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Continuous aesthetic judgment of image sequences

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ABSTRACT

Perceptual judgments are said to be reference-dependent as they change on the basis of recent experiences. Here we quantify sequence effects within two types of aesthetic judgments: (i) individual ratings of single images (during self-paced trials) and (ii) continuous ratings of image sequences. As in the case of known contrast effects, trial-by-trial aesthetic responses are negatively correlated with judgments made toward the preceding image. During continuous judgment, a different type of bias is observed. The onset of change within a sequence introduces a persistent increase in ratings (relative to when the same images are judged in isolation). Furthermore, subjects indicate adjustment patterns and choices that selectively favor sequences that are rich in change. Sequence effects in aesthetic judgments thus differ greatly depending on the continuity and arrangement of presented stimuli. The effects highlighted here are important in understanding sustained aesthetic responses over time, such as those elicited during choreographic and musical arrangements. In contrast, standard measurements of aesthetic responses (over trials) may represent a series of distinct aesthetic experiences (e.g., viewing artworks in a museum).

Judgments of absolute magnitude (e.g., of brightness, loudness, etc.) as well as subjective valuation (e.g., of monetary lotteries) appear to be made with respect to changeable reference points (De Martino, Kumaran, Holt, & Dolan, 2009; Stewart, Brown, & Chater, 2005). As a consequence of this reference dependence, such judgments change on the basis of contextual factors such as presentation order (Hellström, 2001) and preceding judgments (Stewart, Brown, & Chater, 2002). To what extent do these principles apply to aesthetic valuation? Sequential effects arising from recently viewed stimuli have been shown to affect the perceived beauty of photographs (Tousignant & Bodner, 2014), and facial attractiveness (Chang, Kim, & Cho, 2017; Cogan, Parker, & Zellner, 2013; Pegors, Mattar, Bryan, & Epstein, 2015). A common effect found in such studies is a stimulus *contrast effect* – ratings are biased away from the visual pleasantness of the previously presented image. In addition, extensive familiarization toward either complexity or simplicity results in increased aesthetic preferences for the contrasting attribute (Tinio & Leder, 2009). Indeed, virtually all influential theories of aesthetic experience strive to accommodate past experiences in some way, whether in the form of novelty (Berlyne, 1971), prototypicality (Martindale, Moore, & West, 1988), or memory integration (Leder, Belke, Oeberst, & Augustin, 2004). However, the link between aesthetic responses measured over single trials and those experienced over longer timescales remain unknown. Here we shed further light on sequential aesthetic processing by studying judgments made toward discrete and continuous presentations of images.

At present, we aim to compare aesthetic judgments made across two modalities: ratings of single images and continuous ratings provided over image sequences. This will allow us to test whether sequences elicit identical aesthetic responses as their constituent images when judged in isolation. Trial-by-trial responses to individual images remain the standard level of analysis for studies of aesthetic judgments (for a review, see: Leder & Nadal, 2014). On the other hand, the continuous methodology is an extension of the method used by Kahneman, Wakker, and Sarin (1997) to observe regularities in subjective experiences over time. Kahneman et al. (1997) were originally interested in the momentary affect of subjects viewing video clips. Variants of this method were also used to track momentary hedonic enjoyment (Kahneman, Kahneman, & Tversky, 2003) as well as discomfort (Kahneman, Fredrickson, Schreiber, & Redelmeier, 1993). We introduce this method as a means of measuring aesthetic value over a fixed interval of time (during the presentation of a sequence of images). By assembling images into sequences, we hope to reproduce (in a simplified manner) effects present during the continuous and structured nature of artistic delivery (such as in songs, plays, film, etc.). In contrast, trial-by-trial presentations may be seen as analogous to viewing separate artworks in a gallery featuring a mixture of themes. Images

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represent a unique stimulus class that can be presented without alteration in both discrete and continuous formats. Thus, the use of images as stimuli bears two main advantages, namely: (i) images are presentable identically for both measures; and on this basis, (ii) average responses across both cases are comparable. Image sequences also reflect the recommendation of Orgs, Hagura, and Haggard (2013) who studied aesthetic judgments of choreographic structures. Similar to their study, we construct sequences using individual images that follow a particular order of presentation.

Given the use of specific choreographic phrases (Blom & Chaplin, 1982) and song structures (Lomax, 1962), as well as individuals' capacity for narrative-based reasoning (Cohn, Jackendoff, Holcomb, & Kuperberg, 2014), we aim to test for arrangement-level differences in aesthetic response. We hypothesize that single and sequential presentations will yield different aesthetic ratings as well as underlying sequence effects. First, using discrete (trial-by-trial) measures of aesthetic judgments, we test whether such judgments exhibit previously observed sequence effects. Next, we record moment-to-moment judgments while participants observe image sequences (constructed using a subset of the same images). This allows us to compare average responses and relevant adjustment dynamics across the two modes of presentation. In addition, we test for declarable preferences toward particular sequence types using a binary choice task.

1. Method

1.1. Participants

26 adults (16 female; $M = 23.54$ years, $SD = 3.02$ years, range = 18–28 years) participated in all three phases of the study consecutively. Participants were Columbia University undergraduate and graduate students recruited from advertisements placed throughout the university's main campus. Participants completed each task at a private computer station in about 60 min. Participants were briefed about the details of all three tasks and were compensated with $10 for participating. All procedures were approved by the Columbia University Institutional Review Board (protocol #IRB-AAAR3901).

1.2. Procedure

We began our experiment by measuring aesthetic ratings of individual stimuli presented in pseudorandom order. Then, subjects faced two additional tasks. In one of these tasks we presented a series of image triplets in a continuously changing presentation while recording momentary aesthetic ratings in real time. In effect, we first measure trial-by-trial ratings of images drawn from alternating categories (e.g., a dance posture, followed by a fractal pattern). Subsequently, the continuous condition presents triplets of images drawn from a single category (e.g., three dance postures). We also conducted a choice experiment with a subset of the constructed triplets to test whether preferences are spontaneously declarable (i.e., without having to view them sequentially) for different sequence types. The order of the continuous rating and choice tasks were counterbalanced across participants in order to control for familiarity and confirmation bias effects.

1.2.1. Experimental stimuli

Each phase of the experiment described below utilizes a single set of 36 image stimuli. This set included both artificially-generated fractal patterns and illustrated human poses (Appendix Fig. 1). Of the human pose images, stimuli consisted of solo (ballet) and partnered (swing) dance poses. Abstract stimuli were generated using an automated fractal generator (XaoS) and human poses were comprised of free license vector images. Human poses and fractal patterns were used following the basic assumption that they were likely to elicit non-zero aesthetic ratings (based on their previous applications in the extant literature). All images were rendered in grayscale for uniformity.

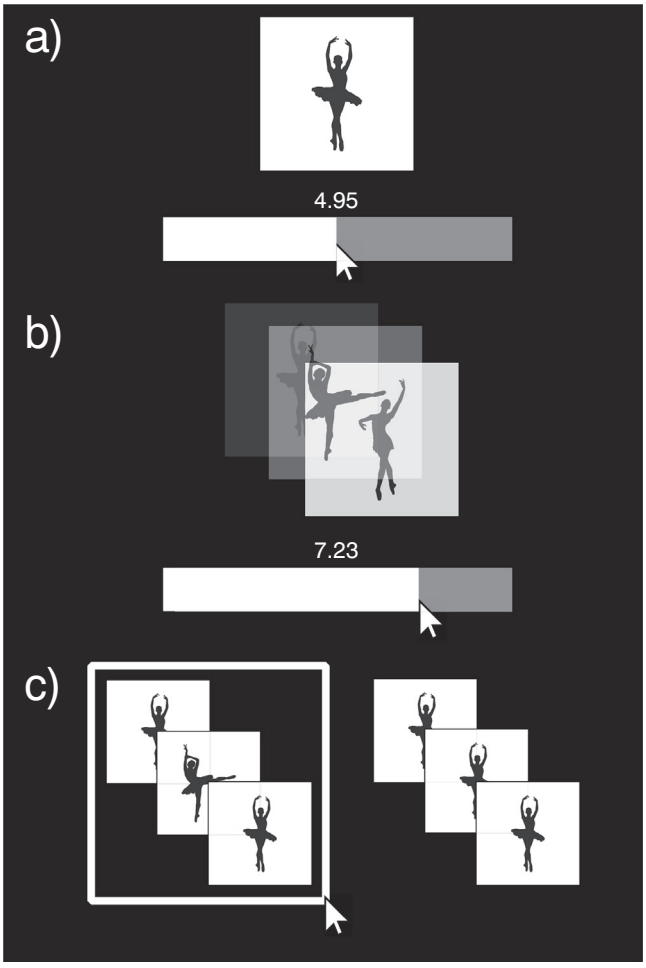

Fig. 1. (a) First, subjects responded with individual ratings from a scale of 0–10 on stimuli presented in random order. Stimuli were drawn from different categories consecutively, so as not to induce perceptions of continuity (e.g., a ballet image could only be followed by a fractal or partnered dance image). (b) In the continuous rating phase, subjects' ratings were continuously recorded as they were shown triplets from single categories (each individual image was presented for 3 s). (c) In the choice phase, subjects chose between repeating or non-repeating sequences which triplet they would prefer to witness sequentially.

1.2.2. Discrete rating phase

In the discrete rating phase (Fig. 1a), subjects were presented with members of each stimulus category in pseudorandom order – consecutive stimuli were chosen to be from different categories but were otherwise chosen randomly from their respective sets. Subjects were instructed to rate on a continuous slider bar how pleasing they perceived the on-screen stimuli, ranging from 0 (not pleasing) to 10 (most pleasing). Subjects were able to declare their judgments up to a precision of two decimal places and were not limited in the time available to declare their ratings. Each image was presented with three repetitions, amounting to 108 trials for 36 image stimuli. The reliability and variability associated with each image's ratings, along with details of these measures, are available in Appendix Fig. 2.

1.2.3. Continuous rating phase

In the continuous rating phase (Fig. 1b), participants were presented with sequences of triplets consisting of members of a single category (e.g., three fractal images). Each member of the triplet was presented for 3 s while subjects continuously indicated their rating (on the same scale as the initial discrete rating phase). In order to separate the presentation of each sequence, an inter-trial interval of 1–3 s (randomly