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The Relation between an Afterimage Induced by Male or Female Figures and Emotions

Emocje a powidok wywołany sylwetkami kobiety i mężczyzny

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ABSTRACT

Studies exploring the relationship that occurs between an afterimage induced by a stimulus of certain meaning and emotions are presented in this paper. Obtained results shed light on the afterimage phenomenon's function in the perception process, as well as help to answer the question of the degree to which an afterimage is a carrier (manifestation, reflection) of emotional content of perceived stimulus. The relation between duration time of an afterimage of a female figure with regard to duration time of an afterimage of a male figure and the level of emotional problems concerning one's mother was examined. Sixty-eight students of both genders took part in this research. The results showed that high level of emotional problems concerning one's mother elongates duration time of an afterimage of a female figure with regard to duration time of an afterimage of a male figure on the statistically significant level. Obtained data allows us to conclude that duration time of an afterimage is related to emotional problems of an examined person.

Keywords: perception; afterimage; emotions; meaning

Illusion always precedes perceiving.
George Orwell

INTRODUCTION

The system of perception operates in the regime of a dynamic balance between an internal and external world. In the case of disturbing this balance, for

example, by going beyond certain values of perceptual parameters – this is in case of very strong or very weak stimulus (deprivation, subliminal stimulus) – perception phenomena called "afterimages", "aftereffects", "pseudo-hallucinations" or "latent cognition" arise. Those phenomena can be understood as manifestation or disclosure of a cognitive and behavioral subliminal activity described by: Hermann von Helmholtz (1985) as control programme of perception, Karl Pribram (1971) – as feedforward stimulation, Stephen Kosslyn (1996) – as a sensory buffer, Iosif Bzhalava (1971) – as setting, R. Zajonc (1984) – as exposition effect, Sigmund Freud (1974) – as manifestation of unconsciousness' functioning present in the so-called Pötzl effect.

The aim of this paper is to answer the question whether the meaning of the stimulus (as a form associated with certain experiences) and emotions associated with it are related to the duration of an afterimage. In other words, whether the meaning of the stimulus understood as the compound of contents and emotion (in the cognitive-emotional configuration) is related to the duration of the mentioned phenomenon. The term "meaning" is understood here in an empirical and emotive manner and is reflected in one's behavior, i.e. the manifestation of meaning is an expression of affection or antipathy towards a certain object.

WHAT IS AN AFTERIMAGE?

Since the times of Hermann von Helmholtz, i.e. for the last 150 years, many authors showed that an afterimage is centrally determined (Davies, 1970, pp. 181–189; Teichner, Wagner, 1964, pp. 141–156; Smith, Ruuth, 1973, pp. 34–38; Eysenck, 1962, pp. 405–406; Schwartz, 1980, pp. 63–76). Contemporary studies of a spiral afterimage corroborate this view, e.g. Stuart Anstis, Frans Verstraten and George Mather (1998) think that an afterimage is associated with cognition and that it can function as an equalizer and corrector of perceptual errors or as a coding optimizer which means that this phenomenon is interpreted as a manifestation of a process which modifies the cognition process which influences the perceived material. This view is consistent with the *outflow theory* by von Helmholtz and can be placed in its wide understanding, that is within the approach in which this concept is applied to the explanation of a general course of the visual perception process and not only to the explanation of image stabilization in case of head or body motion. Moreover, an afterimage understood by Bzhalava (1971) as a perceptual attitude is compatible with the *outflow theory* or even confirms it.

In the light of von Helmholtz's (1985), Bzhalava's (1971) as well as Anstis et al.'s (1998) notions, an afterimage can be understood as a manifestation of top-bottom controlling of perception (that is as an effect of central sites influencing visual receptors) or as a reafference (as it was assumed by Richard Held [1965,

pp. 84–94]). It is important to remind here that the central origins of this phenomenon were also pointed out by S. Freud who described it as "remnants of perception" (Freud, 1974). The founder of psychoanalysis expressed this view while commenting on experiments on an afterimage presented by Otto Pötzl at the assembly of Psychoanalytic Association in Vienna in 1917 and placing its shortened description in a revised edition of his work titled *The Interpretation of Dreams* (*Die Traumdeutung*) published two years later. Pötzl's experiments viewed from today's perspective can be understood as pioneer experiments on latent attitudes and on subliminal influence of stimuli on perception. Moreover, what is important from the perspective of this paper, is that they indicate the relation between the afterimage and content as well as the meaning of a perceived stimulus.

The relation between an afterimage and the content of the stimulus that induced it

Is it the case that the afterimage is differentiated due to the content of the stimulus that has induced it? The McCollough effect (1965, pp. 1115–1116) that enables the demonstration of the relationship between the direction of edges of the stimulus and the color of an afterimage suggests that this interdependence exists. One may assume that if – in this phenomenon – the aftereffect depends on the direction of the inductive lines of the stimulus, then it should depend on the shape of the stimulus as the shape is nothing else than an angular line or a set of small connected lines which form different shapes. Works of such authors as Rob van Lier, Mark Vergeer and Stuart Anstis (2009, pp. 323–324) or Gregory Francis (2010, pp. 19–22) are steps towards this view. They show that the color of the afterimage depends not only on the direction of the lines but also on the form of the inductive stimulus which in those cases takes form of a star.

However, the question arises whether it is only the color of an afterimage that is connected with the contents of the stimulus as in the case of the McCollough effect and the research by Francis (2010). Maybe also the duration of this phenomenon is related to the contents of the stimulus or to psychological processes and cognition? Experiments conducted by Hans J. Eysenck (1962, pp. 405–406) and other researchers (Anstis, 2012, pp. 515–518) revealed the existence of a relationship between extraversion and afterimage duration as well as between learning and an afterimage. Moreover, researches conducted by Mirosław Z. Harciarek (2003, pp. 111–118) allow an assumption that the relationship between the level of aggression and the duration of the aftereffect of an image of a knife exists, which is significantly longer in aggressive subjects than in subjects who show low levels of aggression. Those works suggest that the relationship between the duration of an afterimage and both central processes as well as the contents of the stimulus probably exists. They show that in subjects who have emotional problems sym-

bolized by a given stimulus, the duration of an afterimage induced by this stimulus is prolonged. The elongation of duration time of an afterimage reaction in case of emotional problems resembles a delayed reaction to words in psychoanalytical associations lists used in order to find unconscious complexes. It also brings to mind an implicit association test in which elongated duration is a manifestation of an ambivalent attitude of an examined person. It is worth mentioning that in the case of strong emotional problems not only the afterimage duration is prolonged but also a spontaneous appearance of afterimage in the perception field occurs as a supraliminal phenomenon which in extreme cases take form of migraine or epilepsy scotoma. It is not unlikely that this scotoma is a kind of an endogenously induced afterimage.

The results of research conducted by Bela Julesz (1971), regarding binocular vision, should also be included in the group of works suggesting that an afterimage is connected to the contents of its stimulus. This author had proven that afterimages induced separately in the left and right eye which consist of a system of dots arranged in a seemingly chaotic way, and a meaningful perceptual form (gestalt) can arise. This experiment shows the possibility of afterimage's contribution to shapes and the process of perception of figures allows us to make a supposition that visual images can emerge on the basis of afterimage as well, or that the afterimage is a component of our perceptions, though we are not aware of that (Anstis, Vergeer, van Lier, 2012, pp. 515–518).

The above-mentioned data allows us to assume that the afterimage phenomenon is related to cognition and it is worthwhile to be analyzed in a broader context and not only as an effect of activity or organization of the retina receptors in an eye. In other words, the proper outlook is to understand it as a phenomenon related to broadly understood reception of information, what includes the meaning of perceived objects. A narrow understanding of this phenomenon and considering it merely as a phenomenon itself in fact excludes its analysis as an element of the cognition process which is not helpful in understanding the role of an afterimage in perception.

How to examine the meaning (distinctive features) of the content of a perceived stimulus included in the afterimage?

Due to the relativity of forms of thinking and diversity of experiences, the mere sign or form is not a universal or unequivocal medium of contents or meaning, that is *signans* (sign, form) does not have to be consistent with *signatum* (object, experience) (de Saussure, 1995). Thereby, even if we assume that the duration of a given form of afterimage is a manifestation (medium) of the contents of the stimulus, it does not mean that it is not an effect of other contents and meanings or a result of yet another influences, i.e. gender, temperament, psychophysi-

cal condition.[1] So how to examine distinctive features of the contents of a given stimulus that are reflected in the afterimage, i.e. how to examine the afterimage of women's figure so to infer that its duration reflects (or does not reflect) woman's features and experiences connected with a woman, in other words that the obtained results are not the effects of other factors? This question is valid of course only if we accept the hypothesis saying that the afterimage is in fact a manifestation (a medium) of the contents and meaning of the stimulus – and this should be accepted if von Helmholtz's *outflow theory* is correct.

As it is known, the introduction of context enables the understanding of meaning. So is it also applicable (in case of the examination of a female figure) to use the context in order to make sure that the female figure means a woman and no other contents, or is not an effect of the influence of other factors? Taking into account the achievements of linguistics it seems that in this case the best option is to use a binary opposition stimulus. The application of the oppositions in linguistics, since the times of Ferdinand de Saussure (1995) and Roman Jakobson (1980) and therefore comparing pairs of signs, is regarded as a medium (manifestation) of difference in meaning and as a manner of defining distinctive features. On this basis, in the experiment presented below, the meaning of contents of a graphic symbol of a woman was contrasted with the figure of man, so the reference to the function of opposite structures was made assuming that the figure of man is a binary opposition and a context (background) for the figure of woman. The comparison of the duration of afterimages of both figures enables the assumption that obtained time differences are resulting from different contents that are posed by an applied stimuli, i.e. they are resulting from different reception of affecting forms of a woman and man.

Please note that also the McCollough effect is based on the opposition of contents that are constituted by the relation of horizontal and vertical lines to each other. This opposition basically enables this effect and enables the experience of afterimage complementary colors (green and red). Without the binary opposition of vertical and horizontal lines, i.e. the opposition of contents, the McCollough effect could not be demonstrated. Moreover, the afterimage (of color or contrast) alone can be understood as a binary opposition in relation to the inductive stimulus. In other words, both in the proposal of examining of afterimages of woman's and man's figures as opposition and in the McCollough effect we deal with double binary character, where, on the one hand, the afterimage is characterized by its natural binary opposition towards the stimulus, and on the other, there are two stimuli which are oppositional when it comes to the contents. It seems that the oppositional (binary) relation combines the contents of the stimulus and the af-

[1] Since it is a centrally conditioned phenomenon, thereby it can be an indicator of mental tension or other central disruptions, such as tiredness or poor psychophysical condition.

terimage contrast. This close relation of opposition of contents and opposition of contrasts colors in the McCollough effect brings to mind an opposition (complementarity) of the figure and the background which is preferred in gestalt psychology which serves to explain the process of contents and the meaning of perception.

METHOD

The research problem

The main aim raised in this paper is the analysis of the afterimage as the medium of the perceived meaning of the stimulus. As it was said in the introduction, the meaning of the stimulus is defined as a union of the contents of the stimulus, i.e. its form in relation to the oppositional form, and emotions or emotional problems connected with it. Therefore, the meaning is specified here as the union of contents and emotions as their configuration which constitutes a cognitive-emotional entity. The aim of the research is to state whether the relationship between the level of emotional problems with one's mother and the relation of unevenness of duration of afterimages of a woman figure (W) and man figure (M) exists. The demonstration of this uneven relation would lend credence to the validity of the *outflow theory*, according to which afterimages are the signals which control visual perception.

Design of the experiment

The independent variable is the level of emotional problems related to one's mother which takes a high or low level measured in points. The dependent variable is the duration of the afterimages of a woman or a man figures which are measured in seconds.

Control procedures were used in the experiment. They enabled stating that factors such as: gender, age, emotions or the stimulus form itself do not differentiate the duration of an afterimage in the analyzed group in a significant manner. The experiment refers to one age group so the age of the subjects can be considered as a controlled factor.

Two research hypotheses concerning the strength of the relationship between the level of emotional problems and the figures of the unevenness of duration of afterimages of a woman and a man were stated. The first one concerns the significance of the difference between the average duration of an afterimage of a woman figure and the average duration an afterimage of a man figure in the group of subjects with a high level of emotional problems with their mothers. The second one concerns the analogous difference between the average duration of the afterimages of the figures of a woman and a man in the group of subjects with a low

level of emotional problems with their mothers. It was assumed that if the relation between the duration of an afterimage and the contents of an inductive stimulus exists, in the case of the first hypothesis, a significant level of the relation between obtained average durations of afterimages should be obtained and in the case of the second hypothesis, this relation should not occur, so the differences between obtained averages should not be statistically significant.

Hypothesis 1

In the group of subjects with a high level of emotional problems concerning their mothers, the average duration of afterimages of a woman's figure is significantly longer ($p < 0.05$) than the average duration of afterimages of a man's figure (W > M).

Hypothesis 2

In the group of subjects with a low level of emotional problems concerning their mothers, there is no significant difference between the average duration of afterimages of a woman's figure and the average duration of afterimages of a man's figure.

Subjects

Sixty-eight students of the Academy of Physical Education in Katowice (Poland) were examined. The group included 33 men and 35 women. The age of the subjects ranged from 20 to 22 years.

RESEARCH TOOLS

Measurement of the level of emotional problems with one's mother

In order to identify the level of emotional problems with mothers, the I scale of the Sentence Completion Test created by Joseph M. Sacks and Sidney Levy (1950, pp. 357–402) was used. The test is of projective character and it is intended for diagnosis of emotional disorders. It consists of 15 scales that refer to various life areas. Each scale consists of four unfinished sentences, which an examined person should finish with the first thought in mind written down. Answers are subjected to the qualitative analysis, i.e. their contents are taken into account, as well as to the quantitative analysis which is based on an evaluation of the degree of conflicts' intensity in every area of life according to specified criteria. Formal side of the completed test is also evaluated, i.e. time spent on answering each sentence,

number of words used or way of expressing oneself. Four-degree scale is used for the calculation of results.

Measurement of the duration of afterimages of the figure of a woman and the figure of a man

In order to measure the duration of afterimages, an experimental method was used. As stimuli induct afterimages, two figure-stimuli which were the carriers of emotional charge, i.e. the figure of a woman and the figure of a man, were used. It was assumed that both of those forms are good carriers of contents related to one's mother and father and therefore they induce clear reactions, since neither men nor women can ignore the role of gender in their lives or erase their past experiences connected to the genders which have shaped their individual and social development.

Measurements of the duration of the aftereffects of figures of a woman and a man were identified by a specially constructed device. The screen on which subjects were looking at was black, in the form of a circle with a diameter of 8 cm. Two versions of the screen were prepared. The first one had a cut out figure of woman in its central area and the second one a figure of a man. Those screens were put on a holder in the shape of a cylinder with a length of 9 cm and with a base shaped as a circle with a 7.5 cm diameter. A holder with the screen was put on the stand. Inside the holder a 25 W bulb illuminating the screen was installed. The height of the figures cut out in the screen was 4 cm and their surface area was 4.5 cm^2. From the back, the figures were covered by white tracing paper which dispersed the bulb's light evenly, so the subject could observe an evenly illuminated figure of a woman or a man (depending on which screen was put on the holder). The distance between the face of the subject and the screen was 55 cm. The time of exposure of the stimulus (illumination of the figure), which was inducing the afterimage, was 60 seconds. When the exposure was finished and the bulb was switched off, a timer was turned on and the subject was asked to close his or her eyes and to specify when he or she started to see an aftereffect, how it proceeded and when it ended. In order to be sure that the afterimage ended, the subjects were asked to remain seated with closed eyes for another 30 seconds, even if the afterimage was no longer observed. After this time, the subject was asked to open his/her eyes. Three hours before this experiment, all of the examined persons underwent a pretest examination of the afterimage which enabled them to get acquainted with this phenomenon and the procedure of experiment as well as with the instructions which specified what they were supposed to do as examined subjects. They were also informed about the great significance of the accurate reporting on the afterimage phenomenon after turning off the screen and closing their eyes, i.e. about an accurate description of the afterimage, the moment of its appearance and its disappearance.

The procedure and the conduct of experiment

All of the 68 subjects were examined with the Sentence Completion Test and the duration times of the afterimage phenomenon were measured for each person with the use of the previously prepared device. After placing the subject in front of the device and giving the instructions, the screen illumination was switched on. The subject focused the sight on the illuminated figure and after switching off, he/she closed his/her eyes and reported what he/she can see – when the aftereffect appears, how it proceeds and when it ends. Each person was examined twice, i.e. in the first examination, the duration of an afterimage of a figure of a woman was measured and in the second one, the procedure was repeated with measuring of the duration of the afterimage of a man figure.

RESULTS

In the I scale of the Sentence Completion Test, the subjects obtained from 0 to 8 points. The median amounted to 2 points and the most frequently obtained result (modal) was 1 point. Subjects who obtained results in the I scale were placed in 1 and 2 decile (i.e. those who obtained between 4 and 8 points) were classified as the group of a high level of emotional problems with their mothers (group H), whereas subjects whose results were placed in 8 and 9 decile (i.e. who obtained 0 points) were classified as the group with a low level of emotional problems with their mothers (group L).

Obtained duration of afterimages in the examined groups had a normal distribution. Regarding the results of the afterimage of a woman figure (W), the arithmetic mean in the examined group ($N = 68$) equaled $M = 135$ seconds with a standard deviation of $SD = 35$ seconds, whereas the average duration time of the afterimage of a man figure equaled $M = 145$ seconds and the standard deviation $SD = 40$ seconds. The difference between the average duration of afterimages of figures of a woman and a man in the examined group is not statistically significant. The gender of examined subjects also does not differentiate the duration of afterimages of the figure of a woman and a man at a statistically significant degree. Moreover, statistically significant differences were not observed between a high and low level of emotional problems with one's mother and the duration of afterimages of figure of woman, and high and low level of emotional problems with one's mother and the duration of afterimages of the figure of a man.

High level of emotional problems concerning one's mother elongates the duration of the afterimage of a woman figure in comparison to the duration of the afterimage of a man figure (hypothesis 1). In order to verify hypothesis 1, average values of duration time of woman and

man figures' afterimages were calculated in the group of subjects with a high level of emotional problems with one's mother. As each of the subject was examined twice and the duration of woman and man figures' afterimages were measured for each person, in calculating the significance of the difference between average values of duration times of woman and man figures' afterimages, the *t*-test of the significance of the difference between two averages from correlated trials was used. The value of the *t*-test at the level of statistic significance $p < 0.05$ from the statistical tables for the examined group (n-1 = 15) equals $t = 2.131$. Comparison between value of the *t*-test from tables with the obtained value $t = 2.294$ shows that the obtained result confirms hypothesis 1 at the significance level of $p < 0.05$.

Low level of emotional problems concerning one's mother does not differentiate the duration of the afterimages of woman and man figures (hypothesis 2). Contrary to the results obtained in the group of subjects with a high level of emotional problems with one's mother (Table 1), the group of subjects with a low level of emotional problems with one's mother should not be characterized by a significant difference between the duration of the afterimages of woman and man figures. This state of affairs is the consequence of a lack of emotional differentiation of subjects towards their mothers since there is no emotional aspect, i.e. the contents alone (symbol, shape, sign) does not differentiate the examined group in terms of duration time of woman and man figures' afterimages. In other words, in the examined group with a low level of emotional problems with one's mother, average duration of woman and man figures' afterimages will not significantly differ between each other. Table 2 presents average duration times of woman and man figures' afterimages in a group of subjects with a low level of emotional problems with their mothers. The value of the *t*-test at the level of significance $p < 0.05$ from the tables for the examined group (n-1 = 15) equals $t = 2.131$. The obtained result, regarding a significance of difference from

Table 1. Average values of the duration of afterimages of figures of a woman and a man in the group of subjects with a high level of emotional problems in the relationship with their mothers (group H, $N = 16$) and the level of significance of the difference between the duration of afterimages of figures of a woman and a man in this group

	M	SD
Afterimage of a woman figure (W)	144 s	38 s
Afterimage of a man figure (M)	121 s	24 s
Test of the significance of the difference between two correlated trials	$t = 2.294$*	

* $p < 0.05$; *M* – arithmetic mean; *SD* – standard deviation. Due to the small number of respondents, the Yates's correction has been used.
Source: Author's own study.

Table 2, is consistent with previous expectations, namely there is no significant difference between the average duration of woman and man figures' afterimages in the group of subjects with low level of emotional problems with their mothers (0 points in I scale of the Sentence Completion Test). Figure 1 illustrates the results from Tables 1 and 2.

Table 2. Average values of duration of afterimages of figures of a woman and a man in the group of subjects with a low level of emotional problems concerning their mothers (group L, N = 16) and the level of significance of the difference between duration of afterimages of figures of a woman and a man in this group

	M	SD
Afterimage of a woman figure (W)	131 s	23 s
Afterimage of a man figure (M)	141 s	35 s
Test of the significance of the difference between two correlated trials	$t = 0.411$ n.s.	

M – arithmetic mean; *SD* – standard deviation; n.s. – not significant. Due to the small number of respondents, the Yates's correction has been used.
Source: Author's own study.

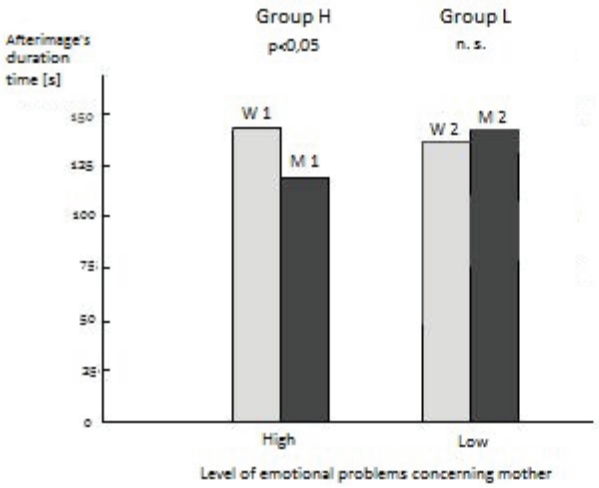

Figure 1. Average duration of afterimages of figures of a woman and a man in groups of subjects with high (H) and low (L) level of emotional problems concerning their mothers. W 1 – average duration of afterimages of figures of a woman and a man in the group of subjects with a high level of emotional problems with their mothers; M 1 – average duration of afterimages of figures of a woman and a man in the group of subjects with a high level of emotional problems with their mothers; W 2 – average duration of afterimages of figures of a woman and a man in the group of subjects with a low level of emotional problems with their mothers; M 2 – average duration of afterimages of figures of a woman and a man in the group of subjects with a low level of emotional problems with their mothers

The obtained results show a significant difference between the duration of woman and man figures' afterimages in the group of subjects with a high level of emotional problems concerning their mothers. In the group of subjects with a low level of this kind of emotional problems, differences between durations of woman and man figures' afterimages are not significant. Thus, the essential factor that does differentiate subjects regarding the emotional problems are the differences in duration times of woman and man figures' afterimages and not the absolute duration time of woman and man figures' afterimages.

DISCUSSION AND CONCLUSIONS

Afterimage as a medium of meaning

The obtained results regarding hypothesis 1 suggest that the duration of an afterimage is connected with the meaning of the stimulus. A high level of emotional problems elongates the duration of woman figure's afterimage in relation to the duration of the man figure's afterimage which is consistent with elongated reaction time for controversial (conflict) stimuli in the Implicit Associations Test by Norbert Maliszewski (2011) that is described in literature as well as with delayed answers to words in the psychoanalytic association list. The direction of the conflict influence of emotions on the cognitive processes, which is the elongation of reaction time in case of emotional problems, seems to reveal a general regularity that occurs in the field of cognition and emotions.

The confirmation of hypothesis 1 and hypothesis 2 indicates a strong impact of emotions and their influence on the duration of an afterimage, where the difference of durations of woman and man figures' afterimages took place only in the group of subjects with a high level of emotional problems with their mothers, but it does not occur in the group with a low level of emotional problems with their mothers. This allows us to notice that in the conducted research – without taking emotion into account – it would be extremely difficult to demonstrate that the duration of a woman and man figures' afterimages alone (that is the sign) is the carrier of the meaning. It seems that a dual-aspect definition of meaning assumed here (see: *Introduction*, *Research problem*), describing it as a cognitive-emotional entity, is correct. This understanding of meaning corresponds with psychoanalytical *cathexis*, which means an "investment" of emotions in specific contents which become valuable for the subject as a result of this process. In case of the experiment described above, *cathexis* means an investment or filling a figure of a man or a figure of a woman with emotion.

Both in the McCollough effect and in this experiment the meaning of the object or symbol possesses not only a dual-aspect (contentual-emotional) character but is based on a double opposition. In the case of the McCollough effect, the

meaning is designated by the opposition of complementary colors (red – green) and the opposition of lines (vertical and horizontal), whereas in the experiment presented here – by the opposition of the afterimage's contrast (bright – dark) and the opposition of contents (figure of woman – figure of man). If we take into account the achievements of linguistics where the value of phoneme is designated by the relation of opposition, the concurrence of those findings and those which were observed in the experiment described above will be striking. It seems that as the relation of opposition between phonemes constitutes primary values (Jakobson, 1980), which enable distinguishing their meaning, in a visual system this basic primary value is constituted by a natural opposition existing in the afterimage of complementary colors coupled with specific symbols which is exemplified in the McCollough effect and in the aforementioned experiment. It seems that a natural arrangement of afterimages, i.e. their binary opposition, enables not only the new perspective on the McCollough effect but also forces reconsideration of position towards the role of the afterimage and function in the formation of the meaning of symbols.

The individualization of the duration of an afterimage

The most important disturbance variable in the conducted experiment seems to be the individualized duration of an afterimage. Therefore, in the examined group significant differences between average durations of afterimages of figures of a woman and a man in the group with a low level of emotional problems with the mother did not occur (average for W = 131 sec., average for M = 141 sec.) (hypothesis 2), despite the fact that differences are observed between individuals. (There are neither significant differences in the duration of afterimages of figures of a woman and a man when it comes to the gender of subjects nor between a high and a low level of emotional problems with one's mother and the durations afterimages of figures of a woman and a man. The differences appear only when the durations of afterimages of figures of a woman and a man are combined with a high level of emotional problems with one's mother.). The duration of the aftereffect phenomenon is individualized and changes in different individuals to such an extent that probably only its comparison with duration of this phenomenon for different forms and measured for one and the same person will indicate his/her emotional problems as well as the realm of meanings. High individualization of afterimage's duration and its time span are also not fully shown by standard deviation. In some individuals, afterimages that lasted more than 300 sec. (in other experiments 1,800 sec.) as well as those which lasted for 30 sec. and less were observed.

The obtained results suggest that the uneven relation of duration of afterimages of figures of a woman and a man is significant in individuals who have

emotional problems with their mothers, i.e. that the collection of durations of afterimages can be understood as an ordered collection in regard to the level of importance of woman and man figures for examined subjects. Relations of unevenness of durations of afterimages can be ranked and on this basis the level of importance of affecting stimuli for individual can be defined. The duration of an afterimage could serve as a diagnostic tool, similarly to the psychoanalytic association list or to the test of implicit associations. The relation of unevenness that occurs between afterimages as well as the relation of opposition of binary forms (figures of woman and man) indicate that afterimages have a specific logical structure (unevenness and opposition are logical relations) and it is not excluded that the set theory can be used for their description which would enable a better exploration of the implicit order of unconscious perception processes, i.e. defining strength (strength of meaning, implicit perceptual preferences) of selected types (categories) of afterimages in the cognition process.

Afterimage as an attitude

Can an afterimage as a manifestation of a program controlling perception as it was postulated by von Helmholtz (1985) function as a setting or an attitude as it was put by Bzhalava (1971)? And if the answer is "yes", then what does this mean? The experiment described above shows that emotional problems with one's mother (an attitude towards her) is manifested in an afterimage, therefore, we can agree with Bzhalava (1971). But if we accept this point of view, another question arises, namely whether an afterimage is a manifestation of an explicit or implicit attitude. Taking into account the existing knowledge about the aftereffect, it should be regarded as a manifestation of an implicit attitude since it arises in specific conditions (it is an effect of relatively strong stimulation and only occasionally emerges from the areas of the subconscious) and it is not available in normal everyday perception. It can be interpreted as a manifestation of subliminal activity (unconscious, automatic, *priming*), as well as a manifestation of elaboration of experiences and, at the same time, as taking position towards previous experiences, or as an expression of cognitive intentions or a cognitive attitude.

It seems that, similarly as in the case of attitudes while analyzing the consistency of implicit and explicit attitudes, the consistency between an afterimage and a perceptual image can be analyzed as well. But is it at all possible for an afterimage not to be consistent with a perceived image? What would that mean? If an afterimage complementary to stimulus in regard to contrast and color will be accepted as the consistency between the afterimage (which is an unconscious component of perception) and the perceptual image, therefore, the positive afterimage, i.e. of the same color or contrast as the inductive stimulus and the afterimage of color or contrast that is not complementary (i.e. a pink, not red afterimage obtained as

a result to green stimulus) will be an afterimage that is not consistent with the perceptual image. As it turns out, this kind of afterimages occur, which has been demonstrated by Halina Jankowska (1939, pp. 189–230) who found that positive afterimages take place in children in the preoperative phase. It is worthwhile to take findings of this author as a starting point for further research concerning the relationship between an afterimage and cognitive processes.

Interpretations of the afterimage phenomenon and directions of further research

In the light of obtained results it can be assumed that the duration of an afterimage is an indicator or carrier of the meaning of the stimulus. It cannot be excluded that an afterimage could serve as "perception's language" and constitutes implicit "internal activity" or deep structure. Then, its relation to perceptions would be similar to the relation between "language" (*langue*) and "speech" (*parole*) understood as a surface structure. The description of visual perception in terms of two levels (afterimage and perceptions) is an application of the metaphor of division by de Saussure (1995) who distinguished language and speech. In this understanding, perception would be a dual aspect process which consists of the unconscious dimension (afterimage, implicit attitudes – as language) and the conscious one (perceptions, explicit attitudes – as speech). It is not excluded that an afterimage can also function as a perceptual filter which selects incoming information and manifests itself as a projection. This incorporation of an afterimage into the process of dual aspect perception fits perfectly in von Helmholtz's *outflow theory* according to which an afterimage is a signal that controls visual perception.

Generally speaking, in the approach proposed here, an afterimage can be understood as a mediating variable (medium) between the external and the internal world, that is between external reality and its experience. According to Charles E. Osgood (1971, pp. 5–64), in the creation of meaning this role of mediating variable is performed by imagination in which also afterimages are included by some authors, e.g. by Kosslyn (1996).

Moreover, the obtained results perfectly fit into the concept by Orval H. Mowrer (1960) who considered every conditioning as learning of meanings which are mediating variables between a stimulus and reaction. If we accept that afterimages are the mediating variable and at the same time are carriers of meanings, it is not only consistent with Mowrer's theory, but also Jerry A. Fodor's (1965) arguments against this theory become unjustified. The argument that a mediating variable (which is a meaning understood as a composition of symbol/sign and emotion) cannot be accurately assigned to a given behavior and cannot be specific is no longer valid since it is exactly the opposite, i.e. every stimulus can have corresponding mediating variable, namely learnt meaning (understood as recording

of experience with given a stimulus in the form of an implicit afterimage). Also Fodor's (1965) second argument becomes invalid. It stated that emotions as mediating variables have a limited range and thus cannot serve as a mediator between a stimulus and the reaction to it. As it was said previously, meaning is a composition of symbol/sign and emotion thereby this kind of mediating variable has unlimited repertoire of meanings. Moreover, the binary character underlined here and the opposition of symbols/signs as well as opposition of meanings – thus, the opposition between positive and negative emotions – fits in Mowrer's theory in which it corresponds with faith and fear. In other words, in understanding of an afterimage as a medium of meanings that at the same time is a mediating variable, Mowrer's intention of integrating notions specific to different disciplines – e.g. attitude (sociology), need for security (social work), tension (psychiatry), anxiety (psychoanalysis) – into a more general term, that is into *expectation* (here afterimage) as manifestation of learnt meanings is fulfilled. Value and topicality of Mowrer's concept is proved by the fact that it is present in currently used exposure therapy methods developed by Edna B. Foa, Kelly R. Chrestman, and Eva Gilboa-Schechtman (2009).

Generally speaking, in a broad sense, an afterimage can be understood as an infrastructure or cognition or its "context", whereas in the narrower sense – as an indicator or medium of meanings. Certainly, further research will confirm this thesis, as well as will strengthen von Helmholtz's *outflow theory* in which an afterimage is a manifestation of perceptual program and in which it is indispensable. It is possible that an analysis of this phenomenon will allow the exploration of the "language" that is used by the visual perception system and will allow us to unveil many psychological diagnoses, perceptual defense mechanisms and psychotherapy mysteries. It is also worth verifying whether the McCollough effect will occur when figures of a woman and a man will be used instead of vertical and horizontal lines. If it happens, it will allow us to look with hope towards further exploration of the human's psyche through afterimage phenomena related to contents and meaning of perceived stimulus.

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STRESZCZENIE

W artykule omówiono badania dotyczące relacji, jaka zachodzi między powidokiem wywołanym bodźcem o określonej treści a emocjami. Uzyskane wyniki mają rzucić światło na funkcję zjawiska powidoku w procesie percepcji, jak również pozwolić odpowiedzieć na pytanie, na ile powidok jest nośnikiem (przejawem, odzwierciedleniem) emocjonalnego znaczenia percypowanego bodźca. Zbadano zależność między czasem trwania powidoku sylwetki kobiety w odniesieniu do czasu trwania powidoku sylwetki mężczyzny a poziomem problemów emocjonalnych z matką. W badaniu uczestniczyło 68 studentów obu płci. Wyniki pokazały, że wysoki poziom problemów emocjonalnych z matką wydłuża czas trwania powidoku sylwetki kobiety w relacji do czasu trwania powidoku mężczyzny na poziomie istotnym statystycznie. Uzyskane rezultaty pozwalają wnioskować, że czas trwania powidoku jest związany z problemami emocjonalnymi osoby badanej.

Słowa kluczowe: percepcja; powidok; emocje; znaczenie