Journal of Consciousness Studies, **5**, No. 1, 1998, pp. 5–18

PSYCHOLOGICAL INVESTIGATIONS OF UNCONSCIOUS PERCEPTION

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Abstract: This paper reviews the history of psychological investigations of unconscious perception and summarizes the current status of experimental research in this area of investigation. The research findings described in the paper illustrate how it is possible to distinguish experimentally between conscious and unconscious perception. The most successful experimental strategy has been to show that a stimulus can have qualitatively different consequences on cognitive and affective reactions depending on whether it was consciously or unconsciously perceived. In addition, recent studies of patients undergoing general anaesthesia have shown that the effects of stimuli perceived unconsciously during surgery can last for approximately 24 hours. Taken together, the results of these recent psychological investigations provide empirical support for the importance of unconsciously perceived information in determining cognitive and affective reactions.

Investigations of unconscious perception have a long history in psychology. In fact, some of the very earliest studies conducted in psychology laboratories in North American involved demonstrations of unconscious perceptual influences. However, despite this interest in unconscious perception since the late 1800s, it has only been within the past fifteen to twenty years that our understanding of unconscious perceptual processes has advanced considerably.

A major reason it took so long to make significant progress is that initially an unanswerable question was asked. The question that most research studies addressed was 'Are stimuli unconsciously perceived?' In other words, the primary goal of these studies was to prove the existence of unconscious perceptual processes. Two different experimental approaches were followed in these attempts to prove the existence of unconscious perceptual processes. One approach was based on introspective measures of awareness and the other approach was based on behavioural measures of awareness. Neither approach was successful, and in the first part of this paper, both approaches are reviewed to illustrate why they were unsuccessful.

Once it was realized that it is impossible to either prove or disprove the existence of unconscious perceptual processes, another more interesting and more productive question was asked. This question assumes that the conceptual distinction between conscious and unconscious perception is meaningful and asks 'Are the consequences of unconscious perception qualitatively different from the consequences of conscious perception?' In the second part of this paper, we describe some of the qualitative differences between unconscious and conscious perceptual processes that have been established. These differences involve both cognitive and affective reactions to stimuli. Taken together, the results of these studies provide rather compelling evidence for the importance of unconscious perceptual processes. In fact, by establishing

[*] Name and address for correspondence. This research was supported by grants from the Natural Sciences and Engineering Research Council of Canada to P.M. Merikle and M. Daneman.

how unconscious and conscious perceptual processes differ, it has been possible to obtain stronger evidence for the existence of unconscious perceptual processes than it was possible to obtain via direct attempts to demonstrate that stimuli are unconsciously perceived.

The final issue we consider in this paper concerns the duration of the influence of unconsciously perceived stimuli. To date, much of the psychological research on unconscious perception has only considered relatively short temporal intervals lasting no more than a few seconds. Obviously, if unconscious perception has an important influence on cognitive and affective reactions, then the effects of unconsciously perceived stimuli must last for considerably longer than a few seconds. Evidence to suggest that unconsciously perceived stimuli can have effects over longer temporal intervals comes from research examining whether patients have memory for events that occurred while they were under general anaesthesia. In general, the results of this research show that unconsciously perceived stimuli can have effects over periods of time measured in hours and days.

Does Unconscious Perception Exist?

Many psychological studies of unconscious perception have attempted to prove the existence of unconscious perceptual processes by demonstrating that stimuli are perceived when subjects are not consciously aware of the stimuli. The basic strategy followed in these studies is to establish conditions under which conscious perception does not occur and then to demonstrate that stimuli can nevertheless be perceived under these conditions. The success of these studies depends completely on the acceptability of the method used to establish the absence of conscious perception. In the earliest studies, inferences concerning the absence of awareness were based on subjects' introspective reports. In general, if the subjects' statements indicated an absence of relevant conscious perceptual experiences, it was assumed that the subjects were in fact unaware of the stimuli. In more recent studies, the absence of relevant conscious experiences has been defined in terms of behavioural measures that indicate an inability to discriminate between alternative stimuli. Studies based on both types of measures have not led to completely convincing results because it is always possible to question whether the measure of conscious perception was successful in guaranteeing a complete absence of ALL relevant conscious experiences.

Introspective measures of awareness

Studies of unconscious perceptual processes based on introspective measures of awareness date from the very beginning of experimental psychology in North America (see Adams, 1957, for a review of many early studies). As an example of this general approach, consider an experiment conducted in the Psychological Laboratory at Harvard by Boris Sidis and reported in his 1898 monograph, *The Psychology of Suggestion: A Research into the Subconscious Nature of Man and Society*. Sidis showed subjects cards containing a single printed digit or letter. 'The subject was placed at such a distance from the card that the character was far out of his range of vision. He saw but a dim, blurred spot or dot' (p. 170). In fact, 'the subjects often complained that they could not see anything at all; that even the black, blurred, dim spot often disappeared from their field of vision' (p. 171). However, when Sidis asked

his subjects to name the characters on the cards, their responses were correct more often than would be expected on the basis of simple guessing, even though many subjects expressed the belief 'that they might as well shut their eyes and guess' (p. 171). Sidis concluded that his experiments indicated 'the presence within us of a secondary subwaking self that perceives things which the primary waking self is unable to get at' (p. 171).

Other investigators reported findings very similar to the findings reported by Sidis (e.g. Peirce & Jastrow, 1884; Stroh *et al.*, 1908). In fact, the basic results are so robust that Adams (1957) has suggested its use as a classroom demonstration. Thus, these early experimental results provide clear evidence that subjects can make accurate perceptual discriminations even when they believe, as indicated by their introspective reports, that their conscious perceptual experiences are inadequate to guide their choices. If one accepts the assumption that it is possible to measure and therefore define conscious perceptual experience solely on the basis of introspective reports, then the results of these studies provide strong evidence for unconscious perception.

However, the assumption that introspective reports give an accurate indication of a subject's conscious perceptual experiences has proved to be problematic. Many researchers feel very uncomfortable measuring conscious awareness solely in terms of introspective reports. A major reason for caution is that it is difficult to know what criteria individuals may use when reporting their conscious experiences (Merikle, 1984). Statements indicating an absence of relevant conscious experiences may simply reflect an individual's preconceived ideas concerning the value of particular types of perceptual experiences for making decisions. For example, it is clear from the subjects' statements in the Sidis experiments that, occasionally, they saw both the card and 'dim, blurred spots or dots'. Thus, introspective reports may only reflect an individual's own theory of how perceptual experiences guide behaviour rather than a true absence of conscious perceptual experience. Given these interpretive issues, results from studies based solely on introspective reports have never been considered to provide conclusive evidence for the existence of unconscious perception.

Behavioural measures of awareness

In the 1970s and 1980s, the attention of many psychologists was captured by the results of a number of studies that used behavioural measures of awareness (e.g. Balota, 1983; Eich, 1984; Fowler *et al.*, 1981; Marcel, 1974; 1983; McCauley *et al.*, 1980). The results of these studies suggested that stimuli were perceived under conditions that did not allow discriminations between alternative stimuli. These studies were based on the intuitively appealing assumption that an inability to discriminate between stimuli indicates a complete absence of conscious perception. Given the plausibility of this assumption, the results seemed to provide convincing evidence for the existence of unconscious perceptual processes. In fact, the results were so compelling that there was a considerable resurgence of interest in the study of unconscious perceptual processes following the publication of these studies.

An excellent example of a study using a behavioural measure of awareness was reported by Kunst-Wilson and Zajonc in 1980. These investigators were interested in demonstrating that unconsciously perceived stimuli influence subsequent affective reactions. They designed an experiment to show that preferences for particular

stimuli can be based on unconsciously perceived events. In their study, subjects were initially shown 10 meaningless, irregular, geometric shapes. Each shape was presented five times for 1-msec each time, and no subject ever reported seeing any of the shapes. Following these initial presentations, perception of the shapes was evaluated by both a forced-choice recognition task (i.e. the measure of awareness) and a forced-choice preference task (i.e. the measure of unconscious perception). For both tasks, the subjects were shown 10 pairs of shapes, with each pair consisting of one 'old' shape that had been presented during the initial phase of the experiment and one 'new' shape that had not been presented previously. For the recognition task, the subjects were instructed to select the member of each pair that had been presented previously, whereas for the preference task, the subjects were simply told to choose the shape that they preferred. The interesting result was that the subjects performed no better than chance (i.e. 50% correct) when they were asked to select the shape in each pair that had been presented previously, but they performed significantly better than chance (i.e. 60% correct) when they were asked to select the shape in each pair that they preferred. In other words, when the subjects were asked to discriminate 'old' from 'new' shapes, their performance suggested that they had never perceived the shapes. However, when the subjects were simply asked to select the shape they preferred, their performance revealed that the previous brief exposures influenced their affective reactions. If one accepts the assumption that forced-choice recognition provides an adequate measure of conscious perceptual experience, then these results provide strong support for the existence of unconscious perception.

In general, the results of studies that have used behavioural measures of awareness provide stronger evidence for the existence of unconscious perception than do the results of studies based on introspective measures of awareness. However, it is still possible to question whether the findings from these studies provide compelling evidence for unconscious perception. For example, given that Kunst-Wilson and Zajonc (1980) did not assess awareness until some time after the initial exposure to the shapes, it is always possible to argue that the subjects experienced a fleeting awareness of the shapes at the time they were presented. It is also possible that whenever stimuli are shown for a very brief duration, subjects do not believe that they have perceived sufficient information to discriminate between stimuli. If so, then subjects may be very unmotivated to perform any behavioural task requiring forced-choice discriminations between stimuli. More generally, it is always possible to question whether any particular behavioural measure is an exhaustive measure of ALL relevant conscious experiences (Reingold & Merikle, 1988; 1990), because there may be important aspects of conscious experiences that are just not captured by any single behavioural measure. For all of these reasons, studies based on behavioural measures of awareness have not provided completely convincing evidence for the existence of unconscious perception. Thus, it has been possible for sceptics (e.g. Holender, 1986) to continue to argue that unconscious perceptual processes do not play an important role in determining cognitive and affective reactions. The one generally agreed upon conclusion from the studies using behavioural measures, as well as from the studies using introspective measures, is that attempting to prove the existence of unconscious perceptual processes has not been a particularly successful research strategy.

How Do Unconscious and Conscious Perception Differ?

Because of the preoccupation with trying to prove the existence of unconscious perceptual processes, the real potential value of the conceptual distinction between conscious and unconscious processes has sometimes been forgotten. Surely, the distinction between conscious and unconscious perceptual processes is much more significant and interesting if conscious and unconscious processes lead to qualitatively different consequences than if unconscious perception is simply a weak form of conscious perception (cf. Dixon, 1971; Merikle, 1992; Shevrin & Dickman, 1980). In fact, it has even been argued that the distinction between conscious and unconscious processes is of questionable value if conscious and unconscious processes do not have qualitatively different consequences (e.g. Reingold & Merikle, 1990). For this reason, one of the most important questions that can be asked regarding unconscious perceptual processes is how does unconscious perception differ from conscious perception?

We suggest that a productive research strategy for investigating differences between conscious and unconscious processes is to use introspective reports to distinguish conscious from unconscious perception, and to determine whether consciously perceived stimuli lead to qualitatively different consequences than do unconsciously perceived stimuli. In the following sections we describe five studies that demonstrate qualitative differences for consciously and unconsciously perceived stimuli. Although each study has used a somewhat different set of procedures to differentiate between conscious and unconscious perception, the one common outcome of all of these procedures is that subjects' introspective reports indicate that they were aware of the stimuli in one set of conditions and they were unaware of the stimuli in another set of conditions. Each study provides a demonstration of a different characteristic that distinguishes conscious from unconscious perception. Together, the results of these studies provide rather compelling evidence for the importance of unconscious perceptual processes in influencing our reactions to stimuli.

Affective reactions

As discussed earlier, Kunst-Wilson and Zajonc (1980) attempted to demonstrate that unconsciously perceived stimuli can influence affective reactions. Recently, Murphy and Zajonc (1993) obtained more convincing evidence for the importance of unconscious perception in determining affective reactions by showing that affective reactions are more likely to be influenced by unconsciously perceived stimuli than by consciously perceived stimuli.

In the experiments conducted by Murphy and Zajonc (1993), subjects were shown a clearly-visible, Chinese ideograph on each of a series of trials. The subjects were asked to indicate on a five-point scale whether they thought each ideograph represented a 'good' or a 'bad' concept. The critical aspect of the experiment concerned what happened immediately before each ideograph was presented. For one group of subjects, the presentation of each ideograph was preceded by a picture of a human face that expressed either happiness (e.g. a smile) or anger (e.g. a scowl). For this group of subjects, each face was presented for such a brief duration (i.e. 4 msec) that no subject reported awareness of the faces. For the second group of subjects, the same

ideographs and faces were presented, but the duration of each face (i.e. 1000 msec) was sufficiently long so that all subjects reported awareness of the faces. The subjects in this second group were told to ignore the faces and to concentrate solely on rating the ideographs.

The important result found by Murphy and Zajonc is that only the briefly-presented, unconsciously perceived faces influenced the subjects' ratings of the ideographs. When the subjects were unaware of the faces, they were more likely to rate an ideograph as representing a 'good' concept if it was preceded by a smiling face and they were more likely to rate an ideograph as representing a 'bad' concept if it was preceded by a scowling face. In contrast, when the faces were clearly visible and therefore consciously perceived, the faces had little or no influence on the subjects' ratings of the ideographs. Thus, the subjects were able to ignore consciously perceived faces and not let these faces influence their ratings of the ideographs. However, when the subjects were unaware of the faces, the emotion expressed by the faces coloured their judgments of the ideographs. These results demonstrate an important qualitative difference between conscious and unconscious perception in that our affective reactions to stimuli may be influenced to a much greater extent by unconsciously perceived information than by consciously perceived information.

Predominant codes

An interesting qualitative difference first demonstrated by Groeger (1984; 1988) is that unconsciously perceived words are coded differently than are consciously perceived words. In an experiment using visual stimuli, Groeger (1984) presented a single target word on each experimental trial and required subjects to select the target word from a matrix of 24 words that was presented immediately following the target word. The critical aspect of the experiment was that the matrix never contained the actual target word presented on the trial. Rather, the matrix included some words that were semantically similar to the target word and some words that were structurally (i.e. visually) similar to the target word. For example, if the target word was *town*, then a semantically similar foil was *city* and a structurally similar foil was *time*. The results of this experiment showed that in a situation in which the target words were presented for such a brief duration that the subjects did not report any awareness of the target words, the subjects tended to select the semantically similar foils. However, in a situation in which the target words were presented for a duration that was sufficiently long for the subjects to report awareness of the target words, the subjects tended to select the visually similar foils. Groeger (1988) found parallel results when he presented the words auditorially rather than visually; semantically related foils were selected when words were perceived without awareness, and phonologically similar foils were selected when words were perceived with awareness. Taken together, the results of these experiments suggest that the way a stimulus is coded varies depending on whether it is unconsciously or consciously perceived. When a stimulus is unconsciously perceived, meaning or semantics is the predominant code. However, when a stimulus is consciously perceived, structural or surface characteristics become more important. Thus, different aspects of a perceived stimulus may determine action depending on whether the stimulus is consciously or unconsciously perceived.

Following instructions

A common belief regarding consciousness is that conscious perception enables one to use the perceived information to act on the world and to produce effects on the world (cf. Searle, 1992). In contrast, unconsciously perceived information leads to more automatic reactions that cannot be controlled by the perceiver. This distinction between the active and passive consequences of perception has been captured in a number of experiments demonstrating that consciously perceived stimuli allow subjects to follow instructions, whereas unconsciously perceived stimuli lead to much more automatic reactions (e.g. Debner & Jacoby, 1994; Merikle & Joordens, 1997; Merikle *et al.*, 1995).

As an example of this type of an experiment, consider a recent study (Merikle & Joordens, 1997) that involved the visual perception of words presented so that they were either consciously or unconsciously perceived. In this experiment, a single word was presented on each trial, and the perceived quality of the words was controlled by varying exposure duration. The duration was either relatively short (e.g. 50 msec), so that most words were unconsciously perceived, or somewhat longer (e.g. 150 msec), so that the words were consciously perceived on the majority of trials. The critical aspect of the experiment concerned the memory test that the subjects were required to perform immediately following the presentation of each word. The subjects were shown the first three letters of the word that had just been presented and they were told to complete this word stem with any word that came to mind EXCEPT the word that had just been presented. For example, if the word presented on a trial was *dough*, then immediately following the presentation of *dough*, the letters *dou* were presented and the subjects were instructed to use any word other than the word that had just been presented to complete the word stem. In other words, the subjects could complete the word stem with *doubt* or *double* but not *dough*.

For present purposes, the most important result found in this experiment was that the subjects had difficulty following the instructions when the words that preceded the word stems were presented for the short, 50-msec duration so that they were unconsciously perceived. Despite the explicit instructions not to use these words to complete the word stems, these words were nevertheless used at times by the majority of subjects to complete the word stems. This failure to exclude unconsciously perceived words was not due to some perverse desire on the part of the subjects not to cooperate because when the words were presented for the slightly longer, 150-msec duration, they successfully excluded the words that were presented immediately before the word stems. These results are completely consistent with the idea that unconsciously perceived information leads to automatic reactions that cannot be controlled by a perceiver. In contrast, when information is consciously perceived, awareness of the perceived information allows individuals to use this information to guide their actions so that they are able to follow instructions.

Predictive strategies

Another example of how unconscious perception leads to automatic reactions and conscious perception allows individuals to modify their reactions comes from a series of experiments showing that prediction based on stimulus redundancy only occurs when the predictive stimuli are consciously perceived (e.g. Cheesman & Merikle,

1986; Merikle & Cheesman, 1987; Merikle *et al.*, 1995). These experiments were all based on a variant of the Stroop (1935) colour-word interference task. On each experimental trial, the subjects were first shown either the word *RED* or the word *GREEN* and these words were presented so that they were either consciously or unconsciously perceived. The subjects were then shown a patch of colour that was either red or green. The task for the subjects was simply to name each colour patch as fast as possible. The standard result found with this task is that it takes *more* time to name a colour patch (e.g. green) when it follows an incongruent colour word (e.g. *RED*) than when it follows a congruent colour word (e.g. *GREEN*). Presumably, this occurs because subjects are unable to avoid reading the word even though they are not required to read it, and reading a colour word that represents a conflicting colour concept (e.g. *RED*) interferes with naming the colour patch (e.g. green). This standard interference effect in colour naming was found independent of whether the preceding words were consciously or unconsciously perceived. However, when the experimental conditions were changed so that incongruent word/colour-patch pairings (i.e. *GREEN*/red or *RED*/green) occurred much more often than did congruent word/colour-patch pairings (i.e. *GREEN*/green or *RED*/red), the results depended on whether the words were consciously or unconsciously perceived. When the words were consciously perceived, it actually took *less* time to name a colour patch when it followed an incongruent colour word (e.g. *GREEN*/red) than when it followed a congruent colour word (e.g. *GREEN*/green). What seems to have happened is that the subjects capitalized on the predictive information provided by the words; they learned to expect that the colour patch on each trial would be the colour NOT named by the preceding word. Such a predictive strategy would facilitate performance on the incongruent trials and slow performance on the congruent trials, leading to a reversal of the standard result. In contrast, when the words were unconsciously perceived, the standard result showing faster responses on congruent trials than on incongruent trials was found independent of the predictive relation between the words and colour patches. In other words, the subjects did not make use of the predictive information provided by the words to change their expectations. These results provide another demonstration of how unconsciously perceived information leads to automatic reactions, whereas consciously perceived information leads to much more flexible reactions. As such, the findings provide additional documentation of this important qualitative difference that distinguishes conscious from unconscious perception.

Influence of context

Our perception of the world is greatly influenced by the context in which we perceive objects and events. Marcel (1980) hypothesized that the influence of context on perception is limited to information that is consciously perceived. To investigate this issue, he conducted an experiment involving the perception of individual words. In his experiment, Marcel presented sequences of three words: the first word in each sequence was a clearly visible context word (e.g. hand or tree), the second word was always a polysemous word with two possible meanings (e.g. *palm*), and the third word was a clearly visible target word related to one of the possible meanings of the polysemous word (e.g. wrist). The purpose of the context words was to bias interpre-

tation of the polysemous words, which were presented under conditions so that they were either consciously or unconsciously perceived. Marcel hypothesized that the context words would only bias interpretation of the polysemous words when they were consciously perceived. In other words, Marcel hypothesized that selective, context-driven perception requires conscious awareness and that in the absence of conscious awareness, the multiple meanings of a stimulus are automatically activated.

To determine whether the polysemous words activated one or both meanings, time to respond to the target words was compared in two conditions. In one condition, the context word and target word were related to the same meaning of the polysemous word (e.g. hand, *palm*, wrist), whereas in the second condition, the context word and target word were related to different meanings of the polysemous word (e.g. tree, *palm*, wrist). It is known that time to respond to a target word is facilitated when the immediately preceding word is semantically related (Meyer & Schvaneveldt, 1976). Therefore, if the context biases interpretation of the polysemous word, then time to respond to the target word should be faster if the context word (e.g. hand) and the target word (e.g. wrist) are related to the same meaning of the polysemous word than if the context word (e.g. tree) and the target word (e.g. wrist) are related to the different meanings of the polysemous word. On the other hand, if multiple meanings of the polysemous word are activated regardless of the preceding context, then time to respond to the target word (e.g. wrist) should be facilitated independent of whether the meaning of the preceding context word is related (e.g. hand) or unrelated (e.g. tree) to the meaning of the target word. The results of the experiment supported Marcel's hypothesis that the context words should only bias interpretation of the polysemous words when they were clearly visible and hence consciously perceived. When the polysemous word was consciously perceived, time to respond to the target word was faster if it was preceded by a meaning-related context word; when the polysemous word was not consciously perceived, time to respond to the target word was facilitated if it was preceded by a polysemous word with a related meaning, independent of the bias introduced by the context word. The results of this very elegant experiment are consistent with the idea that conscious perception of a stimulus is constrained by context but that unconscious perception of the same stimulus leads to automatic reactions that are relatively unconstrained by context.

What is the Duration of the Influence of Unconsciously Perceived Stimuli?

In the vast majority of studies investigating unconscious perception, memory for the unconsciously perceived information has been measured within a few seconds after the information was presented. This aspect of the research designs seriously limits the generality of the results. Given these research designs, it is not possible to know whether unconsciously perceived information leads to relatively long lasting effects or whether unconsciously perceived information has a rather short-lived impact. Obviously, demonstrations of unconscious perception would have considerably greater generality and importance if the impact of unconsciously perceived information can be demonstrated to extend considerably beyond the two or three seconds that typically separates the initial presentation of the information from the subsequent test of memory. Although traditional laboratory studies of unconscious perception have not looked at temporal durations greater than a few seconds, there are two sources of

evidence that suggest that the influence of unconsciously perceived stimuli can endure for many hours. One source of evidence comes from research reported by Poetzl (1917/1960), and the second source of evidence comes from studies investigating memory for events during anaesthesia.

The Poetzl phenomenon

Poetzl (1917/1960) studied the impact of unconscious perception on the manifest content of dreams. In his study, subjects were shown a complex picture of a natural scene for a brief, 100-ms exposure duration. Immediately following the presentation of the picture, Poetzl measured the subjects' conscious recollection of what they had seen by asking them to describe and to draw everything they remembered about the picture. Poetzl then asked the subjects to record any dreams they had that night and to return the following day. When the subjects returned the next day and described their dreams, Poetzl discovered that the dream imagery contained aspects of the original picture that the subjects had failed to report the previous day when he had asked them to indicate everything they remembered regarding the picture.

For present purposes, the important implication of Poetzl's findings is that unconsciously perceived information can remain in memory for many hours. Although there have been failures to replicate Poetzl's results (e.g. Johnson & Eriksen, 1961), Poetzl's critical finding that unconsciously perceived information can appear in the manifest content of subsequent dreams has been replicated a number of times by a number of different investigators (e.g. Fisher, 1954; 1956; Shevrin & Luborsky, 1958). In addition, the conclusion that unconsciously perceived information remains in memory longer than a few seconds is supported by the results of a series of studies conducted by Erdelyi (Haber & Erdelyi, 1967; Erdelyi, 1970). In these studies, Erdelyi showed that recall of the details of tachistoscopically presented pictures improved when subjects engaged in a period of free association between their first and second recall attempts. Taken together, the weight of the evidence from these studies inspired by Poetzl suggests that unconsciously perceived information can have an impact that lasts considerably beyond two or three seconds.

Memory for events during anaesthesia

Recently, we have found evidence from a completely different source that also indicates that unconsciously perceived information can remain in memory for a considerable period of time. This new evidence comes from a meta-analysis we conducted of all studies investigating memory for events during general anaesthesia (Merikle & Daneman, 1996). The altered state induced by general anaesthesia provides an interesting area in which to explore unconscious cognition. One of the primary goals of general anaesthesia is to ensure that surgical patients are completely unaware of all events that occur during surgery. It appears that this goal is satisfied in the vast majority of cases involving general anaesthesia because when patients are asked following surgery to report anything they remember that happened during surgery, by and large, just about every patient claims not to remember anything.

However, for more than 30 years, there have been experiments showing that surgical patients perceive and remember specific events occurring during general anaesthesia. The method used in a number of these experiments has involved placing

earphones on patients undergoing general anaesthesia and then playing a tape containing a number of repetitions of a series of single words during surgery. When patients are explicitly asked following surgery whether they can remember hearing any specific words during anaesthesia, the unanimous answer in most such studies is 'no'. However, when memory is assessed by more indirect methods, there appears to be some memory for events during anaesthesia. For example, if following surgery, patients are presented word stems such as '*g u i* – – ' or '*p r o* – – ' and asked to complete these stems to produce a common English word, there is a small probability that they will produce the words *guide* and *proud* because there are numerous possible completions (e.g. guilt, guild, guile; prove, prowl, probe). In contrast, if the words *guide* and *proud* had been presented on tape during anaesthesia, then the patients are more likely to complete the stems '*g u i* – – ' and '*p r o* – – ' with letters that reproduce *guide* and *prove*, than with letters that produce other possible words.

Even though a number of experiments have provided evidence to suggest that patients remember specific information presented during anaesthesia, there are other experiments that have failed to find evidence that patients perceive and remember information presented during anaesthesia. It is for this reason that we decided to conduct a meta-analysis of all studies investigating memory for specific information presented during anaesthesia. Meta-analytic techniques provide a good method for combining and quantifying the results of individual studies so that it is possible to see general trends across studies. Thus, our goal in conducting the meta-analysis was to establish whether there is any evidence across all relevant studies to support the view that specific information presented during general anaesthesia is perceived and remembered following surgery.

The results of the meta-analysis were straightforward. There is considerable evidence of memory for specific information presented during anaesthesia, as long as the memory test is administered within 24 hours following surgery. Not surprisingly, the meta-analysis revealed that the strongest evidence of memory for events during anaesthesia has been found in those studies that administered the memory tests at the shortest time following surgery. Usually, this has meant that the memory tests were administered in the recovery room as soon as the patients regained consciousness. In contrast, when the memory tests were delayed two or more days following surgery, there is little evidence of memory for any specific information presented during anaesthesia. Given the very reasonable assumption that patients undergoing general anaesthesia are unconscious of events in the external environment, then the results of this meta-analysis provide additional support for the conclusion that unconsciously perceived information can have a relatively long-lasting impact.

Is there memory for unconsciously perceived events beyond 24 hours?

At this point, a reasonable question to raise is whether there is any evidence that unconsciously perceived information can have an impact for even longer than 24 hours. Studies of the Poetzl phenomenon have only shown an impact of unconsciously perceived information on dreams that occur the night immediately following the presentation of the target picture. Also, the results of the meta-analysis of the studies investigating memory for events during anaesthesia revealed that there is basically no evidence of memory when the memory tests are delayed more than 24

hours following surgery. Do these results indicate that memory for unconsciously perceived events only lasts for 24 hours?

We think that there is reason to believe that the impact of unconsciously perceived information may extend considerably beyond 24 hours. One limitation of all studies reported to date is that the stimulus materials have not had personal relevance for the subjects or patients. The typical stimulus materials used in studies of memory for events during anaesthesia have been single words, and in most studies of the Poetzl phenomenon, the stimuli have been pictures of natural visual scenes. Memories for these types of stimuli are subject to considerable decay and interference, and it is not surprising that the influence of any memories formed following unconscious perception of these stimuli may only last for a few hours. If more personally relevant materials had been used in these studies, it is possible that the impact of unconsciously perceived information may have extended over temporal intervals measured in days and weeks.

There is one report in the literature to suggest that unconsciously perceived, personally relevant information may have a relatively long-lasting impact. In one of the first published papers claiming that patients perceive and remember events that occurred during anaesthesia, Levinson (1965) described how he staged a mock crisis while surgical patients were under the influence of general anaesthesia. During surgery, he recited the following statement to 10 anaesthetized patients: 'Just a moment! I don't like the patient's colour. Much too blue. Her lips are very blue. I'm going to give a little more oxygen' (p. 544). Following this statement the surgery was completed, and all ten patients experienced normal recovery. Levinson's critical observations were made one month following the surgery when he hypnotized the patients to see if they could remember anything that may have occurred while they were anaesthetized. Surprisingly, four of the ten patients were able to provide an almost verbatim account of the statement made during the mock crisis, and another four had some memory of the message. Even though these findings are not definitive (see Chortkoff *et al.*, 1995), they are striking and invite speculation. They suggest that unconscious perception may have a relatively long lasting impact if the perceived information is personally relevant and meaningful.

Concluding Comments

The research findings described in this paper illustrate how it is possible to distinguish conscious from unconscious perception. In the early experimental studies, the goal was to prove that unconscious perception existed. This goal was never realized because the findings obtained in these studies were always open to alternative interpretations. However, beginning in the 1970s and 1980s, a different research strategy was adopted. This new strategy was based on the idea that conscious and unconscious perception can lead to qualitatively different consequences. To date, a number of qualitative differences between conscious and unconscious perception have been established. Not only do these qualitative differences show how conscious and unconscious perception differ, but they also provide stronger evidence for the existence of unconscious perception than was ever obtained in experiments designed to demonstrate unconscious perception directly. We expect that future studies will

document additional qualitative differences that distinguish conscious from unconscious perception.

Now that unconscious perception has been shown to have a firm empirical basis, future experimental studies can concentrate on exploring other characteristics of unconscious perception. An important avenue to explore is the duration of the effects of unconscious perception. To date, it has been established that the impact of unconsciously perceived information lasts for at least 24 hours, and there is some evidence to suggest that the effects of unconscious perception may last considerably longer if the unconsciously perceived information has personal relevance. The challenge for future research studies will be to find ways to study the importance of the personal relevance of information in determining the impact and the duration of the effect of unconscious perception while staying within the bounds of what are considered to be ethical research designs. Another important future direction will be to establish whether individuals differ in their sensitivity to the effects of unconsciously perceived information. If it turns out that there are stable individual differences, then it should be possible to establish the characteristics that distinguish individuals who are particularly sensitive to unconscious influences from individuals who are not particularly sensitive to unconscious influences. Given that we now have the tools to distinguish between the effects of conscious and unconscious perception, it should be possible to begin to tease apart the factors that determine how different individuals react and respond to unconsciously perceived information.

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Paper received August 1996