



Distortions of temporal integration and perceived order caused by the interplay between stimulus contrast and duration



Elkan G. Akyürek*, Ritske de Jong

University of Groningen, The Netherlands

ARTICLE INFO

Article history:

Received 11 November 2016
 Revised 10 February 2017
 Accepted 10 February 2017
 Available online 28 February 2017

Keywords:

Temporal order judgment
 Temporal integration
 Stimulus contrast
 Missing element task

ABSTRACT

Stimulus contrast and duration effects on visual temporal integration and order judgment were examined in a unified paradigm. Stimulus onset asynchrony was governed by the duration of the first stimulus in Experiment 1, and by the interstimulus interval in Experiment 2. In Experiment 1, integration and order uncertainty increased when a low contrast stimulus followed a high contrast stimulus, but only when the second stimulus was 20 or 30 ms. At 10 ms duration of the second stimulus, integration and uncertainty decreased. Temporal order judgments at all durations of the second stimulus were better for a low contrast stimulus following a high contrast one. By contrast, in Experiment 2, a low contrast stimulus following a high contrast stimulus consistently produced higher integration rates, order uncertainty, and lower order accuracy. Contrast and duration thus interacted, breaking correspondence between integration and order perception. The results are interpreted in a tentative conceptual framework.

© 2017 The Authors. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Human perceptual awareness has some paradoxical properties. We are able to detect flashes of light that last only 1 ms, but we cannot reliably estimate just how brief that is (Efron, 1967). It has also long been known that despite our apparent sensitivity, rapid sequences of brief visual stimuli can outpace the visual system relatively easily. This difficulty does not seem to rest with any particular stimulus being too brief to process perceptually, but rather with the speed at which one stimulus is followed by the next. It has long been known that in extremis, at high succession speeds, stimuli are simply perceived as simultaneous (Exner, 1875). Before that unified state is reached, two presumably related phenomena occur: Confusion arises about which stimulus came first, and also, the identities of individual stimuli may get blended to the extent that they are perceived as parts of a single composite stimulus, which comprises all the features of its multiple constituents.

Evidence for the first phenomenon comes from temporal order judgment (TOJ) tasks, in which observers are presented with two almost simultaneous stimuli, and are asked to decide which of the pair came first: When the stimulus onset asynchrony (SOA) between them falls from approximately 100 to 20 ms, observers drop from near-perfect order judgments to effectively guessing (e.g., Jaśkowski & Verleger, 2000). The accuracy of order judgments is thought to depend on a central, cognitive function, rather than modality-specific factors, since TOJ tasks involving visual, auditory, and tactile stimuli, all produce similar estimates of the critical interval (Hirsh & Sherrick, 1961; Sternberg & Knoll, 1973).

* Corresponding author at: Department of Psychology, Experimental Psychology, University of Groningen, Grote Kruisstraat 2/1, 9712 TS Groningen, The Netherlands.

E-mail address: e.g.akyurek@rug.nl (E.G. Akyürek).

The second phenomenon, the temporal integration of successive stimuli, is typically found in tasks that test the observer's ability to respond to a feature that is only apparent from the combination of two individually shown stimulus displays. One exemplary procedure is the missing element task (MET; Akyürek, Schubö, & Hommel, 2010; Hogben & Di Lollo, 1974), which presents two brief, successive displays of simple stimuli such as dots or small squares within a regularly spaced grid of 5 by 5 positions, such that the first display contains 12 of these stimuli, and the second display another 12. One position in the grid is thereby left empty, for the observer to find. Trying to mentally compare the two partial displays from memory is not a feasible strategy in this task, but the missing element is easily found if the observer is able to perceptually integrate the two displays. Such temporal integration becomes increasingly difficult as the total display duration increases, particularly beyond 100 ms. Like temporal order judgments, it appears that integration is similar across modalities, suggesting it has a central source also (Saija, Andringa, Başkent, & Akyürek, 2014).

Intuitively, it seems likely that temporal integration and order judgment are closely related. If two successive stimuli are temporally integrated, and perceived as a unitary event, surely a temporal order can no longer be assigned between them. Vice versa, if the stimuli appear to occur so close together in time that their order can only be guessed at, that would suggest a degree of simultaneity that would be associated with integration. The timing of the stimuli obviously strongly governs both the ability to assign order and the tendency to integrate. However, although a strong correlation between integration and order perception may indeed exist (for a demonstration in a rapid serial visual presentation [RSVP] task, see Akyürek et al., 2012), it may not always be perfect.

In the MET, observers often report a sense of having seen multiple stimuli (i.e., they detected a temporal gap), which implies a minimal awareness of some order, even if the stimuli still appeared to 'fall in line', and integration succeeded. When Kinnucan and Friden (1981) measured MET performance (% correct localization) with stimuli of varying brightness, and subsequently asked observers to rate the degree to which the successive MET displays appeared as one, the outcomes differed as a function of their brightness manipulation. The authors suggested that actual temporal integration and the subjective appearance of unity may rely on different mechanisms, and the latter on discontinuity detection in particular—a function that is presumably central also to temporal order judgments.

Further hints for a possible dissociation between integration and TOJ may be found in studies of stimulus intensity effects in integration tasks. Many studies report inverse intensity effects, that is, integration is found to be enhanced by less intense stimuli (e.g., Bowling & Lovegrove, 1981; Di Lollo & Bischof, 1995). A similar phenomenon of "inverse effectiveness" has also been found in multisensory integration tasks, where less salient stimuli are more easily integrated between modalities (Meredith & Stein, 1983). In TOJ tasks it has also been found that higher stimulus intensity facilitates temporal separation (Jaśkowski & Verleger, 2000), which reflects the same dynamics. Yet, there have been reports of an opposite relationship as well, in which higher stimulus intensity impedes separation (e.g., Ueno, 1983; Wilson, 1983). A complicating factor in the interpretation of many of these collective studies is the possible role of retinal afterimages, elicited by using bright stimuli on a dark background. Nonetheless, one account for the discrepant effectiveness that has been offered is that task characteristics vary, namely whether observers are (implicitly) asked to judge stimulus offset or total duration (Nisly & Wasserman, 1989; Wasserman & Nisly-Nagele, 2001, although see also Di Lollo & Bischof, 1995). It is conceivable that such characteristics may similarly underlie possible differences between integration (in the MET) and TOJ tasks. In line with this notion, Jaśkowski (1996) has argued that because stimulus intensity effects found on visible persistence are not necessarily mirrored in TOJ performance, TOJ may not strongly rely on perceived duration.

When the strength of the first and second display is independently manipulated, such that a brighter stimulus follows a dimmer stimulus, or vice versa, the outcomes are even less uniform. In a TOJ task, Bachmann, Pöder, and Luiga (2004) found that when the relative contrast of a pair of stimuli was manipulated, observers tended to report the stimulus with the lowest contrast as the first. Performance was thus best when the first stimulus was dim, which does not point to inverse effectiveness. Inverse effectiveness would predict higher perceptual latency and more integration with the second stimulus, and thus lower TOJ performance. In line with these findings, however, are reports by Kinnucan and Friden (1981; Experiment 1) and Johnson, Nozama, and Bourassa (1998), who found increased integration when the first stimulus was stronger than the second in a MET paradigm, again suggesting direct rather than inverse effectiveness. Johnson and colleagues nonetheless also showed that inverse effectiveness was again obtained when the two displays were matched in luminance. In a similar vein, Long and O'Saben (1989) also observed inconsistent intensity effects on integration.

Finally, it is conceivable that temporal integration and temporal order judgments are differentially affected by the deployment of exogenous (stimulus-driven) and endogenous (volitional) modes of attention.¹ Exogenous attention is engaged by stimulus-related manipulations, such as intensity, while endogenous attention responds to (learned) contingencies, such as predictable stimulus timing. Lawrence and Klein (2013) recently demonstrated that exogenous and endogenous factors can have different, dissociable effects on performance (reaction time and accuracy) in temporal attention tasks. Exogenous and endogenous factors are typically not explicitly controlled for in temporal integration and order tasks, but it is conceivable that they are differentially involved in these two tasks, which might lead to different response profiles.

Summarizing, even though conceptually temporal integration and order judgment would appear to be two sides of the same coin in perceptual awareness, the collective body of studies on these phenomena shows relatively little consistency. The relationship between temporal integration and order judgment thereby remains underspecified. A closer examination

¹ The authors thank Massimiliano Papera for suggesting this possibility.

Download English Version:

<https://daneshyari.com/en/article/5041728>

Download Persian Version:

<https://daneshyari.com/article/5041728>

[Daneshyari.com](https://daneshyari.com)