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FACTORS INFLUENCING THE ILLUSION OF WARMTH

VA Gheorghiu, E Koch, H Fialkovski, W Pieper and G Molz

Justus-Lieberg University, Giessen, Germany

Abstract

Investigations concerning the influence of suggestion on warmth sensations are one of the favoured topics of suggestibility research. The great uncertainty concerning the perception of objective or faked warmth stimuli turned to be favourable premisses for such experiments. Methods such as the heat illusion test (Scripture, 1893; Seashore, 1895) have been used in various investigations for many years. The main purpose of such research was to investigate relationships between this kind of test and other suggestibility measures, applied dependently or independently from a hypnotic context. However, it has been found repeatedly that the readiness to respond to faked sources of warmth is heavily dependent on situational factors. The question to be examined is whether situational factors should become a matter of research themselves in order to enlarge our knowledge concerning suggestive processes. The present study investigated some of these factors, namely: type of simulated sources of warmth; affected area of skin; and set factors preceding the actual experimental trials. By far the strongest effects were found for the set factors. When the faked stimulation was embedded in procedures enhancing plausibility, the susceptibility to react was significantly greater. It was postulated that the heat illusion procedures may be useful in assessing various conditions influencing suggestibility. The results are discussed in terms of more general psychological perspectives.

Key words: situational factors, suggestibility, warmth sensations

Introduction

The investigation of suggestion effects carried out independently of hypnosis are (despite some new contributions in this field) a kind of 'Cinderella' of psychological research. However, this work has a high theoretical and practical relevance (Gheorghiu, Netter, Eysenck and Rosenthal, 1989; Schmaker, 1991; De Pascalis, Gheorghiu, Sheehan and Kirsch, 2000). From time to time it is mentioned that the influence of this deficiency affects the research of hypnosis and hypnotic suggestibility as well (Kirsch, 1997; Gheorghiu 2000). On the contrary, the so-called 'waking suggestibility' has been a favoured topic since the advent of psychology (Seashore, 1895; Binet, 1900; Stern, 1903; McDougall, 1908). One of the oldest research subjects – which is taken up again here – concerns the influence of warmth sensation.

Heat sensations induced by suggestion are an everyday experience. Sometimes, when it is cold and you are entering a room, you might experience a pleasant feeling of warmth being attributed to the oven in the corner. Nevertheless, as you approach

the oven, you might find out that it is actually cold (Schneider, 1948). Moreover, it is possible that you would actually have the impression that the oven was warm or even hot. It happens also quite often that on touching a cold iron you feel warmth because you assumed it was plugged in. Distortions of heat sensations occur not only in connection with external sources of warmth but also with body sensations. Many people overestimate their body temperature believing they have a fever when the thermometer actually contradicts this impression.

Missing or insufficient frames of reference in an ambiguous or unstructured situation may lead people to resort to hypothesis-driven strategies. It was recognized very early that it is difficult for people to draw adequate conclusions from insufficient, ambiguous or uncertain information. This stimulated research on the impact of different forms of suggestion on human judgements and sensations, including heat sensations.

Seashore (1895) was probably the first to research this topic. As part of a series of investigations on perceptual deceptions he used the so-called 'heat illusion test' (Scripture, 1893). The device applied for this test consisted of a wire that could be heated by leading electric current through it. There were two switches which could be used to turn the current on and off. One of the switches was perfectly visible to subjects but the other one was hidden. The experimental task was to grasp the wire between the thumb and forefinger upon a starting signal and to say 'Hot' as soon as warmth was experienced. Reaction time from the starting signal until response was the dependent variable. In the original experiment, during the first two of five trials the current was actually switched on, so that subjects actually experienced warmth when grasping the wire. After the initial trials the current was turned off by secretly operating the hidden switch. No change would be noticed by subjects because the overt switch was left untouched. In later trials, the wire was actually not heated. However, subjects were still asked to concentrate their attention on what they were doing and to indicate when the wire became warmer.

Subsequently, procedures likes this or similar procedures have been used in many experimental investigations. Some of the questions being explored with these techniques are listed here:

- Is it possible (if so, to what extent) to evoke heat sensations when no objective source of heat is present? What is the degree to which imaginative processes influence these illusions (Seashore, 1895; Scott, 1910; Abraham, 1962; Hammer, Evans and Bartlett, 1963; Evans, 1967)?
- How can the relationship between the heat illusion test and other scales of the so-called 'waking suggestibility' be described? (Aveling and Hargreaves, 1921; Eysenck and Furneaux, 1945; Furneaux, 1964; Gheorghiu and Langen, 1971).
- What kind of relationships exist between the heat illusion test and hypnotic susceptibility? How strong are these relationships (Eysenck and Furneaux, 1945; Hammer et al., 1963; Hilgard, 1965; Woody, Dragovic and Oakman, 1997)?

The results of these investigations are hardly comparable because of variations in experimental conditions:

- *Duration* of trials varies to a large extent – times from some seconds up to a minute have been employed (if information on trial duration is reported at all).
- Similarly, *instructions* given to subjects are hardly comparable across some examples: 'determination of the lower threshold for temperature' (Scott, 1910); 'heat

discrimination and judgement' (Abraham, 1962); 'a study of the effects of relaxation' (Hammer et al., 1963). Also, the instructions are not always reported.

- Furthermore, *differing skin areas* have been used for stimulation – finger, forearm, forehead etc.
- A wide variety of *supporting influencing factors* has been employed, e.g. applying objective heat stimuli before, after or between diagnostic trials.
- Finally, *different devices* have been used as a faked source of warmth, e.g. wire or rod getting warm, an air blower etc.

Furneaux (1964) was one of the first to tackle the topics mentioned above. In particular, he noted that even quite small changes in procedure of the heat illusion test might lead to an appreciable influence on the nature of the responses evoked in such tests. Moreover, it has been shown recently that the relationship between the heat illusion test and hypnotic susceptibility is heavily dependent on context factors. In a study by Woody et al. (1997) the correlation between measures of both variables was reported to be much lower than in some of the previous studies (Eysenck and Furneaux, 1945). In contrast to the study of Eysenck and Furneaux (1945), the subjects in the study by Woody et al. (1997) were completely unaware that hypnosis was relevant to the investigation.

However, a number of studies demonstrated that, in fact, it is possible to evoke sensations of warmth through pretended presentation of an objective stimulus, and that there are inter-individual differences in the reactions to such stimulation. Starting with Seashore (1895), many interesting theoretical and methodological considerations concerning the influence of suggestion on the sensation of warmth have been discussed, most of which have since fallen into oblivion.*

The results of research on suggestion are strongly contingent on situational factors. It is therefore evident that such situational factors should be studied systematically in order to discover their specific influence on the efficiency of suggestions. The heat illusion test seems to be particularly useful in research of this type, since it has been used in many investigations. Thus, it offers the possibility of studying the phenomena of suggestion from a broader perspective with the option of arriving at integrative concepts and explanations. The present study investigated some of the situational determinants of suggestibility, focusing on factors closely related to everyday experience.

Type of simulated source of warmth

By the use of different sources of warmth in the simulation approach, the impact of prior experience on the disposition to react in suggestive situations was tested. On the one hand, for example, there is lifelong experience that electric bulbs and lamps emit warmth which can be felt when approaching them. On the other, hardly anyone has experienced the warmth emitted by the human hand (especially when it was warmed) which also can be felt when the hand gets closer to the skin.

The aim of the present study was to test whether different experiences lead to different efficacy of suggestions, that is, whether a lamp is more efficient as a means of sugges tion than a hand when, in fact, neither of them emits warmth. As elaborated

*Growing interest in the problems of suggestion and suggestibility may bring researchers' attention back to these problems, and also to other questions not mentioned here, such as the direct and explicit influencing of warmth sensations by hetero- or auto-suggestion.

earlier, it was hypothesized that the susceptibility to feel warmth should be greater when using the lamp as source of faked heat radiation than when using the hand.

Area of the skin

We wanted to test whether the area of the skin was an important factor, that is, whether warmth was experienced when 'applied' to different areas of the skin. Four different areas were tested, namely, the finger-tips, palm, wrist and bend of the elbow. The faked stimulation was applied to each of these four areas.

The rationale behind this question was the fact that there seems to be evidence that the susceptibility for warmth is different in those four areas. Typically, with objective stimulation, the distant areas (finger tips) are less sensitive than the proximal ones (bend of the elbow). However, this fact is unknown to most subjects as they have no such personal experiences. We wanted to test if the faked stimulation would produce the same pattern of subjective intensities of sensations than the real one.

'Set' versus 'Non-set' condition

We wanted to investigate if the readiness to react on the faked stimulation is dependent on experimental set conditions. Here, 'set' means a short-term disposition which causes perception or behaviour to be changed in a certain direction (Dorsch, 1992). The main purpose of the present study was to find out to what extent the plausibility of deceit techniques may be improved through ritualized procedures. Hence, optimizing the effects of suggestion was a primary aim. The influence of plausibility and credibility, as well as the role of rituals, are considered relatively little in the research of suggestibility (see Gheorghiu, Koch and Götz, 2000). It was intended to bring about the set condition through a ritual preceding the actual experimental trials and it was hypothesized that in the set condition the suggestion would exert stronger effects than in the non-set condition.

Method

Subjects

Sixty-three female students of various departments of the University of Giessen were approached in a campus café and agreed to participate in the study. Their mean age was 23.9 years, ranging from 19 to 32 years. (Exclusively female subjects participated in the experiment simply because of organizational circumstances.)

Apparatus

In order to simulate emitting of warmth two procedures were used.

The lamp-test

This consisted of a halogen bulb (20 watts) which could be lowered along a metal stick to which it was attached. Below the lamp, and in a fixed position, there were two lenses. In order to keep heat radiation from actually falling through the lenses two infra-red filters were attached to them. The upper lens also served to parallel the light rays. Thus, the circle of light became smaller and smaller, and at the same time more pronounced, when the bulb was lowered. The diameter of the light circle varied from 2.5 cm to 1 cm for the highest and lowest positions of the bulb, respectively. Measurements were taken from the four areas of the hand and forearm mentioned earlier. In order to keep the distance between the skin of the subject and the bulb

constant across subjects and areas of the skin, the device was placed on two wooden bars. The light fell in between two threads running from bar to bar. Subjects placed the respective skin area between the bars, slightly touching the threads. They were instructed to indicate the moment when they first experienced warmth. The bulb was then lowered slowly. On the metal stick, there was a scale ranging from 15 cm down to 0 cm for the highest and lowest positions of the bulb, respectively. The distance between the lowest position of the lamp and subjects' skin was 5 cm. Consequently, the distance of at least 5 cm between lamp and skin always was too big to make any perception of warmth possible under normal conditions.

The hand test

The hand test was much easier. Here, the source of warmth was the hand of the experimenter. Before each trial, the experimenter placed his hand on a heating pad. After that he lowered his hand slowly toward the respective skin area, whilst holding a ruler in the other hand. The movements of the hand started from the same distance of 15 cm and, as in the lamp test, never came closer to the skin than 5 cm – a distance at which, under normal conditions, no perception of warmth should be possible. The instructions were the same as for the lamp test. Subjects gave a signal as soon as they felt warmth, and the distance between the examiner's hand and the subjects' skin was measured.

The maximum duration for both tests was 10 s. This duration, as well as the speed of lowering the bulb or hand, was controlled by use of a stop-watch.

Unlike the classical test by Seashore (1895) which simulated the conducted heat, radiant heat was used in the present study because it was more suitable for the intended comparisons.

Procedure

Subjects were told they would be participating in an experiment concerning 'the thresholds for feeling warmth, and the differential susceptibility of various areas of the skin to warmth'. They were instructed '… to concentrate well on the adequate area skin, because the warmth would be generally very weak'. Subjects were also told that they might feel the warmth very well, hardly or not at all, due to various factors such as air temperature, humidity and the relaxation of the body. They were also assured that there were no 'good' or 'bad' responses and the only important thing was their feeling which they should indicate on a self-rating scale.

The faked stimulation of the four areas of the skin was performed with both tests. The set condition was a between-subjects factor with two levels. Subjects in the set condition had to perform the styrofoam test before the experiment started: their hands were placed on a piece of styrofoam until they started to feel warmth. As styrofoam is a bad conductor of warmth, subjects would certainly experience some warmth after a time. We wanted to convince them that a warmth sensation can be forthcoming and that this rather discreet warmth sensation could only be perceived if subjects were concentrating on the respective skin area. Following this, the areas of the skin were encircled with a ball-pen. This was supposed to focus attention on the selected skin area.

Another experimental manipulation preceded each test: before the lamp test, subjects were asked to move their hands really close to the lamp (in a position above the lens filtering heat radiation – so the heat of the lamp could actually be perceived). In a similar fashion, before the hand-test, the experimenter moved his hand so close to

each subject's cheeks that a 'real' warmth sensation was provoked. The intention of both manipulations was to convince subjects that heat could actually radiate from the respective sources. As in the styrofoam procedures, the aim was to enhance the plausibility of the experimental task. Subjects in the non-set condition did not undergo these extra manipulations.

There were three major independent variables; whereas the set versus non-set conditions were between-subjects factors, the areas and type of source of warmth were within-subjects factors. In addition, two more factors were introduced in order to control for possible confounding effects. First, there might have been differences in the perception of the left and right hands, so experimental data were taken for both sides, with random serial order of areas and sides within each test. Second, the serial order of the tests was varied. Half the subjects took the lamp test, the others took the hand test first. Taken together, there were 16 trials (two × right and left sides × four areas × two versions of the test), thus, we ended up in a five-factorial experimental design with three within-subjects factors (type of source of warmth, area of skin, left and right sides) and two between-subject factors (set versus non-set conditions, hand test versus lamp test first). There were 15 subjects per cell with one exception: because of errors on the assignments of subjects to cells there were three more subjects in one condition.

The main dependent variable was the distance (in cm) from the lamp to the hand or from the hand position when subjects indicated feeling warmth.

Results

Distances

According to the experimental design outlined above, a five-way analysis of variance (ANOVA) was performed on the distances. The factors 'orders of tests' and 'side of the body' proved to be non-significant; there were neither main effects nor interactions involving these factors. So, the data across these two factors were collapsed using the means of left and right sides per area. The ANOVA was then repeated with three factors about which we had hypotheses:

- Set – present versus absent (between-subjects).
- Source of warmth – lamp test versus hand test (within-subjects).
- Area of skin – finger tips, palm, wrist, bend of elbow (within-subjects).

The results are presented in tables 1 and 2. As can be seen in Table 2, there were no main effects for the source of warmth. There was a main effect for the area of skin. Subsequent multiple Student's *t*-tests with Bonferroni-adjusted significance level ($\alpha = 0.05/6$) showed that the tests performed on the wrist (Area 3) and bend of the elbow (Area 4) led to significantly ($t = 4$; $df = 62$; $p<0.01$) greater distances than finger tips (Area 1). The palm did not differ significantly from the other areas.

In addition, there emerged an unpredicted source of warmth by area interaction. Inspection of the means showed that, for the hand test, susceptibility was lowest in the finger-tips (2.2 cm) and highest for the bend of the elbow (3.3 cm), whereas for the lamp test, susceptibility was highest at the wrist (3.1 cm).

By far the strongest effect was found for the set factor. When the tests were embedded in a procedure that enhanced credibility (as in the set condition), the distances

Table 1. Mean (±SD) of distances (cm)

	Hand test Area				Hand total	Lamp test Area				Lamp total	Set total
'Set'	1	2	3	4		1	2	3	4		
Absent	1.3	1.5	1.4	2.1	1.5	1.6	1.6	2.1	1.6	1.7	1.6
	(1.6)	(2.0)	(2.0)	(2.5)	(1.7)	(2.0)	(1.8)	(2.6)	(2.4)	(2.0)	(1.7)
Present	3.0	4.0	4.1	4.3	3.8	3.7	3.9	4.0	3.5	3.8	3.8
	(3.7)	(3.2)	(3.5)	(4.4)	(3.4)	(3.4)	(3.5)	(3.3)	(3.4)	(3.1)	(2.9)
Total	2.2	2.8	2.8	3.3	2.7	2.7	2.8	3.1	2.6	2.8	2.8
	(3.0)	(3.0)	(3.2)	(3.8)	(3.0)	(3.0)	(2.0)	(3.1)	(3.1)	(2.8)	(2.6)

Table 2. Analysis of variance

Effect	*F*	*df*	*p*
Between subjects:			
'Set'	12.74	1	<0.01
Within subjects:			
Source of warmth	0.05	1	0.83
Area	3.30	3	0.02
Interactions:			
'Set' * Source	0.16	1	0.69
'Set' * Area	0.72	3	0.54
Source * Area	3.22	3	0.02
'Set' * Source * Area	0.98	3	0.42

between source of heat and skin area at which subjects indicated feeling warmth were more than 2 cm larger than in the condition where no set was induced.

In order to explore this effect further, an additional analysis was performed. As known from earlier research on sensory suggestibility, the distributions of scores are often positively skewed because of a floor effect. This is caused by the fact that there is always a considerabl e number of non-responders who have zero scores. So, it was reasoned that in the set condition there should be a smaller number of non-responders than in the non-set condition. This proved to be true for each of the 16 measurements per subject. In the non-set condition, the percentage of non-respondents ranged from 40% to 63%, whereas in the set condition this percentage ranged from 18% to 33%. Consequently, there was not even an overlap in range.

Discussion

Lamp test versus hand test

The hypothesis that the lamp test would exert a stronger suggestive influence than the hand test was not confirmed. One possible explanation for this may be the fact that in everyday life a lamp is usually seen as a source of light, and that it also emits

warmth is a relatively unimportant side-effect which rarely comes to people's minds and therefore could not influence subjects' feelings during the experiment.

Apparently of greater importance were factors embedded in the experimental manipulation itself, both in the lamp test and in the hand test. In both cases the experimental influence is very similar. At the beginning the situation was very ambiguous. All subjects (both in the lamp test and in the hand test groups) were told that the warmth would be very weak. Afterwards, the 'sources of warmth' slowly approached the skin. This is the most important factor: subjects learned that it takes time before they could feel (if at all) warmth. The data show that, indeed, subjects reacted mostly at the end of the movement of the 'source'. It is therefore possible that the nearer the 'source' comes to the skin, the stronger is subjects' concentration of attention and expectancy.

It is also possible that such manipulations create a tendency for compliant behaviour. On the other hand, the conformity tendencies should not be overestimated because, as stated above, the number of non-reactors is relatively large.

The lamp test differed from the hand test in one interesting aspect, that is, an additional source of influence was embedded in it. As the lamp approached the skin, the circle of light became smaller and smaller, and more pronounced. There was no such additional influence in the hand test, but our data suggest that this additional factor was ineffective, contrary to the widespread belief that such side factors enhance the tendency to yield to suggestions. Similarly, Meternich (1974) gave up using additional sensory associations in his battery of acoustic and tactile tests as they produced no significant effects in comparison with a control group.

Set versus non-set

The presence of a set produced an evident enhancement of susceptibility to suggestions. This may be due to the experimental induction of certain expectations because the procedure used in the set condition convinced subjects that they could really feel warmth. Moreover, because of the styrofoam test, subjects had the opportunity to learn that it takes time before the warmth is actually perceptible, and that it was very weak.

It is not possible to identify all the factors that contributed to the efficacy of suggestions in the set condition – even the distinct encircling of the areas on the skin on which 'warmth' was to be radiated could be of some importance. However, it seems reasonable to assume that the 'initiation rituals' enhanced the plausibility of the procedure. As a result, the distances at which subjects 'felt' warmth indicated a greater suggestibility. The subjects apparently assumed that there must be a stimulus forthcoming, so there must be a sensation of warmth. It is also worth mentioning that in the set condition the number of non-reactors was considerably smaller that in the non-set condition.

The enhanced efficacy of the suggestions in the set condition is the most important result of the present study. The set rituals preceding the actual experimental trial are trivial, however, in the context of the suggestive manipulation they enhance hypothesis-guided processes in warmth perception. What matters are not facts, but phenomena that appear to subjects to be facts.

Carefully interpreted, the results support further research approaches. Three of them should be delineated now.

Heat illusion

The heat illusion procedures can be used – beyond their traditional application as suggestibility tests – as a tool to verify top–down processes. Among others, the following aspects should be kept in mind:

- It remains to be investigated whether such top–down phenomena would remain effective when, instead of a faked stimulation, a real warmth would be applied. Investigations into suggestion (and also into placebo phenomena) were usually carried out in an 'either–or' paradigm: faked versus authentic stimulation; placebo versus verum; and so on. It is suggested that this must not necessarily be the case: it is also possible to construct 'either-or-both' designs. For example, it is possible that suggestive influence can cause subjects to perceive objective stimulation faster (and perhaps even more clearly) in comparison with the situation in which such suggestive influence is absent. One of the main advantages of the heat illusion test as a method for investigating factors determining the efficacy of influence lies in the fact that warmth sensations are inherently ambiguous, indistinct and vague. Judgement based on perception of warmth is a rather difficult task even when investigated in connection with objective stimuli of warmth (Engel, 1976).
- Further, the relation between top–down and bottom–up processes should be examined. It is not possible to predict under which circumstances and how intensely differences between objective, stimulated or imagined stimuli of warmth are perceived. The difficulty of generating such judgements was demonstrated by Gheorghiu and Sandler (1973) who applied the method of 'inverse labelling': at the beginning, the efficacy of a 'warmth generator' was shown to subjects. Afterwards, subjects were told to imagine that the wire they were holding in their hands became warmer and warmer, and they could see that the power feeder was detached from the socket. The majority of subjects attributed the warmth they felt to their imagination, similar to the 'Perky effect' (Perky, 1910).
- Finally, the role of 'leading ideas' (in the sense of Binet, 1900) or the 'response expectancy' (in the sense of Kirsch, 1990) in top–down processes should be investigated. In the experimental situation a kind of 'logic of the matter' seems to arise, triggering hypothesis-guided judgements which have self-confirming functions. It may be assumed that the similar effects of the hand test and lamp test described above can be understood in this context. Although two different kinds of 'warmth stimuli' were employed, in both test situations the same 'leading idea' (continuous approaching of the warmth sources to the respective skin area) might have been pursued by subjects. A causal relation is suggested, which conducts the suggestible subjects to believe that they have sensed warmth.

Suggestion effects

Another field of research concentrates on optimizing suggestion effects. In this context, it makes sense to consider the influence of *plausibility* and *rituals* in more detail. In traditional research on suggestibility – based, like the hypnotic procedures, on the influence of direct suggestion – the plausibility of the experimental situations played only a minor role. With the introduction of indirect techniques – producing an 'as–if' situation – plausibility of manipulations grew increasingly important. In the process of deception, as Irle (1979) points out, we are always interested in minimizing situational veridicality and in maximizing subjective certainty. The objective of an experiment of deception is therefore to maximize the certainty of the subject. On the other hand, the literature on hypnosis especially emphasizes the high importance of *rituals* in order to evoke the intended suggestion effect (for an overview see Revenstorf and Peter, 2000).

The practical relevance of this research field results from considerations on the therapeutical application of the placebo effect. Not only has the efficiency of the

verum to be improved but also of its substitute – the placebo. This includes the application of suggestive rituals, too.

Psychometric test of suggestibility

Finally, our results affect the heat illusion techniques as a psychometric test of suggestibility. Recently, we focused on this topic and developed a consistent scale for the measuring of suggestion on warmth perception, based on three categories of suggestion:

- Initiation – of non-existing warmth stimuli.
- Intensification – of stable *real* warmth stimuli.
- Generalization – of sensation of a real warmth stimulus to a sensation of a faked one.

First results show relationships to relaxation procedures in the sense of Schultz (1932). Further, we intend to verify whether there are also relationships between this scale of warmth suggestibility and different hypnotic suggestibility scales.

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Address correspondence to:
VA Gheorghui,
Justus-Lieberg University,
Fachbereich Psychologie,
Otto-Behaghel-Str. 10,
35394 Giessen,
Germany.

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