Assimilation and contrast – two effects of information integration

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As it is well known, the judgment of a stimulus is affected by the context the stimulus is embedded in. This influence can be described by integration rules that hold across various judgmental tasks. Which type of effect results, assimilation or contrast, depends on the judgment component in which information integration is operative. When an attribute of the context is integrated into the judgment equivalent to the stimulus to be judged, assimilation[1] of the response toward this attribute occurs. When, on the other hand, an attribute of the context is integrated into an internal standard relative to which the stimulus is judged, we find contrast with respect to the context attribute. These two types of context effects will be outlined in the following sections. In particular, it will be asked what relation exists between the processes in which information integration produces assimilation or contrast. Do assimilation- and contrast-producing processes exclude one another? Or can these processes operate simultaneously with the overt effect being determined by the predominant process? These questions will be discussed using the results of an experiment on the Delboeuf illusion. Subsequently, the purposiveness of context effects will be considered. The differentiation of stimuli within and between categories will turn out to be one of the aspects of purposiveness.

Context as a source of additional information

In judging an attribute of an object or of an individual, there is a tendency to use all the information available. Let us consider, for example, the task to assess the helpfulness of a person on the basis of a description comprising behaviours as individual information and the profession as categori-

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[1] Assimilation and contrast are used here as descriptions of observed phenomena not as theoretical concepts.

cal information. The categorical information elicits a memory representation of the profession that comprises both the typical magnitude and the extremes on the helpfulness dimension (Bruner, 1957). If a correlation between helpfulness and profession is supposed, the typical magnitude X_o can be used as an additional piece of information. The typical magnitude is integrated into the judgment together with the value X assigned to the behavioural description. Anderson's (1981) Information Integration Theory formalizes this process by assuming algebraic functions, especially an averaging rule

$$Y = a\,X_o + (1-a)\,X, \quad 0 \leq a \leq 1, \tag{1}$$

where Y is the result of the integration the subsequent decision process is based upon and a is the weight of the categorical information. This process produces assimilation towards the category representation: The higher the value of X_o, the higher the value of Y.

Well known examples of this type of context effect are stereotyping and halo effect (Anderson, 1981; Petzold, 1992).

Context as a constituent of internal standards

Contextual information can also play another role. It can be incorporated into internal standards. This will be demonstrated for the special case of categorical judgment. There is some evidence that the extremes of the range formed by all stimuli presented serve as internal standards (e.g. Parducci, 1965). More specifically, the internal variable X onto which the current stimulus is mapped will be transformed into a decision continuum Z used to select the response. According to the range model, this transformation is given by

$$Z = \frac{X - K}{G - K} \tag{2}$$

where K is the lower and G the upper extreme of the range.

The range model can be generalized by assuming that not only the extremes of the stimulus range but also other standards may contribute to the formation of the subjective range. We may assume that internal standards result from a weighted average of the extremes of the stimuli with the corresponding attributes of the context. That is,

$$k = (1 - w)\,K + w\,C_1 \tag{3a}$$
$$g = (1 - w)\,G + w\,C_2, \tag{3b}$$

where k is the lower and g the upper internal standard and C_1 and C_2 are attributes of the context with w being their weight. Consequently,

$$Z = \frac{X - k}{g - k}, \tag{4}$$

To illustrate how information integration operates in the formation of internal standards, two examples will be outlined: the influence of anchor stimuli and the joint action of several frames of reference.

Influence of anchor stimuli

If a constant stimulus is presented prior to each serial stimulus, the judgments shift away from the scale value of this anchor stimulus. This effect can be explained by assuming that the anchor is integrated into an internal standard according to Equation 3a or 3b. For simplicity, we consider only the case that the anchor stimulus is situated below the serial stimuli. Then, the anchor A is integrated into the lower standard and we have

$$k = (1 - w)\,K + w\,A \tag{5a}$$
$$g = G. \tag{5b}$$

A study on categorical judgment of the length of lines corroborates this information integration approach to the effect of anchor stimuli (Petzold, 1982).

Joint action of several frames of reference

That a frame of reference refers to the category the stimuli belong to is virtually a truism. Frequently, the stimuli pertain to different categories that can be activated in judging the stimuli. This means, different frames of reference could be operative in the judgment process. How do these frames interact? Is only one of them the selected frame that determines the judgment or is some combination of frames that act in the judgment process?

There is some evidence that in selecting judgments mostly a combination of frames of reference operates, particularly when one category is embedded in another. We find such a hierarchical relation of categories for the

pitch of sounds played at different instruments. One category is formed by all the experienced pitches. The piano covers nearly this entire overall category. Sounds of particular instruments such as the violin or the trumpet form categories subordinate to the overall category.

Instrument	Lowest semitone	Highest semitone	Middle of the range	Empirical boundary	Theoretical boundary
French horn	20	55	37.5	38.9	39.2
Trombone	20	52	36.0	37.7	38.2
Flute	40	74	57.0	51.6	52.6
Piccolo flute	54	85	69.5	62.4	61.3
Violin	35	83	59.0	53.0	54.0

Table 1. Empirical and theoretical boundaries for binary classification of sounds into "low" and "high" pitches for different instruments.

A study by Budde (1980) demonstrated the joint action of frames of reference belonging to different categories. Subjects were asked to classify sounds of the piano into "low" and "high". The boundary between the two classes was in the middle of the range of sounds. That is, counting sounds in semitones from 1 to 85, the boundary was situated at the semitone 43. Afterwards, subjects were asked to classify sounds of other instruments in the same way. The results are reported in Table 1. As can be seen, the empirical boundaries between "low" and "high" deviate systematically from the middle of the range. The boundaries are lower than the middle of the range for "high" instruments; they are higher for "low" instruments. This means that the empirical boundaries for particular instruments shift towards the boundary found for the overall category. From this follows that both the range of the particular instruments and the range of the overall category are operative in the classification of sounds

The mechanism mediating this joint action of two frames of reference can be regarded as the integration of internal standards. More specifically, the lower extreme of the overall category, $K_{overall}$, and the lower extreme of the particular instrument, K_{part}, are integrated into a lower standard k. Equivalently, the upper extreme of the overall category, $G_{overall}$, and the upper extreme of the particular instrument, G_{part}, are integrated into an upper standard g. That is, we have

$$k = (1 - w) K_{part} + w K_{overall} \tag{6a}$$
$$g = (1 - w) G_{part} + w G_{overall}. \tag{6b}$$

Using these equations, we can estimate the weight w from the empirical boundaries b, that is

$$w = \frac{2b - (K_{part} + G_{part})}{(K_{overall} + G_{overall}) - (K_{part} + G_{part})} \qquad (7)$$

The mean value of w averaged over the instruments was 0.31. This value was used to calculate theoretical boundaries for particular instruments. The results are reported in the last column of Table 1. The rather good accordance with the empirical boundaries supports the information integration approach to the joint operation of two frames of reference.

Relation between assimilation- and contrast-producing mechanisms

The question arises as to whether the assimilation-producing process and the contrast-producing process described above are exclusive or can operate simultaneously. In the latter case, the observed phenomenon is determined by the predominant process. If the weight a of the typical value in Equation 1 is comparatively high, assimilation will occur. If, however, the weight w of the extremes in Equation 3 is comparatively high, we find contrast.

There are some studies that support a joint operation of both processes. One unpublished study by this author concerns the Delboeuf illusion. That is, a circle surrounded by a larger concentric circle appears larger than the same circle containing a smaller inside circle. An experiment was performed to examine whether this phenomenon is caused by a process of information integration, in which the size of the context circle is integrated into the judgment together with the size of the focal circle to be judged.

Patterns of circles were presented that contained two red circles of different size arranged horizontally. The left circle was the focal circle that was mostly provided with a concentric blue circle: a larger outside or a smaller inside circle. This additional circle was the context circle. The size of the right circle, the test circle, could be changed by manipulating keyboard buttons. Subjects were instructed to adjust the test circle to be equal to the size of the focal circle.

Two focal circles, 54 mm and 61 mm in diameter, and two ranges of context circles were used. In the upper range, the increments in the diameter of the context circles relative to the focal circle were 9, 18, 27, 36, and

45 mm. In the middle range, the increments were -18, -9, 9, 18, and 27 mm. For half of the subjects the focal circles were combined with context circles of the upper range, the other half was presented a combination of focal circles and context circles of the middle range. Additionally, the focal circles were presented without a context circle.
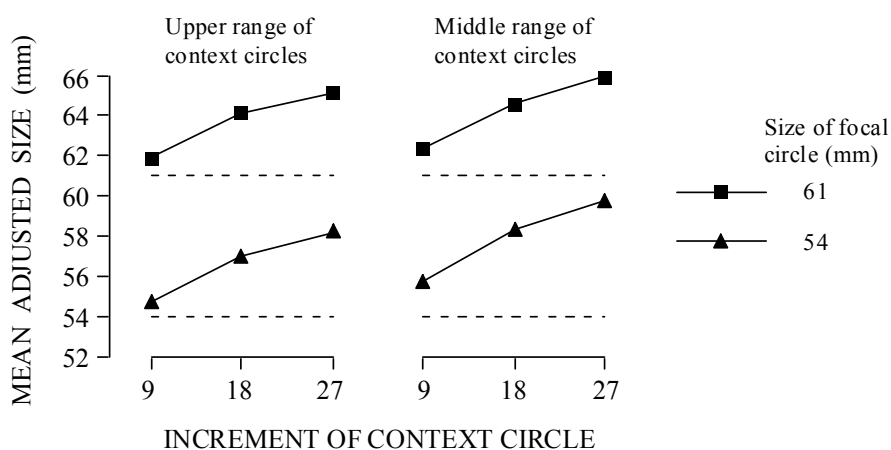

Figure 1. Mean judgment of focal circle as function of increment of context circle. The dashed lines indicate the diameter of the corresponding focal circle.

The two ranges of context circles contain three common increments: 9, 18 and 27 mm. These increments and the two diameters of the focal circle form two 3×2 designs, one for each range of context circles. These designs allow to test whether focal circles and context circles are integrated into the judgment obeying an adding-type rule. Additionally, comparing the judgments for the two ranges of context stimuli we can examine whether the range of context stimuli affects the judgments

Figure 1 plots the mean adjusted size of the test circle as a function of the increment of the context circles. The left panel presents data for the upper range of context circles, and the right panel presents data for the middle range. As can be seen, the judgments increase with increasing size of the context circles. Moreover, judgments exhibit a pattern of parallelism. This result supports an adding-type rule for the integration process.

It is revealing to compare the left with the right panel. The judgments are higher for the middle range of context circles than for the upper range.

This means contrast with respect to the range of circles. The contrast effect is confirmed by considering the judgments of the circles without a context circle. The difference between the adjusted size of the test circle and the size of the circle to be judged was -1.50 mm for the upper range and -0.96 mm for the middle range. In an additional experiment, a lower range was used in which the increments were -9, -18, -24, and -30 mm. In this case the difference was +1.20 mm. Apparently, the judgments of circles were affected by the position of circles relative to the range of context circles, even when the focal circle was presented without a context circle.

The experiment indicated that the context circles affected the judgments in two ways. First, the size of the current context circle was integrated into the judgment together with the size of the focal stimulus. Secondly, the range of all context stimuli participated in forming the internal standards that were involved in the judgment process.

A study by Chlavadetscher (1991) on the Ebbinghaus illusion also provides evidence for the joint operation of two processes. A *U*-shaped curve was found for the relation between the judged size of the focal circle and the distance between focal circle and context circles. This curve can be explained by assuming an assimilation-producing process and a contrast-producing process which operate simultaneously. Additionally, the findings suggest that the assimilation-producing process declines much faster with an increase of the distance between the focal circle and the context circles than the contrast-producing process does. This indicates that the weight of context information differs in a typical way for the two processes. An analogous conclusion can be drawn from a priming experiment by Herr, Sherman, and Fazio (1983).

To summarize, some studies suggest that the assimilation-producing process and the contrast-producing process can operate simultaneously. As the weights of context variables are generally different in the two processes, one of the processes is predominant and determines the net effect of context.

Purposiveness of assimilation- and contrast-producing processes

If stimuli may be assigned to different categories, the integration of the typical value X_o into the judgment has two consequences concerning the differentiation of stimuli. From Equation 1 follows that the difference between the values of *Y* for two given stimuli of the same category is $\Delta Y = (1 - w) \Delta X$. In the case that no categorical information is integrated, we have $\Delta Y = \Delta X$. From this follows that the difference ΔY is smaller when cate-

gorical information is integrated than when categorical information is missing. Put another way, the integration of categorical information leads to a reduced differentiation of stimuli within the category.

However, if we consider stimuli belonging to different categories, the difference

$$\Delta Y = (1 - w)\,\Delta X + w\,\Delta X_o$$

is greater than ΔX for small values of ΔX. This means that the differentiation between categories is enhanced when categorical information is integrated.

Just these predictions were confirmed by a study by Tajfel and Wilkes (1963). Subjects were asked to estimate the length of eight lines. In one condition each of the four shorter lines was labelled with the letter *A*, while each of the four longer lines was labelled with the letter *B*. Thus, we have a strong relationship between the length of lines and their class membership. In a second condition the lines were presented without any label. The results indicated a sharp increase in the interclass difference for the condition with labels compared with the condition without labels. The difference between the estimated length of lines 4 and 5 was considerably higher with a superimposed classification. On the other hand, there was a tendency for the stimuli within each class to be judged less different in the condition with labels than in the condition without labels. This means that a superimposed classification reduces the differentiation within a class.

The integration of the extremes of a category leads to opposite consequences. The range on the judgment dimension is generally smaller for a certain category than for all magnitudes experienced. Consequently, the slope in Equation 3 is higher. This means that the differentiation of stimuli is enhanced within a category when the extremes of the category-specific range are integrated into internal standards. The differentiation between categories is reduced because stimuli of different physical value may elicit the same response when they belong to different categories.

The question arises as to whether the variation of stimulus differentiation within and between classes is a mere by-product of information integration or an essential function of the integration of categorical information. The latter is suggested by some studies in which the goal of judgmental tasks was varied. In an experiment on the influence of profession on the judgment of helpfulness (Abele & Petzold, 1998), person descriptions comprised behaviours as individual information and the profession as categorical information. The behaviours were combined with one of two professions. There were two modes of presentation. In the mixed presentation,

120 descriptions containing different professions were presented in a random order. In the blocked presentation, 60 descriptions belonging to one profession were followed by 60 descriptions belonging to the other profession. Apparently, subjects used the presentation mode as a metainformational cue to task purpose. To measure how subjects interpret the purpose of the task, they had to rate the importance of differentiation between categories and the importance of differentiation within categories after the task. Mean ratings are presented in Table 2.

	Importance of differentiation	
Presentation mode	Between categories	Within categories
Mixed	386	247
Blocked	311	345

Table 2. Estimated importance of differentiation of stimuli between and within categories for two modes of presentation.

As can be seen, the mixed presentation was interpreted as a cue for differentiation between categories, whereas blocked presentation was a cue for differentiation within categories.

The two modes of presentation were applied again in a subsequent experiment in which the ecological responsibility of persons was to be assessed on a graphic rating scale. Again, person descriptions containing one behaviour and a profession (Greenpeace employee or stockbroker) were presented. Additionally, all behaviours were rated without information about the profession. As can be seen in Table 3, mean judgments indicate assimilation toward the category in the mixed presentation and contrast in the blocked presentation. To examine the stimulus differentiation within a category, the difference between judgments of positive items (responsible behaviour) and negative items (irresponsible behaviour) was calculated for items with and without a profession. Table 4 shows that the mixed presentation led to less differentiation of items with a profession than of those without a profession. The opposite finding was revealed in the blocked presentation. Now we find more differentiation for items with a profession than without a profession.

These results confirm the predicted relation between the kind of context effect and the differentiation of stimuli. When the categorical information produces assimilation, the differentiation of stimuli within categories is

reduced compared with the case of missing categorical information. However, when contrast appears the differentiation is enhanced. Furthermore, the kind of context effect seems to be controlled by the goal of the judgment task. When subjects believe that the differentiation within categories is more important than the differentiation between categories, contrast connected with a higher differentiation within the categories is found. However, when they believe that the differentiation between categories is more important, the inverse effect appears.

Presentation mode	Without profession	Greenpeace employee	Stockbroker
Mixed	301	311	291
Blocked	303	291	311

Table 3. Mean judgments of person descriptions with different categorical information and for different presentation modes.

Presentation mode	Without profession	With profession
Mixed	158	132
Blocked	130	165

Table 4. Difference between the judgments of person descriptions containing responsible and irresponsible behaviour.

The goal of the task was directly varied by the instruction in a further experiment. In one condition, subjects were informed that the differentiation of stimuli within the categories was most important. The consequence was that contrast and an enhanced differentiation between categories appeared also for the mixed presentation. The explicit goal given by the instruction overrode the implicit cue induced by the presentation mode and, consequently, the context effect was inverted.

The described results suggest that the differentiation of stimuli is one of the goals at which the integration of categorical information may be directed. Another goal can be to use all information available to enhance the confidence of judgments. All these goals specify the purposiveness of integration processes emphasized by Anderson (1996).

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Abstract

Assimilation and contrast in judgmental tasks are considered as effects of information integration. While assimilation appears when context attributes are integrated into the judgment equivalent to the representation of the focal stimulus, contrast occurs when context attributes are integrated into internal standards. Both processes may jointly operate in judgment processes. If so, the observed effect is determined by the predominant process. If categorical information acts as context, the kind of context effect is connected with a typical variation of the stimulus differentiation within and between categories. Assimilation is combined with an increase of differentiation between categories and a decrease of differentiation within categories, whereas contrast is linked to the opposite tendencies. Whether the assimilation-producing process or the contrast-producing process is predominant is partially determined by the goal of the task.

Riassunto

L'assimilazione e il contrasto nei compiti di giudizio sono considerati come effetti di integrazione delle informazioni. Mentre l'assimilazione compare quanto gli attributi contestuali sono integrati nel giudizio equivalente alla rappresentazione dello stimolo focale, il contrasto si verifica quando gli attributi contestuali sono integrati in standard interni. Entrambi i processi possono operare congiuntamente nei processi di giudizio. Se è cosi, l'effetto osservato è determinato dal processo predominante. Se l'informazione categoriale agisce come contesto, il tipo di effetto contestuale è connesso alla variazione tipica della differenziazione dello stimolo entro e tra le categorie. L'assimilazione è combinata ad un aumento della differenziazione fra le categorie e ad una diminuzione della differenziazione entro le categorie, mentre il contrasto è associato alle tendenze opposte. Lo scopo del còmpito determina in parte se è predominante il processo che produce l'assimilazione o quello che produce il contrasto.

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