumstances within which the

impression of causality is modified by a tendency to attribute some explicit second order property (i.e. the transfer of energy) to the causal relation between the motions of B and A. A second, and in some senses similar type of 'relay type' effect was described by Kanizsa & Vicario (1968) as "piú che un lancio sembra una stafetta" (more than a launch resembling a relay, p.95) although in this instance the motions of A and B were classified as separate ("due movimenti") and as such distinct from the conditions under which A launches B into motion ("lancio").

Kanizsa and Vicario also described a number of potential patterns of causal relations in metaphorical terms, classifying as "reazione" (reactive) instances of "jumping back", escaping", avoidance or even with explicit reference to the intentional withdrawal of B ("B arretra intenzionalmente"). In a series of experiments aimed to examine the perception of causality given a "negative delay" between A and B (this is to say a subset of conditions under which B starts to move before the motion of A is terminated), Kanizsa and Vicario noted that the negative delay encouraged causality reports that were generally reactive (i.e. metaphorical) in character.

On reflection, we considered that the precise spatio-temporal characteristics of the paradigm employed by Kanizsa and Vicario may have encouraged the use of metaphorical reports rather than the use of either direct reports of launching, or of a launch effect that resembles a relay effect (i.e. reports with reference to some second order property within the causal relation A-B which are classified as separate motions). The reason for this is that in each instance of negative delay A stopped moving at the starting position of the movement of B. This means that the conditions more generally associated with the perception of B being launched by A would only apply when the negative delay B – A was set to 0 ms. We considered the alternative proposal that, should A catch up and make contact with an already moving B, the motions of A and B would overlap and any translation of energy fro A – B should occur prior to the termination of the motion of A. In other words, we would expect a slightly more 'direct' perception of causality between A and B and consequently, rather than the report of causality by the use of metaphor, we expected causality reports to be formally equivalent or identifiable with those describing the conventional launching effect. Put another way, given an instance of a negative delay between A and B in which A comes to collide with B, the collision conditions ordinarily associated with the launching effect would also be implemented and should, therefore, influence the reported effects in much the same way.

In Experiment 1, we implemented the Michotte paradigm with an equal number of (varying) positive and negative delays between the time of collision of Object A with Object B and the initial motion of Object B. In effect, for negative delays A would 'catch up' with B at a slightly later time and spatial location than it would ordinarily collide with a stationary B. Using a variant on the conventional set of instructions developed by Michotte, we asked observers to indicate for each trial whether they perceived A to 'cause' the motion of B, whether A caused the motion of B with 'some delay', or whether the motion of B was unrelated to A. In Experiment 2, a third causality response was included to those mentioned above to offer observers the option of classifying causal relations between A and B in a metaphorical sense. Consequently, and not inconsistent with the reactive concept of B escaping contact with A (i.e. the option noted by Kanizsa & Vicario: "sfugge il contatto") the observers were also asked to indicate whether 'B was chased by A'.

GENERAL METHODS

The paradigm originated by Michotte was implemented with an equal number of (varying) positive and negative delays between the time of collision of Object A with Object B and the initial motion of Object B. For negative delays, A 'caught up' with B at

slightly later times and spatial locations than it would ordinarily collide with a stationary B. On each trial, Object A moved horizontally from a position some 12 cm from the centre of a computer screen (at a viewing distance of 1.5 m) and at a velocity of 18 cm/sec towards the centre of the screen. After a short latency Object B situated at the centre of the computer screen also started to move in the same direction as A and at a velocity of 9 cm/sec. The latencies for the commencement of motion of B relative to the commencement of motion of A were in 24 intervals of 35.28 ms across the range -405.7 to 370.5 ms. For intervals less than 0 ms the motion of Object B commenced prior to collision with Object A otherwise Object B started to move at some point in time after it received contact from A. All stimuli were presented on a Sony GDM – F520, 21" monitor with the vertical raster set to a screen refresh rate of 140 Hz. Stimuli were generated and the experimental procedure was executed by means of custom software driving a Cambridge Research Systems VSG 2/3 graphics card installed in an IBM compatible PC running Windows 98. Objects A and B were 5 x 5 mm white and yellow squares, respectively, presented on a uniform black background. The experimental stimuli were equiluminent with calibration provided by means of a Cambridge Research Systems OptiCAL photometer. Stimulus presentation occurred in a background of low intensity ambient light to reduce the impact of onscreen persistence. There were 4 experimental sessions of 360 trials divided across 15 blocks (there were in addition 24 practice trials at the beginning of each experimental session).

EXPERIMENT 1

Method

In Experiment 1, 10 observers (4 male, ages ranged from 25-35 years) were asked to indicate for each trial whether they perceived A to 'cause' the motion of B, whether A caused the motion of B with 'some delay', or whether the motion of B was unrelated to A.

Results

As illustrated in Figure 1, the results of Experiment 1 were quite unexpected: While half of the subjects reported between 40% to 60% 'causality' given negative delays between A and B and, alternatively, 'no causality' (Figure 1 (a)), the second set of 5 subjects were entirely consistent in their pattern of reportage - reporting almost entirely 'no causality' given negative delays and with causality reportage starting precisely from delays of 0 ms (Figure 1 (b)). That the tendencies for 40 – 60% causality reportage are unrelated to the perceptual processing of the stimulus seems likely given the percentage of causality reportage exhibits neither slope nor a tendency for variation at extreme values (which might be expected, for example, if persistence or low temporal resolution affected judgments of when Object A stopped moving relative to the onset of motion of Object B). In fact, in spite of (nonsignificant) modulatory patterning neither causality nor the no causality reports varied as a function of variation in negative delay, a pattern of effects suggesting causality reportage following negative delays to be - *prima facie* – a matter of chance.

In spite of an apparent absence of support for our hypothesis that a form of causality perception akin to the launching effect might be encouraged for negative delays the data described in Figures 1 (a) and 1 (b) show another somewhat intriguing pattern of effects. If the sums of the percentage of causality reportage (*c* i.e. A caused B to move plus A caused B to move with a delay) and no causality reports (*nc*) are calculated for each observer separately for the negative (*n*) and positive delays (*p*, respectively $\sum_{nnc}$ and $\sum_{nc}$ relative to $\sum_{pnc}$ and $\sum_{pc}$, the latter including delays of 0 ms) it can be shown that the sums $\sum_{nnc} \approx \sum_{pc}$, with correlation coefficients (calculated separately for the two different sets of

observers shown in Figure 1) of r^2 = .7 for the observers described in Figure 1(a), r^2 = .5 for all of the observers described in Figure 1(b) and r^2 = .95 if one observer with a slightly discrepant pattern of responses is not considered. (Note, Figure 1(b) also shows quite unlike the trend in Figure 1(a) that observers tend against reporting no causality for positive delays). These patterns of effects suggest that observers will tend to distribute their 'causality' and 'no causality' reports in approximately equal proportions across the range of delays, with report distributions over positive delays 'equilibrated' as a property of the distribution of reports over the negative delays. It may be the case that equilibration decides the distribution of reportage over delays to the extent that no causality reportage may be substantially reduced for positive delays as a means of compensating an increased tendency for no causality to be reported following the negative delays.

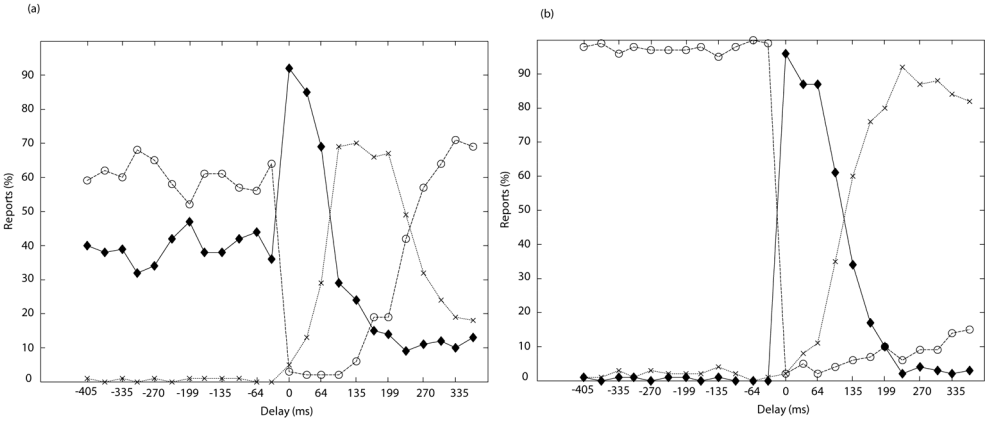

Figure 1: (a) shows the averaged reportage of the 5 observers who reported between 30% to 70% causality and alternatively no causality given negative delays. Solid line shows causality, dashed line no-causality, dotted line delayed causality. (b) Shows the averaged reportage of the 5 observers who reported between 30% to 70% causality and alternatively no causality given negative delays. Solid line shows causality, dashed line no-causality, dotted line delayed causality.

A second outcome relates the positive delay reports from Experiment 1 with those collected in a hitherto unreported pilot experiment that examined only positive delays in the 0 - 405.7 ms range. The measures of interest in this respect are estimates of the time of transition from 100% or maximal causality reportage and the time of zero crossing or 0% causality reportage (estimates of these values were calculated and optimized by means of a series of regression analyses of subsets of the % causality data over delay). In the case of (i) the pilot study, (ii) the 5 observers in Figure 1(a) and (iii) those in Figure 1(b) the times of transition from 100% or maximal causality reportage and the times of zero crossing or 0% causality reportage were estimated at (i) 14 ms – 138 ms, (ii) 2 ms – 144 ms and (iii) 16 ms – 249 ms, leading to descending tendencies for causality reportage (i.e. slopes) of (i) -1.2% (ii) -1.4% and (iii) 2.3% per ms of delay. What emerges from this analysis is that, irrespective to the precise times of transition in causality reportage (which seems to be at variance in the case of (ii)), the slopes of the 5 observers in Figure 1(b) approach a doubling relation relative to those of the data illustrated in Figure 1(a), while exhibiting a near perfect doubling relation to the performance of observers in the pilot experiment, which included only positive delays.

In summary, what emerges from Experiment 1 is, instead of an unequivocal tendency to report causality akin to a launching effect following negative delays, is instead

a tendency to employ one of two different strategies aimed towards equilibrating the causality and no causality reports across the entire range of delays (both negative and positive). The results suggest equilibration is a means of balancing the distribution of reports following positive against the distribution of reports following negative delays. In other words a form of 'report symmetry' characterizes report distributions over delay, centered on 0 ms delay. It also seems that this strategy should be considered to be in interaction with a tendency for perceptual range formation, which may obey a principle of doubling and which might also base itself upon an underlying structure of relatively invariant temporal intervals.

EXPERIMENT 2

The major claim of Experiment 1 is that reportage following negative delays is in some sense task related and neither truly perceptual nor strictly a perception-related inference. However, the possibility remains that this pattern of effects emerges when observers are relatively constrained in their report alternatives and although equilibration seems to apply irrespective to the particular strategy employed, it may come to be relied on to a greater extent because the causality report required of observers in Experiment 1 (i.e. a report of, or alluding to an element of apparent launching) simply does not capture the impression of causality experienced consequent upon the negative delay. Consequently, in Experiment 2 a further report alternative was offered: Specifically, observers were asked to indicate whether 'B was chased by A'. This addition to the response alternatives employed in Experiment 1 captured both the relative temporal order of A – B motion following negative delays, which at the same time offered a possible metaphorical reference to their casual relatedness.

Method

Experiment 2 was identical to Experiment 1 with exception to the following parameters: In Experiment 2 there were 6 observers (1 male, ages ranged from 25-35 years). In addition to the response alternatives detailed for Experiment 1, in Experiment 2 observers were also asked to indicate whether 'B was chased by A'.

Results

The results of Experiment 2 are shown in Figure 2(a). Here it can be seen that reports during the negative delays are divided between 'B was chased by A' (70%) and no causality (30%). Essentially the pattern of effects following negative delays shown by the set of observers in Figure 1(a) is reversed in the sense that the majority of reports indicate a causal relation between Objects A and B, although this seems to be dependent upon offering a report alternative in which that relation is described metaphorically. However, the possibility that observers may be adjusting their responses during the negative delays in order to equilibrate their responses in the positive delays is evident from (i) the invariance of reportage over the range of negative delays (as found in Experiment 1) in addition to which (ii) the pattern of reportage following positive delays is near identical to that shown by the set of observers depicted in Figure 1(a) (see Figure 2(a)). On this basis we might also assume the temporal structures that we believe to underlie and be modified by variations in reportage to be essentially the same (see discussion in Experiment 1).

A description of the proportions of causality and delayed causality reportage, the no causality reports and reports of chasing are given in the pie chart in Figure 2(b). Here, assuming classification of the causality reports used in this experiment are as advised by Kanizsa and Vicario divisible into two discrete classes "lancio" (launching) which

subsumes both the causality and causality with delay reports and “reazione” (reactive) subsuming the report ‘B is chased by A’, the pie chart may be seen to illustrate a form of report equilibration quite in analogy with the results of Experiment 1. The principle difference between these results and those of Experiment 1 are, however, that in this case the division of the report alternatives is not necessarily symmetric over delays (as is clearly indicated in Figure 2(a)) but are instead equally divided across the three response classes used in Experiment 2.

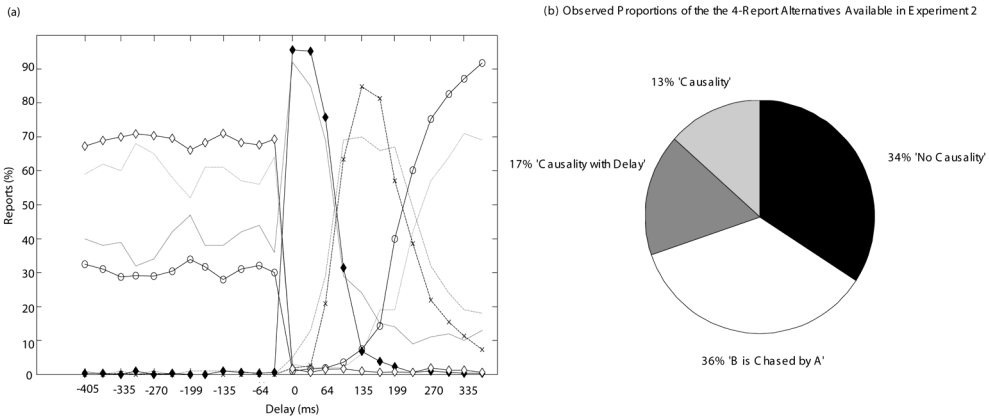

Figure 2: (a) shows the averaged reportage of the 6 observers in Experiment 2. The solid line (filled diamonds) shows causality, dashed line no-causality, dotted line delayed causality and the solid line (unfilled diamond) the % of reports ‘B was chased by A’. For comparative purposes the faded solid, dashed and dotted lines represent the causality, delayed causality and no causality reports of the observers shown in Figure 1(a). (b) shows the proportion of reports made for each of the 4 report alternatives.

DISCUSSION

Both Experiments 1 and 2 reveal an experiment-wise equilibration of the available report alternatives, which becomes evident from apparently anomalous reportage following the introduction of negative delays. On the basis of Experiment 1 equilibration involves the symmetrical division of causality and no causality responses between negative and positive delays. With the introduction of a further class of causality report this symmetrical patterning is not so evident and instead equilibration is carried out across report classes, with the aim of ensuring the number of reports for each class of report remain approximately equivalent. It also seems that report distributions are constrained by, or interact with a tendency for temporal range formation, which may obey a principle of doubling and which might also base itself upon an underlying structure of relatively invariant temporal intervals. In summary, the two experiments described here strongly suggest that causality reportage may be governed by a tendency for subjects to try to balance the number of reports they make such that each response alternative is equally represented

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