NO FREQUENCY EFFECTS WHEN JUDGING CONTRASTS

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Abstract

In literature, experimental findings showed that absolute judgments are affected by contextual effects. In our experiment we tested if judgments of differences, in particular, judgments of brightness contrasts between two chips are affected by the skewing of frequency distributions of stimulus presentations. We asked participants to rate the degree of contrast by using two methods: the category rating method and the adjustment method. Experimental results show that frequency effects do not affect contrast judgments and that there is no difference between the subjective scales obtained with the two methods, except for the "regression effect". Therefore, judgments of differences, contrarily to absolute judgments, are not affected by contextual effects.

Absolute subjective judgments of stimulus intensities are affected by the way stimuli are presented to participants (Parducci & Marshall, 1961; Parducci & Perrett, 1971; Poulton, 1979). When participants rate perceived intensities of absolute physical attributes as luminance, length, speed, and so on, the final subjective scales are biased if stimulus intensities have different frequencies of occurrence. In particular, for a distribution of intensities with a positive skewing of frequencies (smaller intensities are more frequent), subjects tend to overestimate stimuli with medium intensity; for a distribution of intensities with a negative skewing (larger intensities are more frequent), subjects tend to underestimate stimuli with medium intensity (Johnson, 1944; Parducci & Wedell, 1986).

Lockhead (1992) argued that psychophysical judgments cannot be considered absolute judgments of attributes. For example, he cited the work of Arend (1970), wherein judgments of absolute flash intensities are affected by the duration of stimulus presentation. Quantitative judgments tend to increase when flash duration increases, but after a critical value of flash duration, they drop down until they reach a steady value. Therefore, absolute quantitative judgments of flash are affected by the variation of stimulus durations. In his paper, Lockhead presented other perceptual examples against the reliability of absolute judgments.

It is possible to argue, however, that subjects are more reliable when they have to judge how great is the difference between two stimuli, rather than the intensity of one single attribute. For example, brightness judgments are affected by the frequency effect (Tommasi, 2001; 2002). But what happens if subjects are asked to judge brightness differences between two surfaces? It is reasonable to hypothesize, according to Krauskopf's (1963) experimental findings, that judgments of differences between stimuli are less affected by contextual effects than absolute judgments of stimuli. In his experiment, Krauskopf showed that if retinal contours between two surfaces-one of them included in the other-of different colors are stabilized, then participants could no more see the inner surface. Therefore, the perceptual system creates the perceived colors on the basis of intensity variations of sensory signals corresponding to contours or chromatic contrasts between surfaces. Hence, if intensity variations of sensory signals is the starting point for producing perceived colors, then brightness contrasts should be less affected by the skewing of frequencies rather than absolute brightnesses. In our experiment we presented different contrast intensities to subjects who had to rate them by using a quantitative scale. Subjects were also asked to adjust stimulus contrast to reach some determined contrast values expressed by numbers. The subjective scale obtained with the former method (category rating) were compared with the latter (adjustment method) to test which of the two methods presents stronger contextual effects.

Method

Stimuli. A Toshiba LCD 15'' monitor was used to present stimuli. Stimuli were composed by two adjacent chips each by 5° of visual angle. Chips were presented on a checkerboard pattern composed by black and white squares, each by 1.2° of visual angle. Participants observed the stimuli with a distance of 40 cm from the monitor. The luminance values of the contrasts between the left and right chips were, 0.43, 0.82, 1.23, 1.63, 2.05 and 2.47 cd/m^2.

Participants. Stimuli were presented to 60 participants, each with normal-or-corrected with lens view. The age of participants was between 20 and 30 years. 50% of participants were female.

Method. Participants were divided into three groups, each composed by 20 elements. The first group (FG) rated stimuli with a positive skewed distribution of frequencies (smaller contrasts were more frequent); the second group (SG) rated stimuli without a skewed distribution of frequencies (all contrasts had the same frequency); the third group (TG), finally, rated stimuli with negative skewed distribution of frequencies (larger contrasts were more frequent). Furthermore, the three groups were split into two subgroups, each of them composed by 10 elements. The first subgroup had to judge contrast intensities using numbers from 0 (no contrast) to 26 (maximum contrasts). Participants were also told to use only numbers from 1 to 25, because stimuli without contrasts or with maximum contrasts were not used. Then, participants had to adjust brightness contrast between the two chips to obtain the following numerical values of contrast: 2, 6, 10, 14, 18, 24. For the second subgroup the order of the two methods was reversed: the adjustment method preceded the category rating method. For each participant, the presentation order of stimuli was randomized and each stimulus was presented twice.

Results and Discussion

Figure 1 shows the mean subjective ratings of contrast obtained with the category rating method and figure 2 shows the subjective brightness contrasts obtained with the adjustment method. It is possible to observe that subjective scales of contrast are quite superimposed independently from the different skewing of frequency distributions. An ANOVA 2 (category vs. adjustment method) × 2 (order of methods) × 3 (skewing of frequency distributions) showed that the principal factor of method (category vs. adjustment method) was significant ($F_{1,54} = 20.035$, $p < .001$), while the principal factor of order of methods and that of skewed frequencies were not significant ($F_{1,54} = .723$ and $F_{1,54} = .135$, respectively). Interactions were not significant.

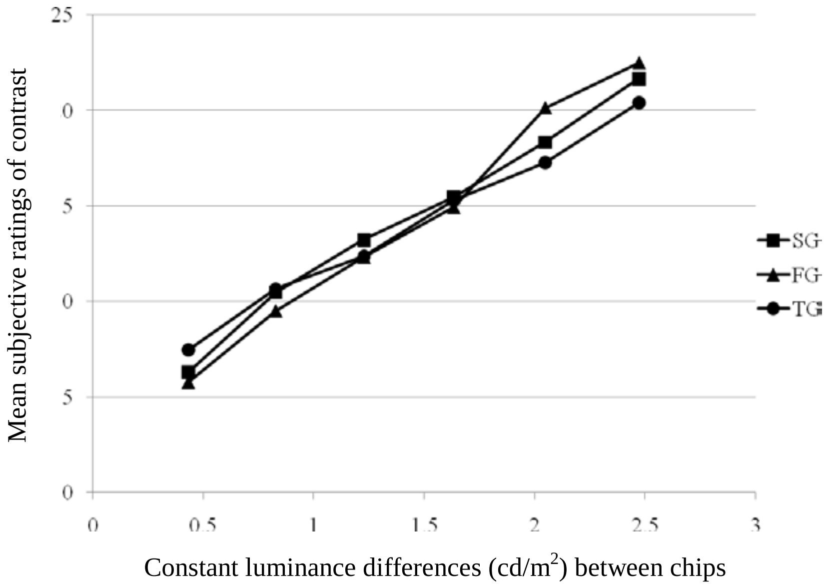

Figure 1. Mean subjective ratings of contrasts obtained with the category rating method for group with no skewed frequencies (SG), positive skewed frequencies (FG) or negative skewed frequencies (TG) of stimuli.

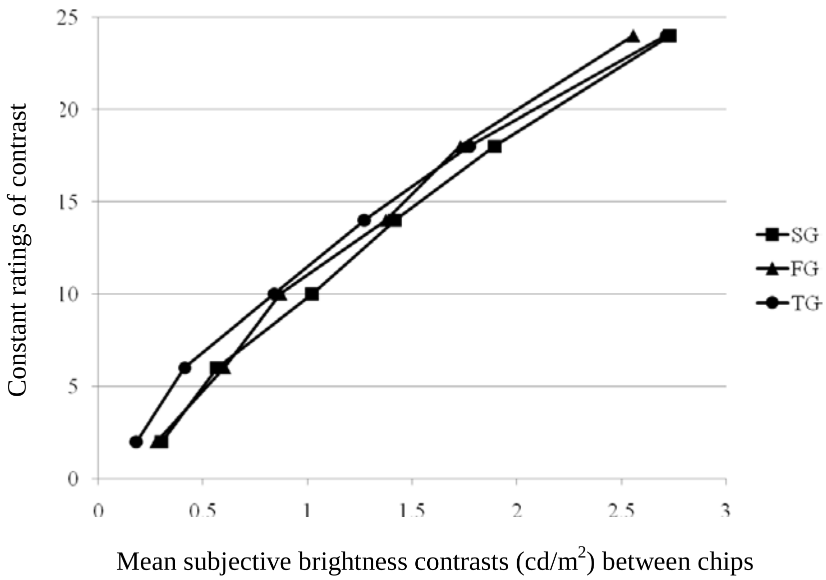

Figure 2. Mean subjective brightness contrasts obtained with the adjustment method for group with no skewed frequencies (SG), positive skewed frequencies (FG) or negative skewed frequencies (TG) of stimuli.

Experimental results show that when participants had to rate brightness contrasts, rather than to rate absolute brightnesses, contextual effects have no more effect on subjective judgments, independently of the method. The order of methods (the category method preceding the adjustment method or vice versa) has no effect on subjective ratings. The effect of the kind of method can be explained by the "regression effect" (Stevens, 1975), by which subjective scales obtained with the adjustment method have a greater range than those obtained with the category rating method. By comparing figure 2 with figure 1, it is possible to see that the range between the extreme limits of the subjective scale obtained with the adjustment method is larger than that of the scale obtained with the category rating method.

According to Lockhead's claims (1992) and Krauskopf's experiment (1963), the human perceptual system is not able to make absolute judgments of stimulus intensities, because every judgments is affected by the way stimuli are presented. Brightness contrasts, however, according to our experimental results, are not affected by contextual effects. Reasonably, the chromatic contrast is more useful than the perception of color intensities, because it is more important for human beings to recognize the shape and dimension of stimuli, rather than the intensity of light reflected or produced by physical objects in the environment. Another possible explanation is that absolute judgments of intensities need a frame of reference, while judgments of differences have not this necessity. For example, a medium gray surface can appear white when illuminated, but it can became dark if a brighter surface is put on it (Gelb effect). The Gelb (1929) effect shows that our perceptual system has no interior frame of reference on the basis of which it could make constant ratings of perceived luminances. Therefore, absolute judgments can be radically changed by the presence or absence of brightness contrasts between surfaces.

In conclusion, the perceived contrast is not affected by frequency effects, because, probably, brightness differences, instead of absolute brightnesses, are the starting point for differentiating and recognizing the objects which compose the visual scene.

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