Attention and Automaticity in the Processing of Self-Relevant Information

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A neglected aspect of the study of social cognition has been the way in which people *select* information for further processing from the vast amount available in social environments. A major contemporary model of attention holds that there are two separate types of processes that operate concurrently: a flexible but resource-limited *control process* that regulates the contents of conscious awareness, and a relatively inflexible *automatic process* that can attract attention to stimuli without conscious intent. Passive automatic processes can either facilitate or inhibit active attentional processing, necessitating either less or more attentional effort, depending on the characteristics of the information that is currently present. On a dichotic listening task in which subjects attended to or ignored self-relevant stimuli, it was found that self-relevant information required less attentional resources when presented to the attended channel, but more when presented to the rejected channel, relative to neutral words. This differential capacity allocation occurred despite subjects' lack of awareness of the contents of the rejected channel. The results supported the existence and interaction of the two processes of attention in social information processing.

Many of the principles of cognitive psychology have been successfully applied to the study of social perception. Until recently, however, most of this research has been concerned with the organization of already acquired social information in memory and its consequences for retrieval and judgmental processes (Fiske & Linville, 1980; Hastie, 1981). As a result, relatively little is known about the role of mental organizations of social information in the *selection* of information for possible encoding and storage from the vast array available at any one time. Such knowledge is essential for the generation of falsifiable predictions of the influence of social constructs or categories in complex social environments (Allport, 1979; Fiske & Linville, 1980; Taylor & Crocker, 1981; Wyer, 1980). Toward this end, the present research is an attempt to apply a widely accepted contemporary model of attention allocation to the domain of social psychological phenomena.

Given the overall limit on one's information processing resources at any given time, one is able to attend to only a small fraction of the overwhelming amount of potential information present in the environment (Boring, 1933, p. 194; Kahneman, 1973; Miller, 1956; Norman & Bobrow, 1976). Therefore, people must be selective, even miserly, in their allocation of processing resources (Bateson, 1972; Erdelyi, 1974; Mischel, 1979). Attention serves as a "gating process," delimiting the range of potential information. This screening of the stimulus field has been found to be an important determinant of the course of information processing. One general approach to causal rea-

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soning has argued that the object on which attention is focused is likely to be perceived as the causal agent (Jones & Nisbett, 1972; McArthur & Post, 1977; Smith & Miller, 1979; Storms, 1973; Taylor & Fiske, 1975, 1978). Fiske (1980) found that the more time subjects spent looking at a slide depicting a stimulus person's behavior, the more the behavior influenced their final impressions of the person.

Active and Passive Perceptual Expectancies

What types of information are more likely than others to attract attention? Psychologists have long been aware that those stimuli that we are ready to perceive have an advantage over others in gaining our attention (e.g., Bruner, 1957; Higgins & King, 1981; Kahneman, 1973; Wyer & Srull, 1981). This "perceptual readiness" can arise in two ways. People can have an *active set*, or conscious expectancy, for the occurrence of some environmental event (e.g., Broadbent, 1977; Neisser, 1967). This can be due to the context of the current situation, which brings into consciousness objects and events that are typically part of that particular scenario through a process of spreading activation (Collins & Loftus, 1975). It can also be mediated by verbal cues, as when a friend tells you to "watch out for Joe—he's been acting strangely today." Active sets, because they reside in consciousness, are temporary perceptual states.

Second, people possess a variety of long-term, or chronic expectancies that have evolved out of frequent and consistent experience within specific environmental domains (Broadbent, 1977; Logan, 1979; Shiffrin & Dumais, 1981; Shiffrin & Schneider, 1977). Considerable experience in a domain results in associations between its constituent elements forming and strengthening in long-term memory (e.g., Hayes-Roth, 1977; Hebb, 1949). Because chronic expectancies are relatively permanent characteristics of the perceptual system itself (Broadbent, 1977), one's active direction is not necessary for them to influence the interpretation of stimuli. In contrast to active sets, then, these chronic, or passive, processes can occur without the person's intent or awareness (Logan, 1980; Posner & Snyder, 1975).

In an ambitious and rigorous set of experiments, Shiffrin and Schneider (1977; Schneider & Shiffrin, 1977) demonstrated that automatic attention responses could be learned for very frequently encountered stimuli, so that attention is automatically drawn to such stimuli upon their sensation without conscious intent or effort. Subjects searched for the presence of targets (either a consonant or a digit) in series of rapidly presented consonant–digit sets. After thousands of trials, subjects for whom the targets were always digits and the distractors always consonants became able to detect the targets regardless of the size of the target array that had to be held in working memory during the search. Memory load did negatively affect performance of subjects searching for different targets on each trial for whom targets and distractors were both consonants. The investigators concluded that, because automatic processing requires no attention, processing resources can be directed to important stimulation whatever the ongoing conscious activity (Shiffrin & Schneider, 1977, p. 161).

Interaction of Attention and Automaticity

It is widely recognized that the processing of any stimulus event almost always involves a mixture of such automatic and attentional processes, and that the phenomenon of real interest is how the two types interact (Logan, 1980; Neely, 1977; Posner & Snyder, 1975; Shiffrin & Dumais, 1981; Shiffrin & Schneider, 1977). Two studies have recently investigated the effects on processing of an active set that is either compatible or incompatible with passive automatic responses.

Neely (1977) tested Posner and Snyder's (1975) hypothesis that the conscious-attention mechanism inhibits automatically activated memory locations. Using the semantic priming paradigm, he presented subjects with priming words that were of the same category as the target word that followed (e.g., BIRD–sparrow), or that through instructions to the subject primed a different category (e.g., subjects were told that the name of a body part meant to expect the

name of a part of a building). Subjects thus had an active set for a building part when they saw the BODY prime whereas, according to the Posner–Snyder theory, BODY should at the same time passively prime the category of body part names. Consistent with this prediction, Neely (1977) found that BODY facilitated the time needed to decide if body part names were words at short delays between prime and target (approximately 250 msec), but inhibited the response time to body part names at longer delays when the active set had had time to focus on the actively expected BUILDING category. In other words, the influence of the passive activation of BODY category members was overridden by the active set for the BUILDING category, so that the usually facilitative effect of prior associations between the prime and target on response speed (Meyer & Schvaneveldt, 1976) actually became inhibitory.

Logan and Zbrodoff (1979) showed that the usual Stroop effect could be reversed in the same way. The Stroop test requires subjects to report one dimension of a stimulus word (e.g., the color in which it appears). When unreported dimensions (e.g., the word's meaning) are incompatible with the reported dimension, time to respond is increased (see Kahneman, 1973; Logan, 1980). The subjects' task in the Logan and Zbrodoff (1979) study was to report the word that appeared either above or below a fixation point. Subjects became much faster in responding to the word ABOVE when it was below the fixation point, and vice versa, when these conflicting trials were the more frequent in the experiment. Thus, prior chronic expectancies were again muted by conscious temporary expectancies.

Although the interaction of simultaneous active and passive processes in social perception is likely to be the rule in real social judgments, it has yet to be directly investigated (Higgins & King, 1981). Passive processes have been implicated recently as important determinants of the interpretation of social information, however. Both those personality-trait constructs a person has recently used (Higgins, Rholes, & Jones, 1977; Srull & Wyer, 1979, 1980) and those that he or she has used frequently in the past (Higgins, King, & Mavin, 1982) are more likely than others to be used in the interpretation and storage of person information. Given that both active and passive processes operate in social perception, the present concern is their working relationship with each other.

Attentional Versus Automatic Processing of Self-Relevant Stimuli

It is assumed here that people develop automatic attention responses to self-relevant information. A subject's own name, for example, is one of the rare stimuli able to break through the attentional barrier of the dichotic listening task and be consciously noticed (Moray, 1959). Moreover, self-relevant stimuli easily attract one's attention, even when such diversion of attention is detrimental to ongoing conscious activity (Brenner, 1973; Geller & Shaver, 1976; Hull & Levy, 1979; Jarvella & Collas, 1974). For example, in a study using the Stroop paradigm, Geller and Shaver (1976) found that the time taken to name the color of a stimulus word was greater for self-relevant than for neutral words. This greater inhibitory effect of self-relevant words relative to neutral words suggests that self-relevant stimuli receive a greater amount of automatic processing. On the Stroop test, this would require additional attentional resources to be directed to the relevant stimulus dimension of ink color, resulting in longer response times (see Logan, 1980).

The present experiment is analogous in design to that of Geller and Shaver (1976). The relatively greater degree of automatic processing given to self-relevant information was again tested, but the interaction of attentional and automatic processing of self-relevant information was also examined. The focused attention paradigm was employed using the dichotic listening task, in which auditory stimuli are presented to both ears simultaneously through stereo headphones, with subjects instructed to attend to one ear while ignoring stimuli presented to the other ear. When an obvious characteristic distinguishes the information to be attended and that to be ignored in this task, as spatial origin does here, subjects are quite able to

keep the contents of the rejected channel out of consciousness (Cherry, 1953; Kahneman, 1973, p. 114; Shiffrin & Schneider, 1977, p. 180). According to the dominant theoretical positions discussed previously, however, the contents of the unattended channel will still be processed to some extent, but will be inhibited from attaining consciousness (Kahneman, 1973; Posner & Snyder, 1975; Shiffrin & Schneider, 1977; see also Shallice, 1972, 1978). Moreover, the stronger the chronic expectancy for an item presented to the unattended channel, the more attention must be allocated to the target channel to prevent that item from disrupting focused attention (Egeth, 1967; Kahneman, 1973, p. 119; Logan, 1980). The greatest threat to disruption of focused attention, requiring the greatest amount of attentional resources to overcome, would be if stimuli for which automatic attention responses had been learned were presented to the rejected channel (Shiffrin & Schneider, 1977, p. 186). But unless the automatic attention response is sufficiently strong, even these stimuli can be inhibited by the active set (Shiffrin & Schneider, 1977, p. 156).

Overview

In the dichotic listening task, subjects were exposed to simultaneously-presented word pairs: a noun in one channel and an adjective in the other. They were instructed to repeat out loud, or "shadow," each of the words in a specified channel as soon as they heard it while ignoring completely the contents of the other channel. To ensure that the ignored channel did not receive any conscious attention, several measures of subjects' awareness of that channel were taken. One section of the adjective channel contained words related to the trait of independence, which was central to the self-description of half of the subjects (*schematics*) and not self-descriptive for the other half (*aschematics*). For half of each of these groups of subjects, the noun channel was to be shadowed and the adjective channel ignored; the remaining subjects shadowed the adjective channel and ignored the nouns. In this way, the independence-relevant and independence-irrelevant adjectives were presented to the unattended channel for some subjects and to the attended channel for the others.

The amount of attentional capacity taken by the shadowing task was assessed by the probe reaction time (RT) technique (Brown, 1964; Posner & Boies, 1971), in which the subject is instructed to optimize performance of the primary task and to use only the remaining capacity to react as quickly as possible to the periodically presented probe stimulus. Given the assumption of an overall limit on one's attentional capacity at any given time, the RT to the probe stimulus is inversely related to the amount of attention being given to the primary shadowing task (Kahneman, 1973, p. 185; Logan, 1979). The less attention needed by the shadowing task, the more attention available to respond to the probe stimulus. Thus, the greater the latency of response to the probe, the greater the amount of attentional capacity being required at the moment by the shadowing task.

If self-relevant information is processed automatically to a greater extent than other information, perhaps even to the point of eliciting automatic attention responses, it should facilitate the shadowing task when presented to the attended ear, and inhibit performance when presented to the unattended ear, relative to information that is not self-relevant. In other words, the automatic processing of the self-relevant information when it is being shadowed should necessitate less attentional resources for the shadowing task than for stimuli receiving less or no automatic processing, but should require more attentional resources to be allocated to the shadowing task to keep it from consciousness when it is in the rejected channel. Therefore, the major hypothesis is that for subjects for whom independence-related information is self-relevant, probe RTs will be relatively lower when the relevant adjectives are presented to the attended ear but relatively higher when the relevant adjectives are presented to the unattended ear.

Method

Design

As manipulation checks on subjects' degree of awareness of material in the unattended channel, the number of errors made while shadowing the attended channel

were tabulated, and subjects' momentary awareness and recognition memory of the trait adjectives were assessed. In addition, if the probe RT is to be a valid measure of spare attentional capacity, the shadowing task may restrict the amount of attention available for reacting to the probe, but the probe task cannot take away from the processing capacity available for the shadowing task (Kantowitz, 1974; Logan, 1979). Accordingly, a group of subjects engaged in the shadowing task without performing the probe task. If the probe task is a valid measure of capacity remaining from the primary task allocation, there should be no differences between the probe and no-probe conditions on the dependent measures. Finally, the ear to which the attended channel was presented was included as a factor in the design, to test for possible differences between brain hemispheres in the processing of the stimuli.

The factors of schematicity (schematic vs. aschematic), channel (adjective channel attended vs. noun channel attended), hemisphere (adjective channel presented to left vs. right ear), subject gender, and probe (probe RTs taken vs. not taken) were completely crossed, with repeated measures on the blocks factor (the two schema-consistent adjective channel blocks and the two schema-irrelevant blocks). The repeated dependent measures were the number of shadowing errors and probe RTs. Unattended-channel recognition memory performance measures were taken only once, at the conclusion of the shadowing task.

A separate control group of 20 subjects (10 schematics, 10 aschematics) engaged in the momentary awareness test, in which the only dependent measures were awareness of the unattended and attended channel contents (yes/no).

Subjects

Participating in this experiment were 145 undergraduates (68 male) enrolled in the introductory psychology course at the University of Michigan. Their participation in the experiment partially fulfilled a course requirement. All but four subjects stated that they had normal hearing in both ears and that English was their native language; data for the remaining four subjects were excluded from the analyses. Subjects were selected for the experiment based on their responses to a questionnaire administered to most of the students in the course at the beginning of the term. The questionnaire consisted of 25 personality characteristics, each of which students rated on a separate 11-point scale for its degree of self-descriptiveness and importance to their self-concept.

Two groups of subjects were selected on the basis of their responses to the independence-related and dependence-related personality characteristic items, following the procedure of Markus (1977).[1] Independent schematic subjects responded in the high end (from 1 to 4) of both the self-descriptiveness and the importance scales on at least two of the three independence-relevant traits (*independent*, *individualist*, and *leader*), and in the middle-to-low range (5–11) of these scales on at least two of the three dependence-relevant traits (*dependent*, *conformist*, and *follower*). Aschematic subjects responded in the middle (5–7) of the self-descriptiveness scales and the middle-to-low end of the importance scales for at least two of the three independence-related traits and for at least two of the three dependence-related traits. Using these criteria, Markus (1977) found independent schematics to be reliably faster, more accurate, and more consistent in the processing of independence-related information than were aschematics, thereby validating the selection procedure.

During debriefing, subjects were asked which of their hands was dominant. Data for the 15 left-handed subjects were excluded from all analyses involving the hemisphere factor because of the less complete cerebral lateralization in left-handed people (Bradshaw & Taylor, 1979; Hardyck & Petrinovich, 1977). These data were included in all analyses reported here, however, due to the nonsignificance of the hemisphere factor.

Apparatus and Materials

Experimental room. The subjects sat in a chair at a small table, facing a partition that hid the experimenter and most apparatus from their view. On a table in front of the experimenter were the tape recorder and RT apparatus (described later). On the table in front of the subject were a pair of Koss KO-727B stereo headphones and (except in the no-probe condition) a small black panel equipped with a light bulb and a button switch (part of the RT apparatus). The 4 × 5.5 × 2.7 m room was carpeted, and its ceiling was tiled with sound-absorbing material.

Stimulus tape. Separate lists of 80 words were recorded on each of two channels of a Sony TC-270 stereo tape recorder, such that one word from each list would be presented simultaneously. The rate of presentation was 750 msec per trial. Both lists were spoken by the same male voice.

The list recorded on one channel consisted of common nouns, such as *table*, *poker*, and *quarry*. The list recorded on the other channel consisted of adjectives used by Anderson (1968) in impression formation research. The first 30 and final 10 adjectives on this channel were unrelated to the trait of independence (e.g., *troubled*, *silly*, *prideful*). The 15 adjectives judged by subjects in the Markus (1977) study to be highly related to the trait of independence plus four additional synonymous words[2] were repeated in various random orders to make up the middle block of 40 adjectives. (I considered it desirable to lengthen the independence-related adjective list from 15 to 40 words in this way in order to allow

[1] Although Markus (1977) also used the Gough–Heilbrun Adjective Check List in the selection procedure its use has been discontinued, as the trait questionnaire alone proved to be a sufficient criterion in subsequent studies (e.g., Markus & Smith, 1981).

[2] The words used in the Markus (1977) study were *independent*, *aloof*, *assertive*, *uninhibited*, *arrogant*, *egotistical*, *unconventional*, *self-confident*, *individualistic*, *ambitious*, *adventurous*, *dominating*, *argumentative*, *outspoken*, and *aggressive*. The four additional words used were *self-assured*, *self-sufficient*, *nonconformist*, and *leader*.

two probe RTs to be taken during the self-relevant block.) The independence-related and independence-unrelated word sets had similar frequencies in the English language, as estimated by Carroll, Davies, and Richman (1971).[3] The first 10 word pairs served as practice for the subjects, because (a) this was a novel task for them, and (b) it has been shown that subjects need a few seconds to focus their attention on one ear in a dichotic listening task (Kahneman, 1973, p. 118; Treisman, Squire, & Green, 1974). Therefore, all dependent measures taken during this initial 10-word block were disregarded in the analyses. The duration of the tape was 60 sec.

Reaction time apparatus. A button was located in front of the experimenter that simultaneously illuminated a light bulb located in front of the subject and started a Lafayette Instruments model 54519 digital timing device when pressed. When the subject saw the light go on, he or she pressed a button next to the light bulb that turned off the bulb and stopped the timer. A Lafayette Instruments model 56024 automatic output device printed each RT to the nearest millisecond.

Recognition test. Two versions of the recognition memory test on the information presented in the unattended channel were constructed, one each for the adjective list and the noun list. The format of both versions was the same: a list of words, half of which had been presented on the unattended channel, and half of which had not been presented. Subjects were instructed to check off those items they thought had been presented. The adjective test contained four sets of 15 items each: independence targets (independence-related items actually presented), independence foils (independence-related but not presented), control targets (independence-unrelated items actually presented), and control foils (independence-unrelated and not presented).

The noun test consisted of three sets of 10 items: independent targets (nouns actually presented while the independence-related adjectives were presented simultaneously on the attended channel), control targets (nouns actually presented while the control adjectives were on the attended channel), and foils (nouns not presented on the unattended channel). For both versions, item order was randomized.

Procedure

Within each gender–schematicity combination, subjects were randomly assigned to one level of the channel, hemisphere, and probe factors. After arriving at a waiting room, subjects were shown into the experimental room and seated. They were informed as to the nature of the shadowing task, and instructed to concentrate their attention on a specific ear, repeating out loud the words they heard in that ear while ignoring the words coming into their other ear. The secondary probe RT task was then explained to all subjects except those in the no-probe condition. Instructions were given to press the button as soon as the light came on, but to consider the shadowing task as the more important of the two. The headphones were fitted comfortably on the subject's head.

The stimulus tape was then started. Each channel was presented at 70 db. (SPL). The experimenter kept track of the number of shadowing errors by crossing off all missed or misstated words on a list. A strict criterion of accuracy was employed: the correct and complete item had to be repeated. In addition, the experimenter activated the RT apparatus (except for subjects in the no-probe condition) at five predetermined times: after the presentation of the 8th, 21st, 39th, 59th, and 78th word pairs. The first time of measurement was during the practice words, the next corresponded to the first control adjective block, the next two to the independence-adjective section, and the final RT to the second control adjective section. (It should be noted that the two independence-adjective section probes did not follow the presentation of the same independence-related word: the two words were *independent* and *argumentative.*) Each time the subject's response stopped the timer, the experimenter activated the timer printer to record the RT.

Immediately after completing the shadowing task, subjects were given as much time as they needed to complete the recognition memory test on the unattended channel items. Subjects were informed that some of the test items had been presented and the others had not been presented. Many subjects balked at completing this test, on the grounds that they were certain they did not remember any of the words presented to the unattended ear. The experimenter asked them to complete it nonetheless, guessing if they needed to. It was explained that although they might think they could not remember any of the words, they still might be able to guess fairly accurately.

Momentary awareness condition. Ten schematic and 10 aschematic subjects participated in a control condition designed to test for momentary awareness of the information in both the attended and unattended channels. Half of these subjects (equal numbers of schematics and aschematics) attended to the noun list and half to the adjective list. These subjects were treated in the same way as subjects in the no-probe condition[4] until the 45th word pair had been presented (this was in the middle of the independence-related section of the adjective channel), when the tape was stopped. Subjects were immediately asked to recall the last word in the unattended ear. If they could not recall it, they were asked to name *any* of the words presented to that ear. If they were still unable to report any of the unattended content, the experimenter informed them that all of the words had been of a certain type—either nouns, verbs, or adjectives. Subjects were asked to guess to which of these three categories the unattended words belonged. Finally, subjects were asked the same series of questions about the information in the attended channel.

After the subjects completed the experimental tasks, they were fully debriefed and thanked for their participation.

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[3] Mean estimated frequencies per million words: Independence related = 9.18, independence unrelated = 12.26, $t(78) < 1$.

[4] If the probe RT task caused any distraction from the shadowing task it would lessen these subjects' chances of being momentarily aware of the unattended channel.

Results

In none of the analyses performed were there any statistically reliable main effects or interactions involving gender or hemisphere, so they are not mentioned further.

Probe RT Validation

In order to ensure that the secondary probe RT task was a true measure of spare processing capacity, it must be shown that it did not itself take processing capacity away from the primary shadowing task. Such interference would be reflected in differences in dependent measures between the probe and no-probe conditions.

In all of the analyses reported (except, of course, the probe RT analysis), the probe factor was included. It had no reliable effect on the number of shadowing errors. In addition, neither probe nor no-probe condition subjects were able to recognize independence-related or control target items on the memory test at better than the chance level of 50%. There was a significant effect of the probe factor on control item hit rate, $F(1, 113) = 8.87$, $p < .01$, with the probe condition subjects endorsing on the average more control targets than did the no-probe condition (48% vs. 38%). The fact that neither group demonstrated any better than chance recognition of the control targets, however, indicates that subjects in the two conditions shared a lack of awareness of the control words in the unattended channel.

The lack of differences between the probe and no-probe conditions validates the interpretation of the probe RT as a measure of spare processing capacity, an inverse indication of the amount of attention allocated to the auditory stimuli. The probe factor is not included in the further reporting of the analyses, which now focus on the schematicity and channel factors.

Awareness Measures

Recognition test. Better than chance recognition of the information presented to the unattended ear would indicate that there had been conscious processing of that information, because conscious awareness of a stimulus is generally considered necessary for it to be stored in long-term memory (Kahneman, 1973; Posner, 1978; Shiffrin & Schneider, 1977). However, there was no statistically reliable main effect or interaction of the schematicity and channel factors on hit or false alarm rates for either independence-related or independence-unrelated recognition test items. For both types of items, and for both schematics and aschematics, false alarm rates were either equal to or greater than hit rates, indicating that subjects had no memory for the stimuli presented to the unattended channel.

Table 1
Mean Proportion of Shadowing Errors by Attended Channel and Schema Relevance of Adjective List Block

	Adjective list block		
Attended channel	First control	Independence	Second control
Nouns ($n = 56$)	.39	.37	.32
Adjectives ($n = 65$)	.38	.33	.38

Shadowing errors. The lack of memory for the unattended stimuli does not prove the absence of conscious awareness of them. It is possible that one could be momentarily aware of environmental stimuli and yet not remember them (Egeth, 1967; White, 1980). As a measure of momentary awareness, the number of shadowing errors was tabulated for each subject. A greater number of shadowing errors made by one group of subjects or a greater number made during the presentation of one type of attended stimuli would indicate a greater possibility that alternating of conscious attention between channels had occurred (LaBerge & Samuels, 1974; Posner, 1978, p. 96).

An analysis of variance of the number of shadowing errors was performed, with repeated measures on the blocks factor (errors made during the first control section, independence-relevant section, and second control section). There was no reliable main effect or interaction involving the schematicity factor. There was a significant main effect of the blocks factor, $F(2, 226) = 4.30$, $p < .025$, and a significant interaction between the blocks and channel factors, $F(2, 226) = 8.13$, $p < .001$. As can be seen in Table 1, shadowing performance steadily

improved over time for subjects repeating the noun list, clearly a result of practice with the novel task. Subjects shadowing the adjective list, however, did much better on the independence-related adjective section than on the control sections. A difference in task characteristics appears to be responsible for this interaction. On the noun list, no single item was repeated, hence no active set could be developed to aid in shadowing. During the independence-related section of 40 adjectives, however, the same 15 words were repeatedly encountered, so that a temporary expectancy for these words would help performance. But when the final 10 control adjectives were encountered, this presumed temporary expectancy worked to the subjects' disadvantage relative to noun-shadowing subjects, who had no such expectancy.

A certain number of shadowing errors by subjects are desirable to ensure that the shadowing task is sufficiently difficult to require their full conscious attention (Norman, 1969). The equivalent numbers of shadowing errors for the two groups are uninformative as to the momentary awareness issue, however, because one cannot know from the number of shadowing errors alone whether they are due to a switching of focused attention to the unattended ear or solely to task difficulty. The results of the third and strictest awareness measure provide a clear answer.

Momentary awareness. None of the 20 subjects in the momentary awareness condition were able to recall any of the words presented to the unattended ear. When the 10 subjects for whom the adjectives were presented in the unattended channel were asked to guess the type of word that had been presented, four guessed adjectives (two schematics, two aschematics), a number expected by chance alone. Only two of the subjects for whom the noun list was unattended guessed correctly. Sixteen subjects were able to report at least one of the final five attended words; the other four subjects reported words presented earlier in the list.

The unequivocal indication of the three awareness measures is that subjects' conscious attention was fully focused on the to-be-attended channel; they were not consciously aware of the information presented in the unattended channel. This is consistent with past research demonstrating subjects' ability to keep the contents of the rejected channel completely out of consciousness when spatial origin distinguishes the two channels (Cherry, 1953; Kahneman, 1973, p. 114).

Amount of Processing

Inspection of the cell means and standard deviations of the raw probe RTs showed that the higher variances were associated with the higher means. Therefore, a natural logarithm transformation of the raw scores was made (Winer, 1971, p. 400).

An analysis of variance of the log RTs was performed, with schematicity and channel as the between-subjects factors and blocks the within-subjects factor. The blocks factor proved significant, $F(3, 219) = 4.47, p < .01$, with the mean log RT steadily declining over the four times it was taken. This is probably another manifestation of the subjects' increasing experience with the novel shadowing task; both shadowing errors and probe RTs decreased over the course of the task.

As the main hypothesis of the study is the reversal of relative probe RTs for schematics and aschematics as a function of channel, the three-way interaction among the schematicity, channel, and blocks factors is of central importance. This interaction was statistically reliable, $F(3, 219) = 3.02, p < .05$. Figure 1 presents the mean RTs for subjects who attended the adjective list (left panel) and the noun list (right panel).

A series of planned comparisons was conducted to determine the source of the significant interaction.[5] Comparison of the individual schematicity by channel cell means at each of the four times of measurement indicated the only significant difference to

[5] Because the interaction of the schematicity and channel factors at single levels of the within-subjects factor was being tested, the denominator of the F statistic for the contrasts was formed by pooling the between-subjects and within-subjects mean square errors (Winer, 1971, pp. 559–563). Due to the unequal number of subjects per cell, the numerator of the contrasts was formed by squaring the difference between the contrasted means and dividing this by the summed ratios of the squared weights and cell ns (Winer, 1971, p. 215).

be on the first independence-related block RT, $F(1, 73) = 6.40$, $p < .025$. The contrast on the second independence-related block RT was marginally reliable, $F(1, 73) = 3.00$, $p < .10$. From Figure 1 it can be seen that schematics took less time than aschematics to respond to the probe when attending to the independence-related adjectives, but relatively more time when the independence information was presented in the unattended channel, as predicted. Probe RTs of schematics and aschematics did not differ on either of the control block measures.

The two-way interaction between schematicity and blocks was assessed individually for the two channel conditions. The two RTs for both the control and independence blocks were averaged to obtain a single and more stable estimate of the amount of capacity used during the relevant and irrelevant adjective blocks. Both interactions proved significant: $F(1, 40) = 9.78$, $p < .01$, for the adjective channel, with schematics' RTs shorter during the independence-adjective block and longer during the control-adjective block relative to aschematics; $F(1, 33) = 4.30$, $p < .05$, for the noun channel, with schematics and aschematics taking nearly identical lengths of time to react to the control probes, but schematics taking longer to react to the independence-adjective probes.

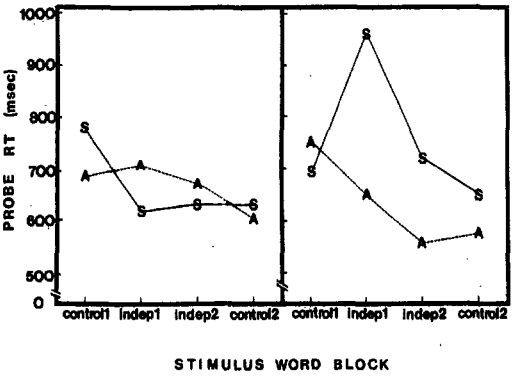

Figure 1. Mean probe reaction times (RT) in milliseconds. (The left panel shows the results of the adjective channel attended; the right panel shows the noun channel attended. A = aschematics; S = schematics.)

Discussion

The results are consistent with the experimental literature on the interaction of attentional and automatic processing (Logan, 1980): automatic processing of the self-relevant information facilitated the shadowing task when part of the attended channel, and inhibited performance when on the rejected channel. An active set to attend to the noun channel was able to overcome the passive processing of the self-relevant information presented to the other channel, but at a cost of attentional capacity. When these passive and active processes were compatible—that is, when the self-relevant words were to be shadowed—less attentional capacity was required for the task. Thus, the present findings are a conceptual replication of Neely (1977) and provide support for the Posner–Snyder (1975) model of attention within the domain of social information.

Another interesting implication of the probe RT data is that schematics apparently made automatic attention responses to the self-relevant adjectives. According to Shiffrin and Schneider (1977, p. 186), decrements in focused-attention ability occur when the to-be-ignored stimuli initiate automatic attention responses. Moreover, Shiffrin and Dumais (1981) defined as automatic "any process that always utilizes general resources and decreases general processing capacity whenever a given set of external initiating stimuli are presented, regardless of a subject's attempt to ignore or bypass the distraction" (p. 117). Thus, the decrease in spare attentional capacity for schematics resulting from the presentation of the independence adjectives to the rejected channel (Figure 1, right panel) demonstrates automatic processing of trait information by those who have acquired chronically accessible constructs for it. The existence of automatic attention responses to self-relevant information presented outside of the subjects' conscious awareness provides strong support for the hypothesis that mental representations of such stimuli play a direct role in the selection of stimuli for further processing.

Why is self-relevant information capable of provoking automatic attention responses? The development of such responses requires

frequent and relatively consistent experience with the environmental event or object (Logan, 1979; Shiffrin & Dumais, 1981; Shiffrin & Schneider, 1977). Because people constantly experience events with themselves as the central focus (e.g., Greenwald, 1980), self-relevant information is likely to be the type most frequently processed. This should lead to greater accessibility in perception and retrieval for mental representations of various sources of self-relevant information (Bruner, 1957; Higgins & King, 1981), and indeed, information relevant to the self is more easily and quickly accessed than other types of information (Markus, 1977; Ross & Sicoly, 1979). So it appears that the principle of greater cognitive skill arising from greater experience within an environmental domain (e.g., Newell & Rosenbloom, 1981) can account for the development of a chronic perceptual set favoring self-relevant stimuli. The present results thus favor the Higgins and King (1981) "energy cell" metaphor for the development of social construct accessibility over the "storage bin" model of Wyer and Srull (1981), as the former stipulates both frequency and recency of activation as factors, whereas the latter specifies only recency of activation.

A recent study by Nielsen and Sarason (1981) is pertinent to these issues. Using the shadowing task, the investigators presented different classes of "emotional" words to the ignored channel for different groups of subjects. The emotional word groups either were neutral, sexually explicit, related to hostility, related to university life, or related to educational evaluation. Only the sexually explicit information tended to intrude upon subjects' focused attention, as was indicated by a greater number of shadowing errors and better recognition memory for the explicit words. That is, sexually explicit words were able to automatically attract attention despite subjects' attempts to ignore them. No other class of words was able to breach the attentional barrier.

These findings are entirely consistent with those of the present study. Sexually explicit words apparently call forth an automatic attention response that is too strong to be excluded from awareness by a control process, unlike the attention response triggered by self-relevant trait terms. The resultant distraction of conscious attention in the Nielsen and Sarason (1981) study caused a deficit in shadowing performance, whereas no such distraction occurred in the present experiment. The present use of the RT as a measure of spare attentional capacity allows an extension of the Nielsen and Sarason results by demonstrating that automatic attention responses can occur but be barred from awareness by an active set or control process, and so remain undetected by the shadowing error measure. Thus, it is possible that the other classes of words studied by Nielsen and Sarason were also processed, but were successfully inhibited prior to achieving consciousness.

Nielsen and Sarason (1981) interpreted their results as evidence that emotionally salient information is able to intrude upon awareness. This would also provide a viable alternative explanation of the present results. Information that implicates the self is emotionally charged to a great extent (e.g., Zajonc, 1980), so it is possible that the emotional quality of the self-relevant information may underlie its attentional effects, not its frequency in perceptual experience alone. Alternatively, the frequency explanation advanced here can also explain the Nielsen and Sarason (1981) results: Sexual themes are most likely very common in thought, such as in fantasizing and daydreams (Singer & Antrobus, 1972), and so by virtue of their greater frequency come to automatically attract attentional resources. The data do not yet permit a decision on whether it is perceptual frequency or emotional quality or both that drives this differential allocation of attentional resources. The frequency interpretation is preferred here on the basis of parsimony; it does not necessitate the postulation that "qualitatively different kinds of information processing" occur for certain types of input, such as sexual information (Nielsen & Sarason, 1981, p. 957).

The present findings suggest that attentional and automatic processes operate in much the same way for social information as they do for nonsocial information. But other important issues have been raised. Perhaps most critical of all are the consequences

of automatic trait information processing. Self-relevant trait stimuli apparently can be processed outside of conscious awareness, but it is not known whether such automatic processing has any influence on the moment-to-moment interpretation of the social environment. This issue deserves further study. If selective attention to certain categories of person information is able to proceed automatically and outside of one's conscious awareness there are considerable implications for our understanding of social perception.

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