Nontransitivity, Indiscriminability, and Looking the Same

Abstract. The philosophical literature on perception tends to confuse the statistical psychophysical relation of indiscriminability with the phenomenal relation of appearing (e.g., looking) the same. I present some experimental results which suggest that, contrary to conventional wisdom, only the former relation is nontransitive.

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The relation of perceptual indiscriminability or "pairwise match" is widely supposed to be nontransitive. For example, Timothy Williamson writes that

> [t]wo stimuli whose difference is below the threshold cannot be discriminated. Since many indiscriminable differences can add up to a discriminable difference, one can have a series of stimuli each indiscriminable from its successor, of which the first member is discriminable from the last. Indiscriminability is a non-transitive relation (1994, 69).

According to Crispin Wright,

> [i]t is familiar…that we may construct a series of suitable, homogeneously coloured patches, in such a way as to give the impression of a smooth transition from red to orange, where each patch is *indiscriminable* in colour from those immediately next to it; it is the non-transitivity of indiscriminability which generates this possibility (Wright 1975, 338-9).

The nontransitivity is thought to cause a lot of trouble. For instance, the possibility of a color (hue) progression of the sort Wright describes, often called a 'phenomenal continuum', is supposed to give rise to a particularly intransigent version of the sorites paradox. Also, the nontransitivity of indiscriminability may call into question the coherence of the ordinary idea of determinate phenomenal qualities—determinate shades or hues, pitches, intensities, and so forth. It seems natural to say that objects have the same determinate quality just in case they are indiscriminable on the relevant dimension. But unlike indiscriminability, the sameness or identity relation is transitive; so this natural way of individuating determinate qualities is not available (e.g., Peacocke 1992; see also Dummett 1975).[1]

Indiscriminability is often run together with the phenomenal relation of appearing (e.g., looking or sounding) the same. The confusion is understandable if one supposes that indiscriminable stimuli *always* appear the same. But in fact there are no such stimuli: not even physically identical stimuli viewed under identical conditions always appear the same.[2] Rather, indiscriminability is a statistical relation: roughly, stimuli are indiscriminable just in case they appear the same in 50 percent of same/different comparisons, or in 75 percent, or 60 percent, etc., depending upon the experimenter's explanatory goals (see any psychophysics textbook). You can't tell that two stimuli are indiscriminable just by giving them a good straight look; you can't tell just by looking, or listening, or tasting.[3] Thus indiscriminability is not a phenomenal relation; and talk about the discriminability or indiscriminability of phenomenal colors is misleading. Properly construed as a statistical psychophysical relation, indiscriminability is clearly nontransitive: there can be a series of stimuli $s_1 \ldots s_n$ such that, under some constant viewing conditions, s_1 appears the same as s_2 in (e.g.) 75 percent of same/different trials, s_2 appears the same as s_3 in 75 percent…and s_{n-1} appears the same as s_n in 75 percent, but s_1 and s_n appear the same in only 30 percent of trials. For convenience, call this kind of series an *indiscriminability series*.

In contrast, the relation of appearing the same is a phenomenal relation that holds (or not) between stimuli at a given time. For example, in characterizing the indiscriminability relation I referred to the frequency with which stimuli appeared the same in pairwise comparisons (trials).

Though we do often speak of objects as appearing the same in a standing sense, I think we can be understood as saying that such objects *would* appear the same if we compared them.[4] And as I explained above, strictly speaking the most we are entitled to claim is that the objects would appear the same with a certain probability—in other words, that they are indiscriminable in the statistical sense.

In light of the distinction between indiscriminability and appearing the same, how should we characterize phenomenal continua? The latter are not plausibly identified with indiscriminability series, in which neighboring members do, but the endpoints do not, appear the same in a certain percentage of comparisons. (A phenomenal continuum is supposed to be phenomenal.) As a first approximation, let us say that a phenomenal continuum is a series of stimuli in which neighboring items appear the same but the endpoints appear different, at a given time, to a perceiver who proceeds along the series giving each pair of stimuli a good straight look (listen, taste, etc.). Or better: a phenomenal continuum is a continuous progression in appearance that is instantiated by a series of stimuli in which neighboring items appear the same but the endpoints appear different, at a given time, etc. The stimuli in such a series need not be indiscriminable; since discriminable stimuli sometimes appear the same (e.g., in 25 percent of same/different trials), there is nothing to prevent a series of discriminable stimuli from instantiating a phenomenal continuum on a given occasion. (Also there is nothing to prevent an indiscriminability series from failing to instantiate one.) Any indiscriminability series can instantiate a phenomenal continuum, but so can some series of discriminable stimuli. Indiscriminability series and phenomenal continua are two different things.

The phenomenology of phenomenal continua is baffling because, even given perfectly constant viewing conditions, the first and last items appear different and yet nowhere between the two is any local difference in appearance discerned. How is this possible? A natural thought is that some of the stimuli in (a series that instantiates) a phenomenal continuum change their appearance as we move along the series, but in some way that we do not or cannot *notice*.[5] The stimuli change the way they look or sound or taste, but we cannot notice the change, and so cannot report it. Call this thought the 'instability hypothesis'.[6] Of course, for a claim of nontransitivity to hold good, the stimuli in a phenomenal continuum must remain constant in appearance throughout; the instability hypothesis must be false. A series in which the stimuli change their appearance doesn't show that appearing the same is nontransitive, any more than the fact that Tom and Dick weigh the same, and Dick and Harry weigh the same, but Tom and Harry have different weights, shows that identity is nontransitive if we've weighed Tom and Dick in 2001, and then Dick and Harry in 2002, and then Tom and Harry in 2003.

In the next section I am going to present some experimental results that appear to support the instability hypothesis. That is, the hypothesis that even under perfectly constant viewing conditions, some stimuli in a phenomenal continuum change their appearance, unnoticeably, as a perceiver moves along the series. The conclusion we should draw, I'll suggest, is that neighboring stimuli in a phenomenal continuum do appear the same, but such a continuum provides no evidence that appearing the same, in contrast to indiscriminability, is nontransitive.

♦

The experiment described below was designed and run in collaboration with Delwin Lindsey and Angela Brown, psychologists of vision at Ohio State University.[7]

The stimuli were a series of 41 patches of colored light that instantiated a phenomenal continuum (on almost all trials) between two slightly but clearly different shades of green. The stimuli were presented on a high-resolution color monitor in the circular arrangement shown in Figure 1. Nothing depended upon the locations of the endpoints. About half of the stimuli were redundant: roughly every other patch in the circle was physically identical to its predecessor.[8] Neighboring physically different patches differed by less than the discrimination threshold or just noticeable difference in hue of our most sensitive subject. (We had established the thresholds of our subjects in an earlier pilot experiment, requiring correct detection on 75% of trials.) The subjects in the experiment were ten philosophy and psychology faculty, students, and staff at Ohio State University, including several faculty and graduate students in psychology of vision.

Each trial began with a same/different comparison of the hues of two neighboring patches, indicated by two black dots as shown in Figure 1. If the subject made a judgment of

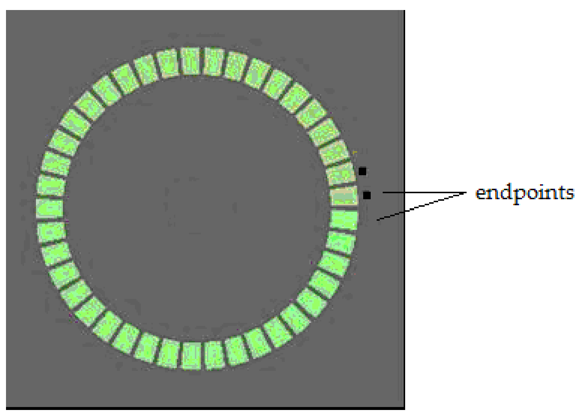

Figure 1

'different' (which happened rarely), the next trial began immediately and she was cued to judge the next pair of patches. (If the patches are numbered #1-#41, the order of the pairs was #1/#2, #2/#3, #3/#4, etc. Consecutive pairs always shared a patch.) If the subject made a judgment of 'same', a disk of colored light appeared in the center of the circle, as pictured in Figure 2. The subject then adjusted the hue of the disk by moving the computer mouse back and forth until the disk matched the hue of the two patches. (The starting hue of the disk and the directionality of

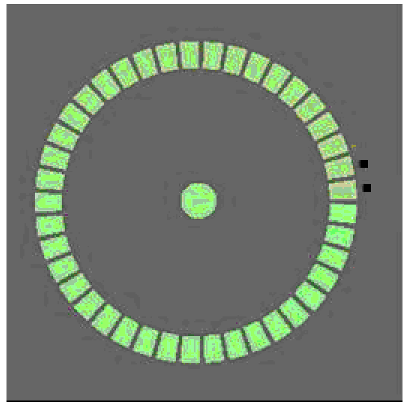

Figure 2

the mouse were randomized.) The disk then disappeared and the next trial began. In this way the subject was taken around the circle, judging each pair of patches *seriatim* and adjusting the hue of the disk accordingly. Subjects went around the circle twice. At the end of the experiment we asked roughly half of the subjects if they had noticed any changes in the colors of the patches during the experiment. All said 'no'.

What we found was that even though all of the patches were in view throughout, and the members of every pair were judged 'same' by every subject on almost every trial, subjects' settings of the disk progressed more or less systematically with the physical values (wavelengths) of the patches.[9] In other words, subjects matched the pair #2/#3 to a longer wavelength than the pair #1/#2, the pair #3/#4 to a longer wavelength than the pair #2/#3, and so on. More to the point, patch #2 was matched to a different wavelength when it was compared to #1 than when it was compared to #3; patch #3 was matched to a different wavelength when compared to #2 than when compared to #4; and so on. Data from two subjects are pictured in Figure 3. On the *y*-axis is the setting of the disk (in arbitrary units), and on the *x*-axis is the number of the stimulus pair to which the disk was being matched. Black triangles indicate redundant trials in which the

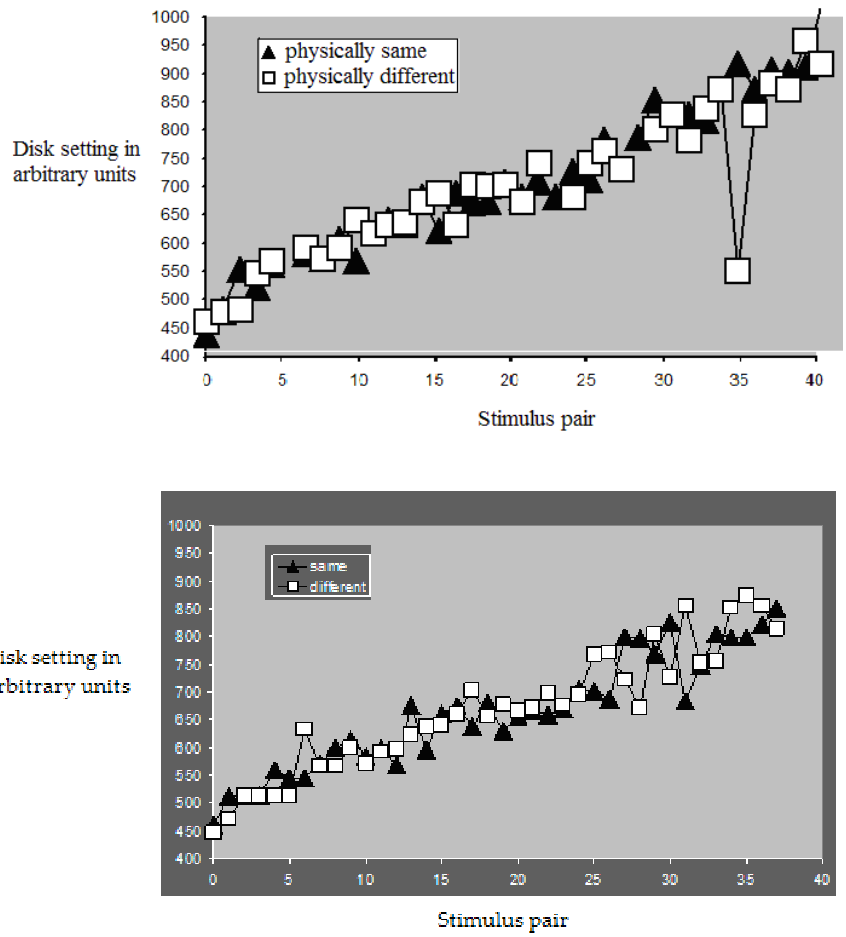

Figure 3. Disk settings (in arbitrary units) for two subjects, on stimulus pairs judged 'same'.

stimuli in a pair were physically identical; white squares indicate trials in which stimuli were physically different. Since the graphs show the disk settings, the data points (squares and triangles) represent all and only trials in which the members of a pair were judged 'same'. (The graphs contain more than 41 data points because subjects went around the circle twice; hence pairs that were judged 'same' both times received two disk settings.) The graphs show fairly steady progression of the disk settings as subjects progressed through the pairs of patches, for both the physically identical and physically different pairs.[10] Figure 4 shows the disk settings averaged across all subjects.

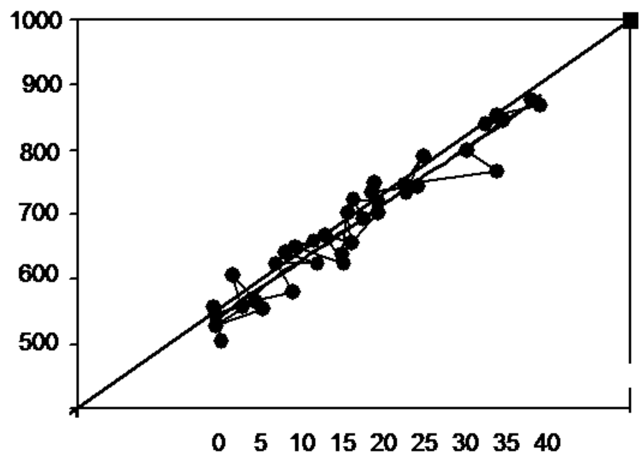

Fig.4. Disk settings averaged across subjects.

No doubt our data allow various interpretations. But they provide at least some support for the idea that individual patches changed their hue appearance in their different pairings; i.e., the patches looked different, but subjects could not notice this. Although the phenomenology is exceedingly difficult to characterize, it seems unlikely that subjects were undergoing merely a subliminal or unconscious sort of perception, since making a same/different comparison and setting the hue of the disk required sustained conscious attention. Borrowing some nice terminology from Fred Dretske (2004), perhaps we can say that subjects saw different hues, consciously saw them, but could not *see that* they were different; or that subjects saw different hues, but could not see *the difference* in hue. Or perhaps they saw different hues but could not see the *changes* in hue.[11]

However the phenomenology should be described, our results appear to provide support for the instability hypothesis: unnoticeable changes in the appearances of individual stimuli occur in a phenomenal continuum. It is these subtle changes, not any nontransitivity, that make phenomenal continua possible. If that is correct, then neighboring items in a phenomenal continuum do indeed appear the same in pairwise comparisons, but the instability of their appearances across different pairings defeats the nontransitivity claim.[12] The nontransitivity claim holds good for the statistical psychophysical relation of indiscriminability because the relevant physical properties (wavelengths, frequencies, etc.) of the stimuli in an indiscriminability series are stable. No instability analogous to that of the hues in a phenomenal continuum occurs in an indiscriminability series as such. Thus although any indiscriminability series can instantiate a phenomenal continuum, such a series is only physically, not phenomenally, stable.[13]

Notes

[1] For recent discussions of perceptual indiscriminability in addition to those discussed above, see for example Siegel 2004, Hellie 2005, Farkas 2006, Chuard 2007.

[2] In addition, as C. L. Hardin (1988) explains, there is reason to think that, given enough trials, any physical difference between stimuli will be detected in a statistically significant percentage of same/different comparisons; in essence, there is no absolute threshold of discrimination. Of course, detection of very small differences may not occur even 50 percent of the time. The point is rather that given enough trials, there will always be *some* statistically significant difference between the frequency with which two physically different stimuli are judged different and the frequency with which two physically identical stimuli are judged different. The smaller the physical difference between stimuli, the more trials will be required to reveal the difference in subjects' responses.

[3] I borrow the phrase "good straight look" from Hardin (1988, e.g.).

[4] Mohan Matthen points out (in correspondence) that we might say, of a presented colored patch, "This looks the same as the patch I saw last night". I suggest that in such a case we mean that the patches would look the same if we compared them.

[5] See for example Raffman 2000 and Graff 2001.

[6] A close ancestor of the change hypothesis is proposed, but not tested, in my 2000.

[7] [email addresses of collaborators]

[8] There were 21 physically distinct stimulus values (wavelengths; but see note 9). If we label the 21 values as *a-u*, their order in the circle can be specified as *a, a, b, b, c, c,* and so on. Consecutive trials then involved the pairs *a*/*a*, *a*/*b*, *b*/*b*, *b*/*c*, *c*/*c*, and so on. (The "redundant" pairs [*a*/*a*,

b/*b*, etc.] tested for false alarms, *viz*., 'different' responses to identical stimuli. The latter data are irrelevant to the present discussion.)

[9] For convenience I use the term 'wavelength', but strictly speaking it is incorrect. Rather, the stimuli were mixtures of broadband lights, and neither the primaries nor the mixtures had a defined wavelength.

[10] This result suggests that subjects may have been matching the hue of the disk to the mean physical value of the two patches in each pair.

[11] Dretske introduces this terminology in order to characterize change blindness. The present results may be reminiscent of change blindness, but subjects experiencing the latter effect are able to notice the change when their attention is explicitly directed to it, whereas that is unlikely to be the case in our study. Also, our experimental condition involved no visual disruption. In general, subjects who experience change blindness fail to notice large changes in visual scenes when the changes occur during a visual disruption such as a saccade or blink or a cut in a film (though see Simons *et al.* 2000). For example, viewers in one experiment failed to notice that two people in a scene had exchanged heads (Grimes 1996).

[12] In that case an individuation of determinate phenomenal qualities in terms of the relation of appearing the same has nothing to fear from nontransitivity. However, it must be remembered that these qualities are highly unstable properties of objects; in particular, they may change from one pairwise presentation or comparison to another.

[13] [acknowledgments]

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