Visual attention and the mechanism of metacontrast

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Rough translation – please do not quote

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Abstract

It was hypothesized that the U-shaped metacontrast function results from the superimposition of 2 monotonic components which reflect mechanisms similar to the peripheral and central processes underlying backward pattern masking (Turvey, 1973). In an experiment using the disc-ring paradigm it was demonstrated that the descending and the ascending parts of the U-shaped metacontrast function are differently affected by (a) exposure duration of the mask, (b) introduction of a task-irrelevant additional stimulus appearing in the contralateral visual hemifield. A second result was that the phenomenal representation of the masking effect is different from the two flanks on the curve. Some data from further experiments are mentioned which indicate that the 'long interval' part of the masking function, which is influenced by the appearance of the irrelevant stimulus, may be related to the control of visual attention.

The experiments, I would like to report on are about a visual phenomenon, that has been detected by the Vienna physiologist Robert Stigler almost 70 years ago, and that he has called ‘metaphotischen Kontrast’ [metaphotical contrast] (Stigler, 1910). From this term the nowadays usual abbreviation ‘metacontrast’ derived.

Metacontrast shows up, if a briefly presented figure – e.g., a cycle disc or a rectangle – is followed by a further stimulus pattern at short temporal distance, and which is laterally connected to it.

The first stimulus (<u>test stimulus</u>) is then affected in its perceptibility by the second stimulus (<u>masking stimulus</u>). Depending on the experimental method used this can be shown in a reduction of the brightness perceived (e.g., Alpern, 1953; Blanc-Garin, 1966; Fry, 1934, Growney, Weisstein, & Cox, 1977; Piéron, 1935), in an increase of the threshold of the test stimulus (e.g., Cox & Dember, 1970; Kolers, 1962; Lefton & Orr, 1975), in a deterioration of its discriminability (e.g., Bernstein, Proctor, Proctor, & Schurman, 1973; Breitmeyer, Love, & Wepman, 1974; Weisstein & Haber, 1965), or identifiability (e.g., Dember, Bryant, & Chambers, 1975; McKeever & Suberi, 1974; Mewhort, Hearty, & Powell, 1978; Schurman, 1972), or simply, that it seems to have vanished phenomenologically (e.g., Burchard & Lawson, 1973; Kolers & Rosner, 1960; Mayzner, Tresselt, & Helfer, 1967; Toch, 1956; Werner, 1935).

Data resulting from these methods are usually presented in such a way, that the interval between the two stimuli appears on the abscissa, and the respective measure for the perceptibility of the test stimulus appears on the ordinate. These curves show a U-shaped function, which is typical for metacontrast: The impairment of the mask is minor for very short intervals, reaches a maximum at about 40-80 msec, and decreases again according to a further prolongation of the interval.

To interpret this U-shaped curve function there are two explanatory models differing in their underlying idea.

The first possibility is that metacontrast is based on a mechanism, which due to its temporal functional features responds best only in case of a certain interval between test and masking stimulus. The descending and the ascending flank of the metacontrast function would then reflect the increasing effectiveness of this mechanism, if the interval between test and masking stimulus would go beyond or falls short of this optimum value.

As Kahneman (1967) suggested this mechanism could be the same one, which forms the basis of apparent motion. In case of median intervals between test and mask it is activated – according to Kahneman's suggestion -, but should apparently lead to a simultaneous movement of one and the same object in opposite directions because of the figural nature of the metacontrast stimuli. According to this model, the perceptive inhibition should result from the disability of the visual system to realize this contradictory movement. Hence, the optimum of metacontrast would coincide with the optimum of the apparent movement.

This explanatory approach has faced a variety of empirical problems (Stoper & Banffy, 1977; Weisstein & Growney, 1969). At present, an approach to the understanding of metacontrast seems to prove more promising, which makes use of later findings from neurophysiology (Breitmeyer & Ganz, 1976; see also Matin, 1975; Weisstein, Ozog, & Szog, 1975). This explanation attributes metacontrast to the fact that the activity following the presentation of the test stimulus is inhibited in 'sustained' neuronal transfer channels by 'transient' arousal coming from the mask. That maximum masking can be registered only in case of a certain interval between test stimulus and mask, which can be explained according to Breitmeyer and Ganz (1976) by different processing velocities of both types of channels. It is assumed that phasic arousal reaches the cerebral cortex 50-100 ms earlier than tonic arousal; to synchronize the two, the mask has to be delayed by a corresponding interval. The U-shaped form figure of the metacontrast function results from the fact – according to Breitmeyer and Ganz (1976) as well as to Kahneman (1967) -, that the efficiency of this inhibitory process is the smaller, the more the interval between test stimulus and mask leaves this optimum value for the one or the other direction.

A second, still not extensively discussed possibility (see Merikle, 1977; Turvey, 1973, p. 40f.) of what might be the reason for the U-shaped course of the metacontrast function is the superimposition of two processing components, which depend each monotonically, but in contralateral directions on the interval between test and mask stimulus. Perhaps the increase of metacontrast in the decreasing region goes back to a mechanism, the masking effectiveness of which monotonically <u>increases</u> as a function of the interval, whereas the increase of the masking function after exceeding the maximum depends on another mechanism, which becomes the more <u>ineffective</u>, the larger the interval between test and mask stimulus is.

For the present this seems to be nothing more than a way of thinking, which seems to be obvious, because such a dismantling of a U-function into two components has often shown to be true in other contexts (an example: The position curve in serial reproduction). Beyond this, there are three empirical arguments in favor of this hypothesis, which justify its experimental investigation:

In looking through the findings it strikes the eye, that certain variables seem to have differently strong effects on the decreasing and the increasing part of the function:

A prolongation of exposure duration of the masking stimulus or a shortening of the exposure duration of the test stimulus considerably strengthens the masking in the decreasing part, but has only a minor effect on the increasing region (Alpern, 1953; Blanc-Garin, 1966; Merikle, 1977).

The difference in masking power between monoptical and dichoptical presentation (which, interestingly, consists of the dichoptical masking being stronger than monoptical masking!) is essentially restricted also to the decreasing flank (Growney & Weisstein, 1972; Schiller & Smith, 1968; Weisstein & Growney, 1969).

A third variable, which apparently becomes effective mainly in the decreasing region of the function, is the angular separation between test and masking stimulus (Growney, 1976; Lefton, 1973; Merikle, 1977). Although, the findings are less clear in this case than in the two preceding ones (see Alpern, 1953 and Growney, Weisstein, & Cox, 1977).

Other variables become mostly effective in that area of the metacontast function, in which performance is about to increase again:

The number of elements out of which the test stimulus is to be reported is nearly of no importance for short intervals, but has a massive effect on the power of metacontrast in the second part (Weisstein, 1966).

Similarly, only this part of the function is sensitive to the masking stimulus' membership to the same cognitive category as the test stimulus (Merikle, 1977).

This pattern of results suggests, that the second part of the metacontrast function reflects ‘higher’ processes of information processing, whereas the mechanism relying on the first, decreasing part, is to be located more peripherally. This assumption would also solve a problem existing in all one-process explanations for metacontrast: On the one hand the masking function for simple stimulus configurations is quantitatively very well predictable from physical stimulus parameters (e.g., Bridgeman, 1971; Weisstein, 1968). This suggests to localize metacontrast at an early stage of processing. On the other hand it also shows sensitivity to factors like figural similarity between test and masking stimulus (Fehrer, 1965; Toch, 1956; Uttal, 1970), and even the encodeability of the test stimulus as a word (Mayzner & Tresselt, 1970), which accounts for a later stage of processing as the ‘location’ of masking. If our suggestion holds true, then these are not alternative, but each other complementing classifications of metacontrast.

This hypothesis is supported furthermore by the comparison of the masking function of individual participants. In some experiments, it hence turned out that interindividual differences in the two parts of the metacontrast function can be formed completely different. For example, Burchard and Lawson (1973) obtained masking functions from 6 participants, the ascending flanks of which were shifted against each other up to 70 msec, whereas the individual performances in the descending part corresponded essentially. Conversely, Eriksen, Becker, and Hofmann (1970) found individually differing courses of the masking function in the first part, but a good correspondence between participants in the area of the ascending flank.

These findings become clear, supposed that the two segments of the metacontast function not only rely on different mechanisms, but that their influence is represented differently on the phenomenological level. According to the circumstances of the experiment and to the random search of participants, the participants could then vary in the ability, to cope well with the one or the other kind of perceptual impairment of the test stimulus. This interpretation is supported by the observation of Schurman (1972), that skilled observers differed from unskilled ones mainly in the performance for short masking intervals, namely because, in case of a figural integration of test and masking stimulus, they were more successful in isolating the test stimulus. Together with similar findings of Ira Bernstein and coworkers (Bernstein, Proctor, Belcher, & Schurman, 1974; Bernstein, Proctor, Proctor, & Schurman, 1973) this leads to the assumption, that both parts of the masking function and the two hypothetical mechanisms of the metacontrast on the phenomenological area can be assigned to a temporal integration between test and masking stimulus on the one hand and its perception in succession on the other hand. In other words: The masking effect in the area of the descending flank would depend on to which degree the test stimulus is still detectable, if it is integrated temporally and figurally with the masking stimulus; the gradual reduction of the masking in the ascending part would, however, describe the increasing perceptibility of the test stimulus as an independent visual object.

The third argument in favor of a two-component theory of the metacontrast results from the comparison with a related experimental paradigm. In case of the so-called 'pattern' masking, the test stimulus – often a letter or an arrangement of letters - is followed by a visual pattern consisting of randomly arranged figural elements which completely overlaps the test stimulus. As – above all – the papers of Spencer (1969; Spencer & Shuntich, 1970), Scheerer (1973; Scheerer & Bongartz, 1973), and Turvey (1973) have shown, the findings resulting from this paradigm ask for the assumption of at least two mechanisms of masking. According to this idea, the first one is located on an early stage of processing, is determinatively influenced by physical variables like duration of presentation and of intensity, and is restricted to the temporal region, in which the test and the masking stimulus form a joint percept. The second mechanism has to be assigned to a more central stage of processing and hence has to be sensitive to factors like the degree of demand of the processing capacity as well as to the disposable time until the arrival of the masking stimulus. Its effect reaches into the temporal area, in which test and masking stimulus are no longer integrated into a joint percept.

It is clear, that this two-factor concept of 'pattern' masking is rather similar to the hypothesis of the basic functioning of metacontrast that I outlined so far. This correspondence means something, as the respective basic data material stems from different experiments, that are generally thought of to investigate different phenomena. It is fair to assume that metacontrast and 'pattern' masking could have functionally more in common than it could be assumed by its appearance.

The considerations mentioned herein basically rely on a comparison between data coming from different experiments. Additionally, they are minor findings that had partly less to do with the intended investigation of the respective experiments, and which are not always statistically covered.

Therefore, it was the purpose of our first experiment to prove these assumed differences directly, i.e., the two questions, we were asking ourselves were:

Is it possible to show that certain experimental variables selectively affect the descending, and other variables affect only or at least mainly the ascending part of the masking function?

Is it possible to show that the effect of the masking is phenomenologically differently represented in the descending and in the ascending part of the function?

Method

The stimuli were chosen according to the Werner disk-ring-arrangement. A black disk on the right side of the fixation point was presented for 5 msec; it was followed by a ring surrounding the disk at an inter stimulus interval of 0-100 msec as the masking stimulus.

The two factors, which we expected to have different effects on the two parts of the masking function, were the exposure duration of the masking stimulus. It could amount to 5, 7.5, or 10 msec.

the presentation of an additional stimulus being identical to the test stimulus in its form, size, and exposure duration. Under the condition ‘with additional stimulus’ this second cycle disk appeared simultaneously with the test stimulus, namely at the same distance from the fixation point as that one, which appeared in the other one, hence in the left half of the field of vision.

The decision on these two variables was also determined by the result of pre-tests, but is also in correspondence with what I reported from the literature at the beginning of the text. We expected that the exposure duration of the masking stimulus would primarily affect the descending part of the function, hence the more peripheral mechanism, whereas the additional stimulus should have an effect on the central processing and thus on the second part of the function.

The second intention of the experiment was to investigate the phenomenological representation of the masking effect. Therefore, the observers judged according to three different criteria:

Detection. The observer said ‘Yes’, if he was sure to have seen the test stimulus, otherwise ‘No’. This instruction leaves open, how the test stimulus is phenomenologically represented in those cases where it is detected by the observer.

Scaling. The perceived darkness of the test stimulus was judged according to a five-point scale, whereby 1 meant ‘white’ and 5 meant ‘black’.

Temporal dissolution. The observer indicated whether or not he perceived a succession of two stimuli. These two kinds of judgments should give information about how the test stimulus was phenomenologically represented in the two parts of the masking function.

The three kinds of judgment were distributed on two conditions of answers:

In condition 1, the observer exclusively made a detection judgment. In condition 2, he judged darkness as well as temporal dissolution. A judgment ‘2-4’ meant, e.g., that the test and the masking stimulus were perceived successively (‘2’), and that the test stimulus had the darkness ‘4’. The scaling of the perceived darkness was related to the inner of the ring in those cases, in which no succession of two stimuli had been seen.

This resulted in the following design: The interval between test and masking stimulus was varied in 10 steps; the exposure duration of the masking stimulus was varied in 3 steps; additionally there was the two-step factor ‘with/without additional stimulus’. In addition to the 60 combinations of these three factors the above mentioned two response conditions were included, so that there were 120 combinations. These were presented 20 times to each of the three observers, respectively.

The response conditions changed blockwise. In each block each of the remaining 60 combinations appeared twice. The presentation was made on a Scientific Prototype-Tachistoscope, model GB. The black stimuli appeared at a visual distance of 120 cm on a white display field with an angle degree of 7 x 5, and with a luminance density of about 40 cd/m^2. The diameter of the disk and the inner diameter of the ring were 27', the thickness of the ring was 13,5'. The test stimulus appeared 54' on the right of the fixation point, and the otherwise identical additional stimulus appeared at the same distance on the left of the fixation point. The 10 inter-stimulus intervals had the same values of 0, 10, 20, 30, 40, 60, 70, 80, 90, and 100 msec.

The succession of the time parameters was controlled by a Massey-Dickinson-system; the experimenter adjusted the additional stimulus by moving a pasteboard disk behind a round position left open in the stimulus field. On a signal of the experimenter, the observer manually triggered the exposure and judged afterwards according to the respective response condition.

Results

The response condition 'detection', in which the observer had to decide only whether the test stimulus can be detected, had also been used in several of the classical experiments on metacontrast (e.g., Werner, 1935; Kolers & Rosner, 1960; Mayzner, 1975). So we are expecting the usual U-shaped metacontast function.

Insert Figure 1 about here

As can be seen in Figure 1, this is indeed the case. (The data of the three observers were mediated, as they did not differ significantly from each other.) The two other factors 'exposure duration of the ring' (curves with varying symbols) and 'additional stimulus' (broken lines) also had a highly significant effect on the detection judgment.

For the analysis of variance the 10 intervals were combined into 3 groups (interval group I: 0, 10, and 20 msec; interval group II: 30, 40, and 60 msec; interval group III: 70, 80, 90, and 100 msec). This was advantageous, because each test block disposed of 6 respectively 8 observations per cell (interval group x exposure duration x additional stimulus condition), which were converted into 'percent yes-judgments', and finally were subjected to an arcsin transformation. With the 10 values from the test blocks as a random sample, an analysis of variance was calculated, in which the observers entered as an independent 3-step factor, and the 3 interval groups, the 3 exposure durations, and the two additional stimulus conditions entered as dependent factors. Furthermore, a separate 3x3x2 ANOVA was calculated for each observer. Intervals ($F(2,54) = 335.8$; $p < .001$), exposure durations ($F(2,54) = 105,64$; $p < .001$), and additional stimulus ($F(1,27) = 164.72$; $p < .001$) showed highly significant main effects. The three observers differed not significantly from each other ($F(2,27) = .53$; n.s.); similarly, none of the interactions was significant with the factor 'observer'. The separate ANOVAs for the 3 observers showed corresponding patterns of result.

Essential to our question are the interactions: Exposure durations ($F(4,108) = 28.33$; $p < .001$) as well as additional stimulus ($F(2,54) = 14.28$; $p < .001$) interacted with the intervals. But there is no interaction between exposure durations and additional stimulus ($F(2,54) = 2.82$; n.s.). The type of interactions corresponded basically to the expectation: In the region of the descending flank the additional stimulus has no perceivable effect on the probability of detection. But it does massively affect the ascending flank; the additional stimulus shifts the flank for about 30 msec to the right. The effect of the exposure duration of the ring can be seen reversely primarily in the area of the descending flank; although it is – in contrast to our expectations – in the second part, too, not completely irrelevant.

To clear the interactions further on, separate ANOVAs for the 3 interval groups were calculated. The exposure duration of the ring was significant for the interval group I ($F(2,54) = 130.24$; $p < .001$), but the additional stimulus was not significant ($F(1,27) = .39$; n.s.). In case of the interval groups II and III, on the other hand, both factors were significant (exposure duration: $F(2,54) = 13.78$; $p < .001$, respectively $F = 6.95$; $p < .01$. Additional stimulus: $F(1,27) = 20.87$; $p < .001$, respectively $F = 182.90$; $p < .001$). Although, a comparison of the F-values as well as a look at Figure 1 show, that the additional stimulus in the interval group III is a far more weighty factor than exposure duration of the test stimulus. The interactions did not reach significance in these analyses, too.

Let us now have a look at the data from the second response condition, in which the observer had to judge the temporal dissolution and the perceived darkness.

Insert Figure 2 about here

Figure 2 shows the scaling data, yet analyzed separately, whether the respective judgment on the perceived darkness was related to the perception of succession between test and masking stimulus (curves on the right, above), or whether the observer perceived only a single visual object (curves on the left). The symbols are the same as in Figure 1.

The course of brightness in case of missing temporal dissolution is similar to the course of the detection curves in the region of the descending flank. Here again, there is an effect of the exposure duration of the ring, whereas the additional stimulus has no impact at all.

For the analysis of variance of the scaling data with the judgment 'simultaneous' only the intervals 0, 10, 20, and 30 msec were taken into consideration, from which over all conditions and observers for each test block at least one judgment was made. (Because of the onset of the temporal dissolution this was no longer the case for the longer intervals.) The medians of the scaling judgments from the 10 blocks were treated like the data from detection (see above, p. x11x). The intervals (which need not been grouped, contrary to the analysis above) showed, as expected, a highly significant effect ($F(3,81) = 616.23$; $p < .001$), the same holds true for the exposure durations of the ring ($F(2,54) = 248.91$; $p < .001$). The interaction between these two factors was also significant ($F(6,162) = 11.21$; $p < .001$). For the factor 'additional stimulus' there was, however, neither a significant main effect ($F(1,27) = .34$; n.s.) nor was it involved in a significant interaction.

The fact, that detection and scaling data behave similarly in the region of the descending flank, leads to the assumption, that the two dependent variables measure the same; more exactly: that the effect of the masking stimulus consists of a reduction of the perceived darkness of the test stimulus in the inner of the ring, and that the observers' detection judgment is based on it. Indeed, it can be seen, that there is a simple connection between the two variables.

Insert Figure 3 about here

Figure 3 shows the z-transformed probability of detection as a function of the scaled brightness for the intervals of up to 30 msec. Each of the data points stands for another combination of interval, exposure duration, and additional stimulus. The values are on a joint straight line of regression. The relation between the variables 'scaled darkness' and 'probability of detection' for the area of the descending flank of the metacontrast curve is hence described by a classical threshold function.

Let us return to the darkness curves (Fig. 2). For intervals longer than 40 msec, the correspondence with the detection curves ends. Because for these a monotonic rise begins. The scaled darkness, on the other hand, remains in those cases, in which the observer does not perceive any succession, on the low level of about 40 msec, i.e., the inner of the ring is nearly white. But if the test stimulus is perceived in this area as an independent visual object preceding the ring, then it appears even more dark as in case of the shortest intervals. In other words: the increase of the perceived darkness in the ascending part of the function happens rapidly, contrary to that in the area of the descending flank; and coincides with the perception of a succession of test and masking stimulus.

Now we have a look at this transition on the perception of succession, i.e., the threshold function for temporal dissolution.

Insert Figure 4 about here

The probability of temporal dissolution as a function of the interval between test and masking stimulus is sketched in Figure 4; the scale of ordinates is z-transformed. The values can roughly be assigned to two threshold functions; one for the conditions with and one for the conditions without additional stimulus. The threshold for temporal dissolution of the succession test stimulus – masking stimulus is thus increased by about 30 msec by the presentation of an additional stimulus.

For the statistical analysis the intervals in the region of the threshold function were combined into two groups (50, 60, and 70 msec vs. 80, 90, and 100 msec). The proportional frequency of detection per test block was determined for each cell of the experimental design and then, after an arcsin-transformation, was put into the analysis of variance, as described above for the detection data. Results: Additional stimulus ($F(1,27) = 219.12$; $p < .001$) and interval group ($F(1,27) = 399.39$; $p < .001$) show significant main effects and interact with each other ($F(1,27) = 75.18$; $p < .001$). This is also the case for the separate analyses for single observers. Exposure duration of the ring is for none of the observers a significant factor, but reaches significance when the 3 observers are combined ($F(2,54) = 7.96$; $p < .01$). On interpreting this minor effect as compared to the two other main effects, a weakly significant interaction intervals x exposure durations x additional stimulus has to be considered ($F(2,54) = 4.22$; $p < .02$). The inspection of the data suggests that the effect of the exposure durations of the ring on the temporal dissolution is essentially restricted to those cases, in which at a low (50-70 msec) interval the temporal dissolution has already begun; this is the case only without additional stimulus.

The additional stimulus thus seems to have the same effect on the temporal dissolution that we have found for the ascending flank of the detection curve; and here as well as there the effect of the exposure duration of the ring is comparably insignificant. This suggests that the temporal dissolution has the same importance for the detection in the region of the ascending flank as the perceived darkness for the descending part of the curve. This suggestion can be easily tested by looking at the correlation between detection and temporal dissolution in the region of the ascending flank.

Insert Figure 5 about here

This correlation is depicted in Figure 5 for the 30 combinations of 5 intervals, 3 exposure durations, and 2 additional-stimulus conditions. As can be seen, the probability of detection for all combinations of parameters is actually identical with the probability of temporal dissolution.

Discussion

The experiment has rather clearly confirmed the hypothesis that the U-shaped contour of the metacontrast function came off by the superimposition of two monotonic components, at least in case of the experimental design used herein. The initial increase of the masking in case of a prolongation of the interval consists of an increasing brightening of the black disk as long as it is perceived as integrated with the ring; this kind of masking is sensitive to the exposure duration of the ring, but remains unaffected by the additional stimulus. The ascent of the function, thus the decrease of the masking power after exceeding the maximum is, however, bounded to perceive a succession between test and masking stimulus. It is accompanied by a rapid change in the perceived darkness of the test stimulus. The threshold for this temporal dissolution is increased by about 30 msec by a stimulus, that appears simultaneously with the test stimulus in the other half of the field of vision. But it only slightly affects the exposure time of the masking stimuli.

What does this dismantling of the masking function mean for the functional bases of metacontrast? On a general level the consequence reads that we have to do with the same coexistence of ‘peripheral’ and ‘central’ processes as in ‘pattern’ masking. (See the above mentioned papers of Scheerer, 1973, and Turvey, 1973.) To assume an individual <u>mechanism</u> of metacontrast would thus be at least uneconomical. But it shall not be denied that <u>effects</u> can be observed under the special conditions of this experimental design that do not show up in other cases of backward masking. To those obviously belongs the additional-stimulus effect that we have found. Finally, I would like to mention some considerations about how this effect could come off, and for this purpose briefly report on the results of four follow-up experiments, which cannot be presented comprehensively due to a lack of time, and, furthermore, the evaluation of which has not yet been completed.

Certainly, it is not about a retinal effect. Evidence for this is among others that it only appears with longer intervals and leaves the perceived brightness unaffected. But as the additional stimulus is effective beyond the limit of the halves of the field of vision, due to the anatomical-functional circumstances in the visual system then, as its substrate, the only possibility for processing is beyond the primary projection cortex. To further narrow down this central stage of processing, we followed the question, by which feature of the additional stimulus the effect is produced. First result: If the additional stimulus is stationary, hence visible during the whole trial instead of flashing up together with the test stimulus, the effect does not appear. Thus, it is produced by the reaction of the visual system onto the <u>appearance</u> of the additional stimulus, and not by the reaction onto its <u>absence</u>. Physiologically speaking, this could mean that the phasic reaction on the additional stimulus is the decisive fact.

If this holds true, then it would be expected, that the effect appears too, if the sudden change of the stimulation does not consist in the appearance, but in the <u>disappearance</u> of the additional stimulus. This expectation has been confirmed (Aufschläger, in preparation). If one assumes according to the hypothesis of Breitmeyer and Ganz (1976) that the function of the phasic transition channels consists in the control of visual attention, then the following provisional assumption of the effectiveness of the additional stimulus can be derived from this: A stimulus appearing simultaneously with the to-be-attended test stimulus in the field of vision triggers a concurrent signal for allocation of attention. Consequently, the allocation of attention to the test stimulus is delayed. As long as the latter was not attended consciously, it is yet susceptible to masking by the ring. To the same degree as the additional stimulus attracts attention concurrently with the test stimulus, the temporal area of effectiveness of the masking stimulus is extended.

According to this hypothesis it can be expected, that the effect of the additional stimulus is strengthened, if its chance of being attended is increased. This might be achieved, on the one hand, by presenting it already briefly <u>before</u> the test stimulus. Indeed, we found confirmation about an additional stimulus preceding a test stimulus being more effective than one following it (Machona, in preparation). Finally, - this is the last experiment, I would like to mention - the value of attention of the additional stimulus might be increased, if the participant is forced to its attention by having to respond to it with a manual reaction. As expected, this dual task-condition deteriorates the performance for the detection of the test stimulus. But the predicted interaction failed to come; obviously, the additional stimulus and the additional task were independent of each other in their effectiveness to the test stimulus (Adler, in preparation). This does not refute the attention hypothesis suggested herein, but it shows that it needs at least considerable specification.

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Figures

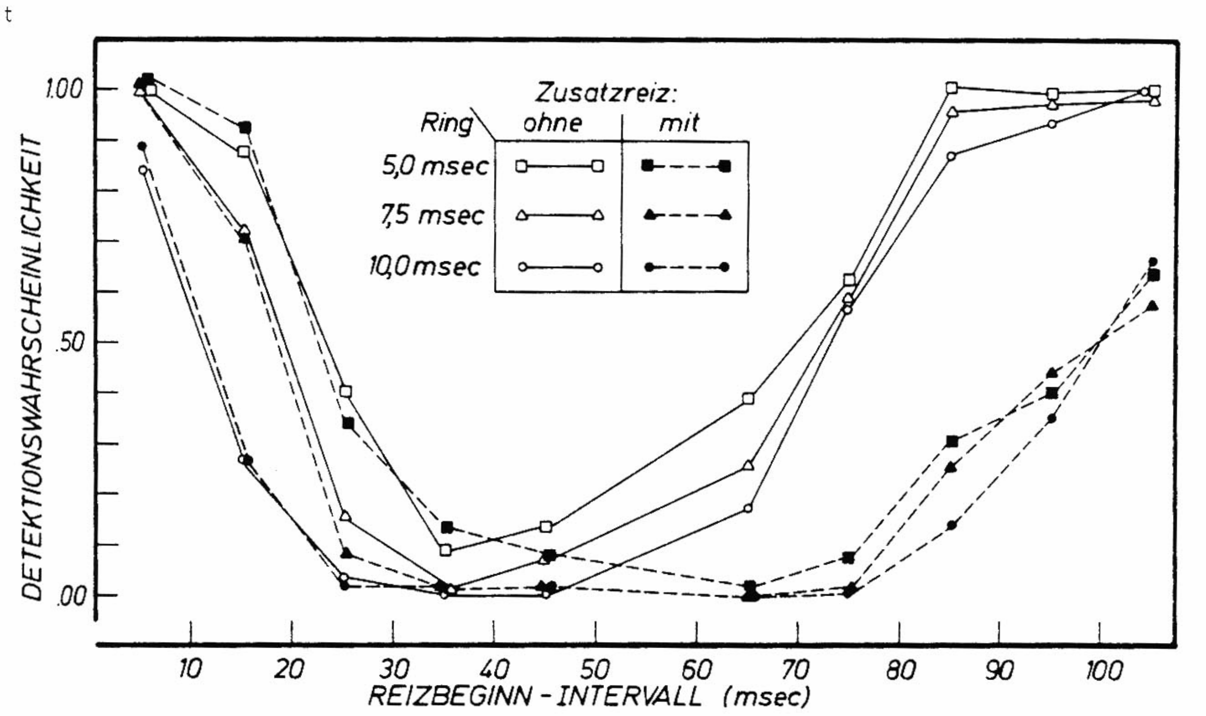

Figure 1

Probability of a ‘yes’ response in response condition ‘detection’. The data of the 3 observers are combined. Abscissa dimension is the stimulus onset asynchrony (SOA), which, due to the constant exposure duration of the test stimulus for all conditions, was 5 msec longer than the inter-stimulus interval (ISI). See further explanations in the text.

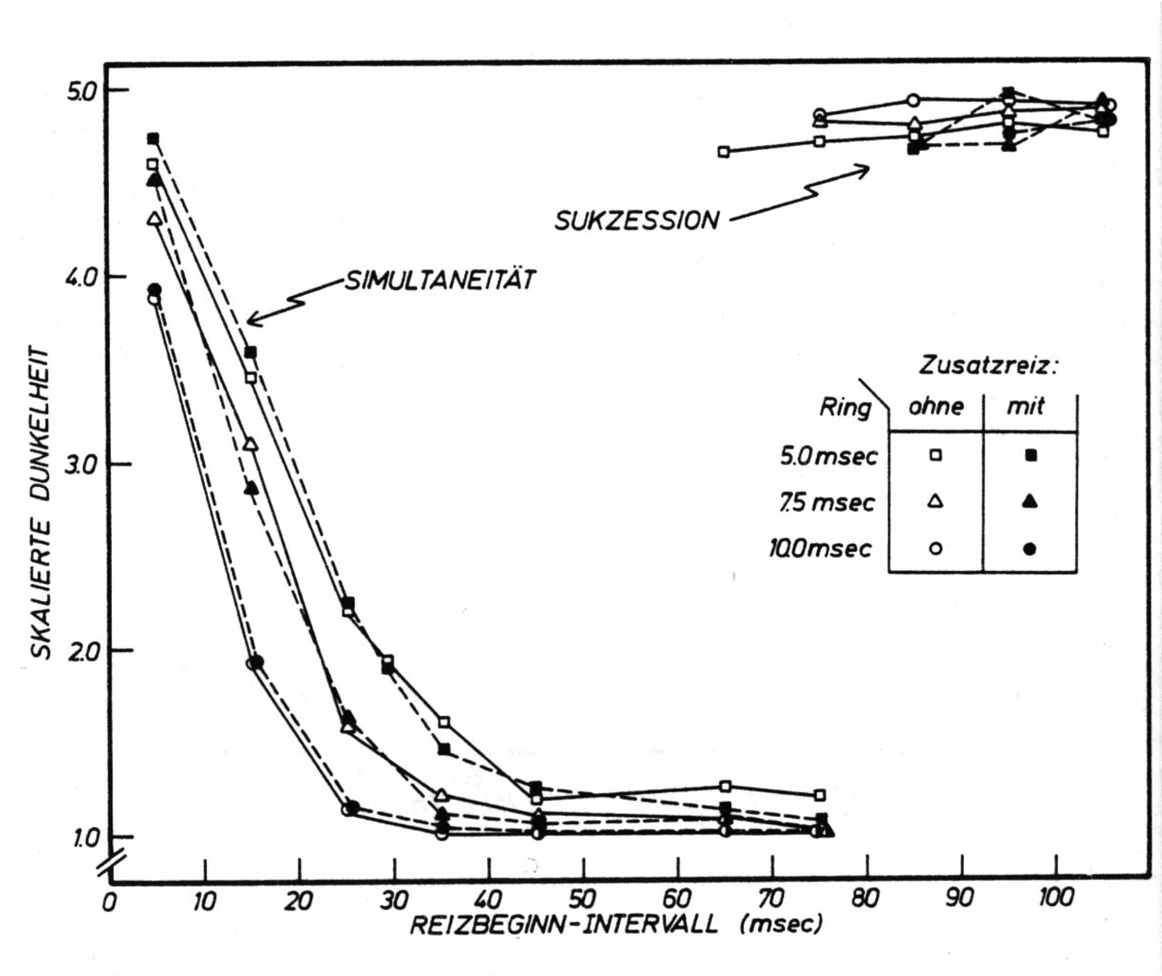

Figure 2

Result of the scaling of the perceived darkness of the test stimulus. The observer disposed of the 5-point category scale, with 5 meaning ‘black’, and 1 ‘white’. In case of perceived succession, the judgment was related to the first one of the two stimuli (the disk), in case of integration of test and masking stimulus to the inner of the ring. The two set of curves showed the median scale values of the 3 observers, separately for these two cases.

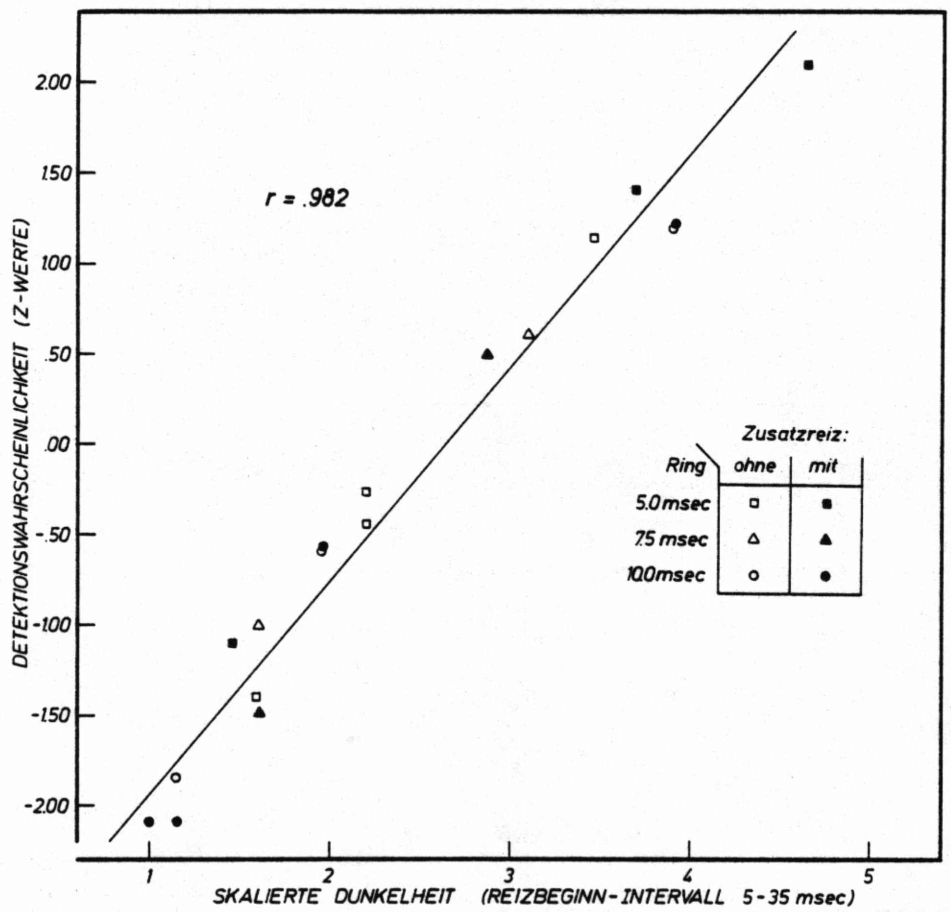

Figure 3

Relation between scaled darkness and probability of detection for stimulus-onset intervals up to 35 msec (= inter-stimulus intervals up to 30 msec). The data points represent a combination of interval, exposure duration, and additional stimulus condition, respectively. The data of the three observers were mediated.

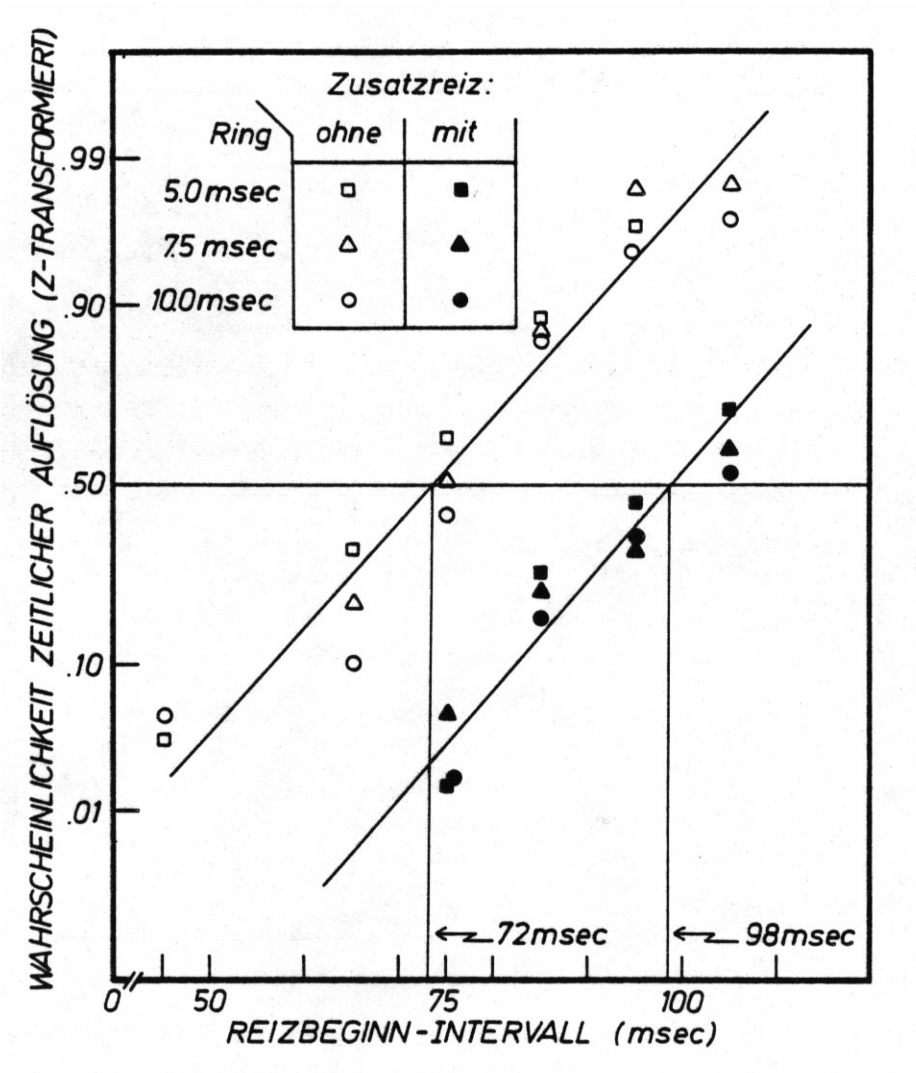

Figure 4

Probability of temporal dissolution (judgment ‘succession’) depending on stimulus conditions. The dissolution threshold is increased by the additional stimulus by about 30 msec. Missing values in the Figure are due to p = 0.00, respectively p = 1.00.

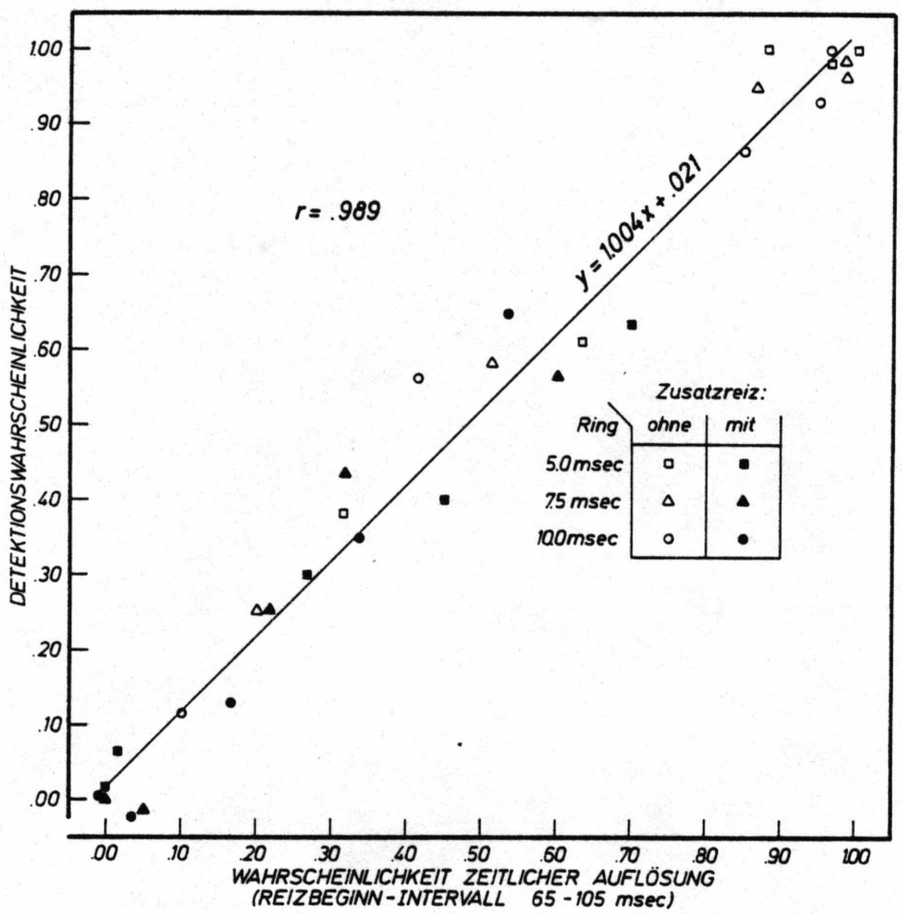

Figure 5

Correlation between probability of temporal dissolution and probability of detection in response condition 2.