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Suboptimal familiar faces exposure and electrodermal reactions

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The hypothesis that the suboptimal mere exposure to familiar faces should generate greater electrodermal reactions than the same exposure to unknown faces, is formulated in this study. Such differences, in number, time, and amplitude, should be smaller when stimulus exposure is optimal. The results of two experiments, in which 60 students participated, allowed to confirm this hypothesis. Indeed, in Experiment 1, electrodermal reactions were more numerous, longer, and of greater amplitude when subjects were exposed in a suboptimal manner (50 msec) to familiar faces than to unknown faces. Those effects were also observed with optimal exposure (400 msec), but they were smaller. Experiment 2 showed that although the stimulus recognition level was 82.83% with optimal exposure, this level was only 51.74% when subjects were placed in the suboptimal exposure condition. Taken together these data lead to conclude that implicit recognition is not entirely determined by explicit recognition.

Key-words: Electrodermal Reaction (EDR), Suboptimal exposure, implicit recognition.

En este estudio se plantea la hipótesis de que la simple exposición sub-óptima a caras conocidas producirá mayor reacción electrodérmica que la misma exposición a caras desconocidas. Tales diferencias en número, tiempo y amplitud, deben ser menores cuando la exposición al estímulo es óptima. Los resultados de dos experimentos, en los que participaron 60 estudiantes, permiten confirmar esta hipótesis. En efecto, en el Experimento 1 las reacciones electrodérmicas fueron más numerosas, de mayor amplitud y duración cuando los sujetos fueron expuestos en forma su-óptima (50 mseg) a caras conocidas que a caras desconocidas. Estos efectos se observaron también con exposición óptima (400 mseg), pero fueron menores. El Experimento 2 mostró que aunque el nivel de reconocimiento del estímulo fue de 82.83% con exposición óptima, el nivel fue

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sólo de 51.74% cuando los sujetos fueron situados en la condición de exposición sub-óptima. Estos datos, en conjunto, nos llevan a concluir que el reconocimiento implícito no está del todo determinado por el reconocimiento explícito.

Palabras clave: *Reacción electrodérmica, exposición sub-óptima, reconocimiento implícito.*

In this study we tested the effects of exposure time, suboptimal versus optimal, of familiar (*i.e.*, public) versus unfamiliar (*i.e.*, unknown people) faces on electrodermal reactions. We in fact tested a hypothesis proposed in a previous study (Channouf & Rouibah, 1993; 1995). Adopting the two process model of Mandler (1984) and Tiberghien, Cauzinille, and Mathieu (1979), we proposed that if in optimal exposure the recognition of familiar faces can, in certain cases, initiate memory search, it is on the other hand probable that, in suboptimal exposure, recognition is made on the basis of familiarity only. This assumption allowed to reinterpret what Zajonc (1968, 1980) called the «preference judgement» or *Preferanda*. In his work's context, the notion of preference judgement constitutes the measure (the dependent variable) of what he called «affective» processing of familiar stimuli. Contrary to this idea, we proposed that the preference judgement was, in fact, an implicit recognition of familiar stimuli presented suboptimally. It should be noted that this very reinterpretation was previously formulated by Mandler (1984).

Preference Judgement or Implicit Recognition?

According to Mandler, Nakamura, and Van Zandt (1987), the effects of exposure to unrecognized stimuli are not specific and also not limited to preference judgement only. Besides the preference judgement used by Kunst-Wilson and Zajonc (1980), other types of judgements can be produced by repeated exposure and notably by suboptimal exposure, for example, surface judgement. These authors reproduced the classic effects of suboptimal exposure but also showed that subjects could provide other judgements than preference: darkness or brightness judgements of meaningless geometric figures. These results allowed the authors to support the idea that preference judgements, as well as the other judgements which have served as dependent variables, are mediated by a feeling of familiarity. However, we can wonder to what degree the preference judgement is in fact implicit recognition simply because of the lack of explicit recognition. Since Nisbett and Wilson work (1977), it is demonstrated that a part of a subject's information processing is neither verbalizable nor accessible to consciousness. Unconscious inferential mechanisms can lead to decisions or judgements.

When subjects are asked about their preference judgements, they will talk about simple familiarity, which is produced by the experimental exposure to the stimuli. There is therefore no conscious memory search in this case. On the other hand, when a subject is confronted with a recognition question, memory search is initiated and the response depends either on exposure time or on the available attention capacity during the initial encoding of the stimulus. This memory search may be successful or unsuccessful. When a response is based on simple familiarity, subjects may «have a preference» for a stimulus without any conscious recognition because they cannot recall the encoding context. When a response is based on memory search (because of the explicit recognition question), subjects can recognize previously presented stimuli because the context is available and can be used as a basis for their decision. It seems that a relevant method to induce a feeling of familiarity is to present familiar stimuli suboptimally. We make the assumption that this feeling of familiarity will be expressed by electrodermal reactions (EDR). We consider those EDR as a measure of the implicit recognition of a familiar object based solely on familiarity. Indeed, the brief exposure time would not allow subjects to initiate a search in memory of the encoding context which could lead to the stimulus explicit recognition. Thereby, the principal hypothesis of this study is that electrodermal reactions should be weaker when the exposure time is optimal than when it is suboptimal; because the optimal exposure time, contrary to the suboptimal one, allows an explicit recognition of the stimulus.

Lazarus and McCleary (1951) showed that when words, associated with electric shock, are presented, the presentation time necessary for the activation of an EDR by these words is less than the time necessary for their recognition. Those data seem to show that the mechanisms underlying the autonomic system are faster than those tied to what is said to be «higher-level processing», which for our purposes is conscious recognition. Furthermore, Leventhal and Scherer (1987) suggested that the quantity of information that it is necessary to match with a mental representation to produce an affective state is less than that necessary for recognition. This can be theoretically explained by phylogenetic reasons. Masling, Bornstein, Poynton, Reed, and Katkin (1991) conducted an experiment in which they showed that electrodermal reactions following stimulus sentences were weaker in the condition where subjects had the time (4 msec with presentation by Tachistoscope) to identify (recognize) the stimulus than where they did not have enough time to recognize it (2 msec).

Work in neuropsychology provides evidence in the same direction. Research reported by Bauer (1984) and other authors (DeHaan, Young, & Newcombe, 1987; Tranel & Damasio, 1985) concerned psychophysiological responses of prosopagnosic patients during facial perception identification tasks. In these studies, it appears that prosopagnosic have a stronger psychophysiologic activation for non-identified familiar faces than for unknown faces. This result allows to suppose that these patients still have knowledge about facial identification but can not explain it verbally. According to Bauer and Verfaellie (1988), electrodermal discrimination of facial identification depends on the prior existence of facial representations in memory. These authors suppose therefore that electrodermal reactions constitute an indicator of implicit recognition. According to Kihlstrom, Barnhardt, and Tataryn (1993), electrodermal reactions of prosopagnosic patient are the proof of an implicit perception.

Research in neuropsychology has also supported the existence of implicit recognition which is not particular to prosopagnosic patients. The same phenomenon can be observed among normal subjects when exposure to faces is suboptimal. We expect therefore that electrodermal reactions will be greater for familiar faces than for unfamiliar faces and that this effect will be stronger when the exposure time of the faces is suboptimal. To test this hypothesis, we conducted two experiments: the first one dealt with the effects of faces (known *versus* unknown) and exposure time on electrodermal reactions. The second dealt with the explicit recognition of faces in suboptimal and optimal conditions. Its purpose was to verify that an exposure time of 50 msec genuinely results in suboptimal perception.

EXPERIMENT 1

Method

Subjects. Subjects for this experiment were 40 third-year university students in Psychology at the Université de Grenoble (France). They were 20 to 24 years old and had normal vision.

Materials. We assembled a series of 16 known faces (politicians, singers, actors, television news reporters, and sports figures), half male and half female. For a second series, we gathered 16 other faces, unknown to subjects. For each of the unknown faces, there existed a corresponding known face similar on the variables sex and age (see Appendix 1 for an example). There were therefore a total of 32 test faces.

The set of 32 faces (scanned) were combined so that no more than three faces of the same nature (known or unknown) were presented successively. A second randomisation was conducted to attenuate order effects. Thus, there were two orders of presentation of the 32 faces. Each subject was exposed only to one of the two orders of presentation during the experiment.

Procedure. We asked each subject to focus on the centre of a Macintosh computer screen placed 40 cm away. The subject sat in a comfortable chair with the torso positioned at 50 degrees, legs outstretched, and feet resting on a 20 cm high foot rest. The experiment took place in a sound proof room. We took these precautions so that the subject's muscles would not be tense. Subjects were told that their electrodermal reactions were being recorded, and therefore, they should not speak or move any part of their body during the entire experiment.

Two Silver-Silver Chloride electrodes were placed on two different fingers of the subject's right hand (dried from any perspiration). Each electrode had a diameter of 1 cm so that the skin area in contact with an electrode was 0,785 cm^2. It should be noted that no conductance gel was added. The electrodes were connected to a biofeedback system (Temp/SC 201T) which amplified skin conductance responses by 10. This amplification did not affect the output, only the display. The biofeedback system was connected to an interface which was itself connected to a 386SX PC computer that recorded data in numeric and graphic form via the Procomp 5DX software. The 386SX PC computer had a processor speed of 16 MHz which was the minimum necessary to run data with the software used. The recording tape chosen to record the signal was one cycle per second which matched the frequency band characterising the EDR bioelectrical phenomenon.

Before the beginning of the experiment, the word «Attention» appeared at the centre of the Macintosh screen to indicate that the experiment was about to begin. When the subject was ready, the experimenter initiated the start of the experiment by pressing the Macintosh computer mouse. A central focal point appeared for 200 msec, after a delay of 500 msec, a face was presented for 50 msec for 20 of the subjects, and for 400 msec for the remaining 20 subjects. Presentation of a face was immediately followed by the appearance of a figured mask for 50 msec, which was identical for every trial and for both sets of faces. With the Macintosh computer used here the time needed for one screen scan is 7,5 msec, so all the stimuli presentation times were proportional to this number and all were constraint by it. That is when we say that a stimulus is presented for x msec, it is presented for (x ± 7) msec.

After each presentation of a trial (focal point / blank / face / mask) the experimenter waited for the skin conductance to be back at the basis level (cutaneous resting potential) before he initiated a new trial. Subjects watched the screen all along the experiment and their skin conductance was recorded during this time. In this first experiment subjects had nothing else to do than watching the screen, they then received visual inputs only (known or unknown faces). These faces were always presented at the centre of the screen, they were black and white pictures all having the same dimensions. It should be noted that the experimenter could not see the stimuli (faces) on the Macintosh screen so as to avoid a possible induction of a reaction.

Results and Discussion

The dependent variables considered in this experiment were the mean number, duration, and amplitude of the electrodermal reactions associated with the faces (known *vs.* unknown) in accordance with the nature of exposure (suboptimal *vs.* optimal). An analysis of variance (ANOVA) was conducted for each variable.

ANOVA 1: Mean Duration of EDR

A significant effect of the nature of the face was observed, both by subjects ($F(1, 38) = 37.579$; $p < .01$) and by items ($F(1,30) = 53.361$; $p < .01$). As can be seen in Table 1, the mean duration of the EDR was greater when the faces were

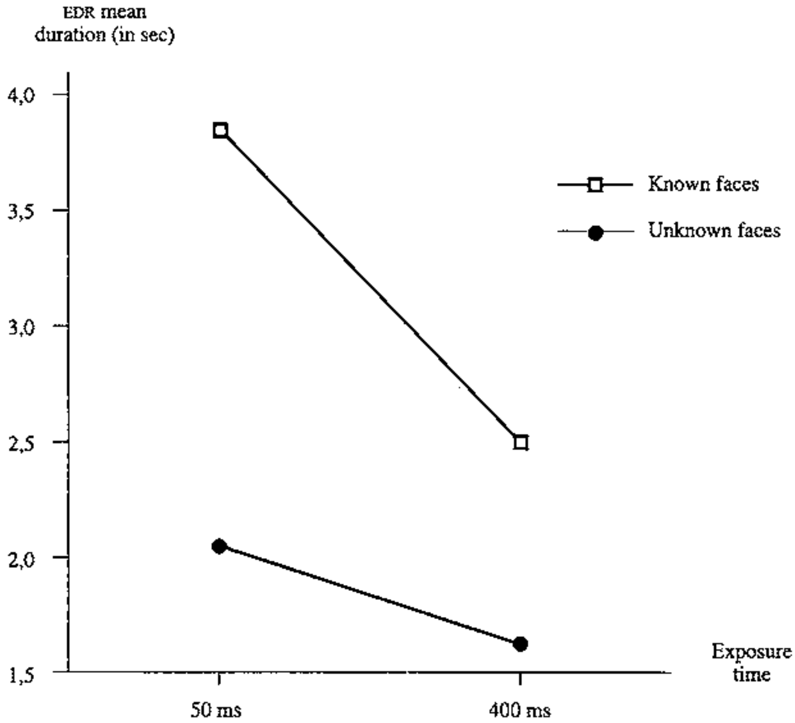

Figure 1. Mean duration of EDR (in seconds) by exposure time (50 *Vs* 400 msec) and type of stimulus face (known *Vs* unknown).

known (3.22 seconds) than when they were unknown (1.82 seconds). This effect remained significant at the .01 level after applying the Newman-Keuls correction. This result is an initial confirmation of our hypothesis that known stimuli would lead to greater electrodermal reactions than unknown items.

No significant effect of exposure time was observed. The interaction between the nature of the faces and the exposure time was significant both by subjects ($F(1,38) = 4.335$; $p < .05$) and by items ($F(1,30) = 5.414$; $p < .05$). As for the known faces, the duration of the EDR was greater for the exposure time of 50 msec (3.88 seconds) than for 400 msec (2.55 seconds). For the unknown faces, this difference was not significant (see Figure 1). The interaction observed here confirms our hypothesis that familiar stimuli presented suboptimally produce greater electrodermal reactions than stimuli presented optimally. It appears that, for unknown stimuli, the quality of exposure (optimal or suboptimal) does not influence the duration of electrodermal reactions.

ANOVA 2: Average amplitude of EDR

Because an EDR's amplitude can oscillate from 2% to 40% of the initial level, we considered that a variation of at least 2% could be accepted as a reaction. However, to calculate the average amplitude of EDRs all responses were taking into account. It should be noted that after any EDR response, it is very slow for the amplitude to fall down to the initial level. This amount of time necessary to go back and stay constant to the initial level is variable, that is why the experimenter could control the interstimuli interval. In this experiment the interstimuli interval was about 10 to 30 seconds.

As for the EDRs' mean duration, we observed, for the EDRs' average amplitude, a significant effect of the nature of the face both by subjects ($F(1, 38) = 34.752$; $p < .01$) and by items ($F(1, 30) = 24.010$; $p < .01$). The average amplitude of the EDR was therefore greater when the faces were known (.17 μV) than when they were unknown (.10 μV) This effect remained significant at the .01 level after the application of the Newman-Keuls correction. The effect of the nature of the faces on the amplitude of the EDR again confirms the importance of familiarity for physiological reactions.

We did not obtain any significant effect of the exposure time. The interaction between the nature of the faces and the length of exposure time was also not significant.

ANOVA 3: Average number of EDR

This analysis of variance revealed a significant effect for the nature of the faces both for subjects ($F(1,38) = 36.715$; $p < .01$) and for items ($F(1,30) = 21.062$; $p < .01$). The number of EDR was greater when the faces were known (6.8/16, or 42.5%) than when they were unknown (4.8/16, or 30%). This effect was also significant at the .01 level with the Newman-Keuls correction. We note here that the number of EDR is weak, below 50%, which means that the subjects don't have EDRs systematically.

Similarly to the amplitude of the EDR, no significant effects of exposure time was observed. Further, the interaction between the nature of the faces and the length of presentation time was not significant.

TABLE 1. MEAN DURATIONS, AMPLITUDES AND PERCENTAGES OF EDR BY EXPOSURE TIME AND TYPE OF STIMULUS FACE

		EDR mean durations	*EDR mean amplitudes*	*EDRs percentages*
50 msec	Known faces	3.88 sec	.189 μV	43.4%
	Unknown faces	2.01 sec	.105 μV	27.2%
400 msec	Known faces	2.55 sec	.156 μV	42.5%
	Unknown faces	1.63 sec	.100 μV	33.7%

Correlations

Besides these three ANOVAs, we calculated the correlations between the three dependent variables, separately for the known and the unknown faces, in order to determine if the three variables represented the same measure. For the known faces, the correlation between average duration and average amplitude of EDR was .843; between average duration and the number of EDR, it was .905; and for the average amplitude and the number of EDR, it was .835. For the unknown faces, the correlation between average duration and average amplitude of EDR was .828; between average duration and the number of EDR, it was .861; and for the average amplitude and the number of EDR, it was .755. All these correlations are significant at $p < .01$. The correlations among the three dependent variables are high, which allows us to suppose that they are measures of one index, the electrodermal reaction of the subjects confronted with the presentation of an unknown or known stimulus (face).

Referring to the table of means, we note that although the percentage of EDR and their amplitude does not differ depending on the nature of exposure (optimal *vs.* suboptimal), the mean duration, on the other hand, is greater when exposure is suboptimal than when it is optimal irrespective of the nature of the face. All the same, this difference was much smaller than what we predicted initially. It is probable that the familiarity of the stimuli (probably related to their frequency of exposure) incites the information processing system to mobilise a very rapid attention which, even if it does not result in explicit recognition, results all the same in what we call an implicit recognition, in this case, electrodermal reactions. As we specified above, work in neuropsychology shows that when subjects have lost the capability of recognizing faces explicitly, they react all the same to these very faces that they are incapable of recognizing explicitly. Our results show that this phenomenon is not limited to prosopagnosics, but it operates as well in non prosopagnosics subjects.

Nonetheless, these results are only valid if we can demonstrate that contrary to a stimulus exposure of 400 msec, a 50 msec exposure really constitutes suboptimal exposure, that is to say, a level of recognition that would not differ from chance. We therefore conducted a second experiment in which we asked the subjects to provide an explicit recognition judgement for the faces presented in optimal and suboptimal conditions.

EXPERIMENT 2

The object of the second experiment was to verify that in Experiment 1 the 400 msec exposure time genuinely allowed for an optimal presentation of the stimulus, and that the exposure time of 50 msec was genuinely a suboptimal exposure time for the faces. This second experiment was therefore identical to the first with regard to the stimuli, the procedure, and the independent variables. The dependent variable, however, was an explicit recognition of the faces that we asked the subjects to produce following stimulus exposure.

Method

Subjects. Twenty first, second, and third-year students at the Université de Provence with normal vision participated in the experiment. They were between 18 and 25 years old.

Materials. The same 32 known and unknown faces used in Experiment 1 were the stimuli for this experiment. The presentation orders were also identical to those in the first experiment.

Procedure. The subject sat 40 cm in front of the computer screen, focusing on its centre. As in Experiment 1, the word «attention» appeared in the centre of the screen and the experimenter initiated the start of the experiment when the subject appeared ready. A central focal point was presented for 200 msec, then after 500 msec a face was presented for 50 msec for 10 of the subjects or for 400 msec for the other 10 subjects. The presentation of the stimulus was immediately followed by a figural mask, as described in Experiment 1.

The subjects watched the screen; they received no other instructions. After the presentation of the stimuli and after a 120 second rest period, the subjects were asked to recognize the 32 exposed faces (16 known and 16 unknown) among other faces (known and unknown but not presented among the stimuli). The subjects were to select the faces they had seen (or those they think they saw in the suboptimal condition) among the set of faces presented to them.

Results and Discussion

To analyze the results, we considered the percent of correct recognition for the known and unknown faces out of the total number of faces presented to the subjects. We compared the percentage of correct recognition in the optimal and suboptimal conditions. We also compared the recognition in these two experimental conditions to chance (50%). We therefore conducted pairwise comparisons of the means. The results indicated a significant overall effect ($F\ (1, 27) = 71.11, p < .001$). The percentage of correct recognition in the optimal and suboptimal conditions was 82.82 and 51.74, respectively. The difference between the levels of correct recognition in optimal and suboptimal conditions is significant ($F\ (1, 27) = 100.71, p < .001$). The difference was also significant between correct recognition in the optimal conditions relative to chance ($F\ (1, 27) = 112.3, p < .001$). The difference between the suboptimal exposure condition and chance was not significant; $F\ (1, 27) = .32, p < .58$. These results indicate that contrary to subjects in the optimal condition, subjects assigned to the suboptimal condition are incapable of recognizing the presented faces. The results of this second experiment allow us to be confident of the validity of the paradigm of suboptimal exposure.

General discussion

This research allows us to state that in the absence of explicit recognition (suboptimal exposure), the subject is nevertheless able to identify stimuli implicitly with the help of physiological discrimination (EDR). Although this phenomenon has mostly been studied among prosopagnosic subjects in neuro-psychology, it is of interest with normal subjects. In fact, it is not certain that this discrimination is only present when explicit recognition is lacking. It is likely that it accompanies every reaction to a familiar object.

Verbal and conscious discrimination can not be considered as the only indicator of what is called information processing. In fact, several kind of informations are processed apart from the consciousness field; the familiarity is one of these informations. Theoretical controversies about familiarity effects are still topical because researchers do not explain those effects in one way. Indeed, two theoretical positions, defended respectively by Zajonc and by Lazarus, are in conflict. According to Zajonc, even thought emotional and cognitive behaviours are phenomenally tightly associated, they depend from separated and partially independent systems. Familiarity would be an important sign of a stimulus emotional value which could be estimated without cognitive processing beforehand or, at least, which does only require a very quick and minimal cognitive processing to be evaluated. According to Lazarus, on the opposite, emotional and cognitive behaviours can not be independent because an emotional experience is necessarily preceded by a cognitive evaluation. Lazarus and his colleagues take as a principle that cognitive evaluation (appraisal) determines the emotion nature. In this cognitive evaluation, environment exchanges which are «useful to the organism» or «dangerous for the organism» can be considered as particularly important features.

However, some researchers think that this discussion is fruitless because of the ambiguity of the «cognition» concept. Indeed, on one hand, this concept can be used in a very strict meaning, which then refers to conscious, verbal and controlled processes (Zajonc, 1980) or, on the other hand, it can be used in a very large meaning which then refers to the all set of processes involving any form of information processing. This point of view was recently supported by neuro-anatomical results. Some researchers even attested that it is impossible to make a distinction between the cerebral structures responsible for emotional behaviours and the ones responsible for cognitive behaviours.

Johnson-Laird considered emotional and cognitive behaviours as some adjusting systems which are phylogenetically developed. Those systems are based on a plurality of components which work together : cognitive and emotional systems have to process environment informations, to select significant stimuli, to give appropriate responses to these stimuli and to memorize the pattern stimulus/response/response's result. In his model, Johnson-Laird's (1994) assumed that to cope with a partially unpredictable environment and to select some action plans amongst several, the organism would have two systems at its disposal:

a) the emotional system, considered as a relief system which aims to swiftly stop the actual action in order to select rapidly an other operational action;

b) the cognitive system, considered as an adaptation system, more complex and developed and able to elaborate variable and flexible plans in order to harmonize all the environment changes; the cognitive system needs time and attention (consciousness) to do its job.

Models such as the one developed by Johnson-Laird (1994) are called «double processes models» because they account for the two systems, emotional and cognitive. It is generally assumed by the double processes theory that a limited set of informations can be processed rapidly, automatically and then without consciousness by the emotional system. On the opposite, an unlimited set of informations can be processed in a controlled and conscious way by the cognitive system. This system is able to elaborate operational strategies by taking into account both environmental changes and memorized informations. It should be noted that even researchers, such as Mandler (1980), who defend a cognitive theory, acknowledge that the processes necessary to evaluate a dangerous or pleasant situation could be, at least in some cases, global, automatic, fast and unconscious.

In the light of this discussion, it is possible to account for the obtained results at two different levels. On one hand, electrodermal reactions, observed when a familiar face was presented, could be explained in terms of implicit recognition of familiar stimulus. On the other hand, this explanation can be questioned. More particularly, the exact nature of the invoked implicit process should be defined. However, even thought our results support the double processes model, they do not allow any irrevocable conclusion about the nature of the involved processes. The issue of the nature of the processes involved in familiarity effects (with any familiar stimuli: faces, objects, pictures etc.) is still a much theoretically debated problem. Nevertheless, there is an agreement about the strength of the observed effects with both normal and brain damaged subjects.

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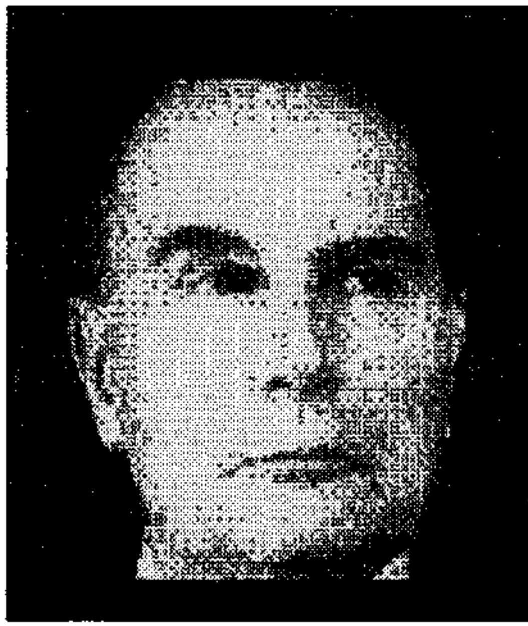
APPENDIX 1. AN EXEMPLE OF USED STIMULI

A known face: François Mitterrand.



The corresponding unknown face.