Social Presence Effects in the Stroop Task: Further Evidence for an Attentional View of Social Facilitation

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In contrast with R. B. Zajonc's (1965) classic view about social facilitation—inhibition (SFI) effects, it was found that the presence of relatively unpredictable audiences and forced social comparison with a slightly superior coactor both facilitated performance in the Stroop task while inhibiting automatic verbal processing. Not only do these findings reveal that social presence can help inhibit the emission of dominant responses, providing further support for an attentional view of SFI effects, but they also demonstrate the power of social situations over what has been thought to be invariant automatic processing. As such, they are inconsistent with the view reiterated in more than 500 articles on Stroop interference over the past 60 years and suggest that more attention should be paid to the situations in which cognition takes place.

The situations in which human beings perceive, manipulate, and interpret information have traditionally been neglected by cognitive psychologists and cognitive scientists in general. According to Levine, Resnick, and Higgins (1993), the recognition of the importance of domain-specific knowledge led cognitive psychologists to take a first step toward a possible inclusion of social factors as part of cognition. This first step, however, did not specifically involve social factors but "did highlight how particular, how situated or contextualized, cognition always is" (Levine et al., 1993, p. 586). As Levine et al. noted, it is in fact necessary to attend not only to knowledge elements but also to the conditions of their use, that is, the situations in which cognition takes place.

In this article our purpose is to show that even relatively simple social situations can have dramatic effects on some basic cognitive responses that have been well established in psychology. Specifically, we argue that the presence of other people can help dominate processes that are viewed as uncontrollable in the Stroop task, suggesting that more can be learned about cognition when studying it in its social context. Interest in the way social presence affects cognition has a long history in social psychology. Under the label social facilitation (Zajonc, 1965), it has been found that audiences and coactors affect individual performance, sometimes facilitating it and sometimes impeding it (see Bond & Titus, 1983; Geen, 1989, 1991; Guerin, 1993, for reviews). In this area, however, it is generally assumed that automatic or dominant response tendencies are facilitated by the presence of others. In contrast with this, our findings in the context of the Stroop task reveal that social facilitation can sometimes result from an inhibition of such tendencies, providing further support for a neglected, attentional view of social facilitation—inhibition (SFI) effects.

SFI Effects

According to Bond and Titus's (1983) meta-analysis of 241 studies, social presence (a) increases the speed of well-learned, simple task performance but decreases the speed of poorly learned complex task performance and (b) impairs complex performance accuracy and facilitates simple performance accuracy. The dominant explanation of these effects has been suggested by Zajonc (1965). A simple task, Zajonc reasoned, is a task in which the performer's dominant tendency is to give the correct response: a complex task is one in which the dominant tendency leads toward incorrect responses. By increasing the individual's level of generalized drive and arousal, the presence of others enhances the dominant-response tendency. Consequently, this presence facilitates simple task performance and impairs complex task performance.

Baron (1986) suggested a completely different explanation of the interactive effect of social presence and task complexity on performance. The key idea here is that social presence, when it is distracting, threatens the organism with cognitive overload, a phenomenon that may itself lead to a restriction in attention focus (see also Cohen, 1978). And attention focusing may produce just the task effects usually viewed as evidence of drive: facilitation of performance (by screening out nonessential stimuli) when the task is simple or requires attention to a small number of central cues, and inhibition of performance (by neglecting certain crucial stimuli) when the task is more complex or demands attention to a wide range of cues.
Several studies (Bruning, Capage, Kosuh, Young, & Young, 1968; Geen, 1976) support the claim that social presence can trigger this form of attention focusing. In Bruning et al.'s (1968) Study 1, being observed by the experimenter tended to improve the performance of participants faced with cues irrelevant to a learning task1 and impaired performance when relevant cues were added (compared to when participants were not observed). Both findings suggest that the presence of others can be associated with a reduction in cue utilization and are hard to assimilate with Zajonc's (1965) solution. As Bruning et al. noted, although these findings agreed with Zajonc's solution when the additional cues were relevant, they disagreed when irrelevant cues were added. Geen (1976) successfully replicated and extended Bruning et al.'s findings by showing that the presence of an observing experimenter and individual differences in anxiety both influence true utilization. Over the years, however, much of the field's attention has been given to Zajonc's drive/dominant-response theory of SFI effects. Although the cue utilization perspective also resolves the paradox associated with these effects, it has been neglected in the past two decades.

In the present article we expand on this perspective by addressing four limitations of past research. First, research on cue utilization has examined only the effects of being observed by a potentially evaluative audience: Participants were either observed or not observed by the experimenter, who, in all conditions, remained in the same room as them. Because the experimenter could be perceived as an expert by the participants, and given the lack of a clear "alone" condition, past research on cue utilization has not offered an adequate test of mere-presence effects (Guerin, 1986). Consequently, whether the mere presence of others can cause attention to focus remains unclear. Second, because of its exclusive focus on audience effects, past research on cue utilization has still left open the question of attention focusing in coactive situations (when the individual is faced with the presence of another person working independently and simultaneously at the same task). Several studies have shown that coaction affects performance only when it makes sense for the participants to compare themselves with the coactor (Sanders, Baron, & Moore, 1978) or when the coactive situation makes social comparison unavoidable and relatively self-threatening (Rijksman, 1974, 1983; Seta, 1982; Seta, Seta, & Donaldson, 1991). It is possible that coaction increased attention focusing in these conditions. Third, attention focusing has been assessed only either on the basis of facilitation or inhibition of performance in past research. Although this may seem sufficient to determine whether social presence can cause attention to focus, the measure of memory correlates of attention focusing may help strengthen the demonstration. Finally, it is true that some of the effects obtained in past research on cue utilization seemed hard to assimilate with Zajonc's solution. These effects, however, do not imply that social presence failed in facilitating participants' dominant-response tendency, which was not specified. In other words, the cue utilization and dominant-response perspectives have not been clearly differentiated in past research; this remains to be done.

The present experiments tested whether several types of audiences and coactors are associated with a reduction in the range of cue utilization, even when this mechanism conflicts with participants' dominant-response tendency. Following Baron's (1986) suggestion, we used the Stroop task in these experiments, in which both performance and memory measures of attention focusing were included.

**Social Presence Effects in the Stroop Task**

According to Baron (1986), one strategy for differentiating the cue utilization and dominant-response perspectives is to focus on poorly learned tasks that involve only a few key stimuli. Here the attention-focusing perspective predicts that social presence should facilitate performance, whereas the drive–dominant-response perspective predicts impairment. We note that the standard Stroop task (Stroop, 1935) is especially appropriate to test such competing predictions.

In this task, individuals are required to identify the ink color in which words and control signs are printed. Typically, the time needed to identify the ink colors of incongruent words (e.g., the word red printed in green) is greater than the time needed to name the ink colors of control signs (+++ printed in green): a robust effect called *Stroop interference*. This interference is the classic example of a task in which a relatively automatic, unintended cognitive process (word reading) conflicts with a relatively controlled, intended cognitive process (color naming). As such, it has been the subject of numerous (several hundred) research projects over the past half century (MacLeod, 1991).

As Besner, Stolz, and Boutillier (1997) noted, the many variants of the Stroop task have been explored theoretically, empirically, and computationally by cognitive and developmental psychologists, psycholinguists, neuropsychologists, and cognitive scientists in more than 500 articles over the past 60 years. A core assumption of virtually all the theoretical accounts is that skilled readers process the irrelevant word without consciousness or intent. Reading the word is said to be automatic in the sense that readers cannot refrain from accessing the meaning of the word despite explicit instructions not to do so (see Besner et al., 1997, for a review). As Anderson (1995) put it: "Reading is such an automatic process that it is difficult to inhibit and it will interfere with processing other information about the word" (p. 100). Apparently, even knowing about the Stroop effect is not protection (Reisberg, 1997), a point suggesting that the processes underlying this effect are not open to control.

To the extent that word reading is the dominant but incorrect response tendency in the Stroop task, Zajonc's (1965) solution predicts that social presence should deteriorate response latencies on the incongruent words and increase Stroop interference. Consistent with this, arousal has been associated with increased Stroop interference in past research. Hochman (1967, 1969) found that increased arousal due to time pressure led to more interference in the Stroop task. Similarly, Pullack, Pittman, Heller, and Munson (1975) found that arousal induced by threat of electric shock also increased Stroop interference.

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1 In this task, participants were faced with 15 rows of seven 0s, with a single test 0 placed beneath one of the seven. The participants’ task was to learn the correct position (from 1 to 7) of the test 0 for all 15 rows. In a no-cue condition, only the sets of 0s appeared. In the relevant-cue condition, each 0 was identified by a numerical subscript (from 1 to 7) that matched its serial position, from left to right. In the irrelevant-cue condition, the subscripts 1–7 were added but were randomly assigned to digits from left to right.
Conversely, if social presence is associated with a reduction in cue utilization, it should improve response latencies on the incongruent words and reduce Stroop interference. Narrowing one’s focus should indeed allow one to screen out the incorrect semantic cues and focus more exclusively on the letter color cues. Consistent with this, Baron (1986) noted that distraction has been associated with decreased Stroop interference in past research. O’Malley and Poplawsky (1971), Hartley and Adams (1974), Houston (1969), and Houston and Jones (1967) all have reported that performance on the Stroop task is facilitated by noise distraction. Results in the Stroop literature even seem to indicate that Stroop interference decreases in active situations. In MacKinnon, Geiselman, and Woodward’s (1985) Study 1, participants performed the Stroop task alone or in presence of a coactor competing for one extra credit. Those working coactively were successful at inhibiting Stroop interference, compared to those working alone. In Study 2, this effect was accompanied by a significant reduction in memory recognition for the Stroop list words, exactly as one would expect if social presence really did cause attention to focus. Because coaction covaried with a desired reward in these studies, however, its causal role in attention focusing remains unclear.

Of particular interest here are dissertation studies of social facilitation and Stroop performance that have been conducted by Crandall (1974), Gribbin (1974), and Lobis (1970). Taken together, however, the results of these studies were inconclusive. Lobis failed to produce significant audience effects with normal participants but found that the Stroop performance of long-term schizophrenics worsened when another person was present. In a pilot study with normal participants, Crandall found that the audience group was slower in naming the color of incongruent words and faster in naming congruent words (providing support for the dominant-response hypothesis—as noted by Crandall). These effects did not occur, however, in Crandall’s subsequent experiments, in which a manual version of the task was used (participants wrote down the first letter of the word or color). Finally, Gribbin found that older participants performed worse with an audience, whereas younger participants performed better. Men also performed better in the presence of an audience, whereas women performed worse. Overall, these contradictory findings do not offer a clear answer to the question raised in the present article. In addition, the dissertation studies suffered from the same limitations as those noted previously. None of them offered an adequate test of mere-presence effects (it seems that the experimenter was always present in the audience condition), and none of them investigated coaction effects. Thus, more research is needed to know exactly how audiences and coactors affect Stroop interference.

Overview of the Present Experiments

We conducted three pilot studies and two experiments to test social presence effects in the Stroop task. In the pilot work it was assumed that social presence can have effects on individuals regardless of any directional influences. Examples of these influences are the distribution of reinforcements, punishments, and feedback cues; the supplying of information; and the setting of norms and standards with which the individual feels obligated to comply. There is indeed evidence for the existence of mere-presence or passive audience effects (Zajonc, 1980), but only when there is some uncertainty about the behavior of the person present (Guerin, 1983, 1986). According to Guerin (1986), this uncertainty is especially high when the person present is a stranger and is not coacting, when he or she is sitting close to the individual, when he or she is doing nothing (compared with when the individual can see that the audience is engaged in a predictable activity), and when the audience cannot be monitored by the individual. In the pilot studies we varied social presence (a same-sex coactor) within subjects and tested whether Stroop interference increases or decreases in these different conditions.

In Experiment 1 we replicated the conditions created in the pilot work on the basis of a between-subjects design and tested whether these conditions also affect recognition memory for the Stroop list words. Several studies (MacKinnon et al., 1985; Seymour, 1977; Stirling, 1979; Williams, 1977) have shown that a significant component of Stroop interference can be localized before response output, at an earlier stage where the degree of semantic processing can be altered. This alteration in social conditions would heighten our confidence that semantic meaning is more effectively “screened” out, as one would expect if the presence of others does cause attention to focus. In Experiment 2 we tested the same effects in the coaction paradigm while including a social comparison manipulation. Not only was this manipulation needed to specify the conditions under which coaction would affect Stroop performance, but it also was especially appropriate for determining the role of distraction in the expected effects.

A computer-keypress version of the Stroop task was systematically used in our investigation. Whereas an oral version was possible when using the audience paradigm, it was not possible in the coaction paradigm, in which the coactor’s and coactor’s oral responses could interfere. Before performing the Stroop task, participants were always faced with training sessions where only color-neutral words (e.g., table) were used, as a means to learn the correct response keys. Because the method and material used in the pilot work are almost identical to that of Experiment 1, they will be only briefly described in the next section of this article (see the Method section of Experiment 1 for more details). Likewise, because sample sizes were small in the pilot work, the corresponding results will be only briefly discussed.

Pilot Work

Method

Twenty-four female undergraduates (N = 8 in each study) volunteered to take part in the pilot work, which was presented as "research on visual perception." Only women were selected because of the low number of men among undergraduates at the time the pilot work was conducted. All participants had normal vision and were naïve concerning the purpose of this investigation. After they had learned the correct response keys, they

2 Another difficulty with the dissertation studies is that the Stroop stimuli were not isolated but presented all together on cards (different cards were used for congruent and incongruent words). As Ksips and Glickman (1962) noted, this "group version" of the Stroop task is not accurate for measuring response speed. Most current researchers in the domain of Stroop interference indeed use a more analytic methodology whereby individual stimuli can be presented and timed (see MacLeod, 1991).
were faced with the Stroop task alone and then in presence (apparently incidental) of a confederate. In Study 1 the confederate sat opposite the participants, on the edge of their peripheral vision, and never looked at them (e.g., read a book). In Study 2 the confederate sat behind the participants and thus remained invisible. In Study 3 the confederate sat opposite the participants, as in Study 1, but watched them 60% of the time. As in previous research on mere presence (see Guerin, 1983), the confederate was positioned in various ways so as not to see the task. In Study 1 and Study 3, the confederate could not see the computer, so she was unable to determine whether the participants had given correct or incorrect responses. In Study 2 the participant’s body blocked the screen. In contrast with previous studies in which participants were observed by the experimenter (see the introductory section of this article), the confederate’s behavior in Study 3 did not imply evaluation. Not only did the participants have no reason to believe that the person present was there to observe them, but also this person was said to be naive about the color-word task (participants were informed that the person present had not performed this task in previous sessions). Likewise, the confederate was always presented as one of the next participants in a different study taking place somewhere else in the laboratory. Thus, the three pilot studies differed only in the degree of predictability associated with the confederate’s behavior. There was also a clear “alone” condition in each of these studies in which the experimenter left the room during the Stroop task and the training sessions both in the alone and the social conditions.

The Stroop task consisted of 60 test trials that were made of basic color words (blue, green, red, and yellow), each randomly generated 15 times by the computer in a color that conflicted with its meaning. Sixty colored plus signs varying in length (+ + + vs. + + ++ ) were used as control patches (resulting in 60 control trials). Participants were instructed to select the key corresponding to one of the four colors in which the words appeared on the computer screen. They were asked to respond as quickly as possible while minimizing errors. Their response latencies were measured in milliseconds.

To assess the emergence of practice effects that may covary with audience effects, we ran an additional study. In this test–retest study (N = 12), the Stroop task was performed twice in isolation.

Results and Discussion

Latencies were analyzed with a 2 (item type: incongruent words vs. control items) × 2 (social presence: alone vs. audience) analysis of variance (ANOVA), with both factors as within-subjects variables.

Study 1: Impact of an inattentive-busy audience. Only a main effect of item type was significant, F(1, 7) = 11.48, p < .02 (\(\eta^2 = .62\)). Latencies were longer for the incongruent words (M = 960 ms, SD = 222 ms) than for the control items (M = 874 ms, SD = 196 ms), indicating a significant Stroop effect (86 ms).

Study 2: Impact of an invisible audience. The two main effects of item type, F(1, 7) = 18.25, p < .004 (\(\eta^2 = .72\)), and social presence, F(1, 7) = 14.03, p < .008 (\(\eta^2 = .67\)), were significant. Latencies were longer for the incongruent words (M = 914 ms, SD = 171 ms) than for the control items (M = 795 ms, SD = 112 ms; interference = 119 ms). Participants were faster at identifying color cues in the social condition (M = 832 ms, SD = 131 ms) than in the alone condition (M = 877 ms, SD = 151 ms), regardless of item type. Although shorter latencies on the incongruent words might decrease Stroop interference, this did not occur because of simultaneously shorter latencies on the control items.

Study 3: Impact of an attentive audience. The main effect of item type, F(1, 7) = 98.55, p < .001 (\(\eta^2 = .93\)), was again significant. Latencies were longer for the incongruent words (M = 912 ms, SD = 159 ms) than for the control items (M = 819 ms, SD = 154 ms; interference = 93 ms). In this study, however, the Item Type × Social Presence interaction also was significant, F(1, 7) = 24.10, p < .002 (\(\eta^2 = .77\)). As shown in Table 1, Stroop interference was much higher in the alone condition (151 ms) than in the social condition (35 ms), in which it did not reach statistical significance, t(7) = 1.83, p = .12. Although Stroop interference can decrease for a number of reasons (e.g., an increase in latencies on the control items alone), this effect was exclusively due to shorter latencies on the incongruent words in the social condition, compared to the alone condition.

The audience effects found in the pilot work held even when taking natural logarithms of the original observations, a more conservative way of testing both main and interaction effects with repeated measures (see Abelsohn, 1995). The additional test–retest study also suggested that these effects did not covary with a practice effect (as also suggested by the results of Study 1). In this study, the data were examined with a 2 (item type: incongruent words vs. control items) × 2 (task session: first vs. second) ANOVA, with both factors as within-subjects variables. As expected, only the main effect of item type was significant, F(1, 8) = 37.43, p < .0003. Latencies were slower for the incongruent words (M = 1038 ms, SD = 260 ms) than for the control items (M = 896 ms, SD = 207 ms; interference = 142 ms).

Unlike what might be expected from the dominant-response hypothesis, participants were faster at identifying the letter color cues of incongruent color words when they worked in the presence of an audience, compared to when they worked alone. As expected, this occurred only when the audience was relatively unpredictable (attentive or invisible), suggesting that mere-presence effects have indeed boundary conditions related to the predictability of the audience’s behavior (Guerin, 1983). Although Stroop interference decreased in only one (attentive audience) of the two critical audience conditions, these preliminary results suggest that

<table>
<thead>
<tr>
<th>Item type</th>
<th>Alone</th>
<th>Audience</th>
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<tr>
<td>Incongruent words</td>
<td>970</td>
<td>151</td>
</tr>
<tr>
<td>Control items</td>
<td>819</td>
<td>149</td>
</tr>
</tbody>
</table>

Table 1

Mean Latencies (in Milliseconds) for Identifying Color as a Function of Item Type and Social Presence in Pilot Study 3

3 Although social presence varied within subjects, the alone and social conditions were not counterbalanced. In effect, it would make little sense to have the social condition coming first, as the impact of this condition could persist in the alone condition. We also agree with Markus (1978, p. 391) that, in virtually all social facilitation studies (regardless of whether social presence is varied between or within subjects), the participant in the alone condition is not “phenomenologically” alone, even when the audience and the experimenter are physically removed and out of sight. This suggests that creating a true alone condition as a baseline for comparison with the audience conditions is in fact extremely difficult. This difficulty would increase if the audience presence condition would come first.
participants focused more exclusively on the letter color cues at the expense of word reading in these conditions. Participants faced with the invisible audience also responded faster on the control items, however. Although this finding is not necessarily incompatible with the cue utilization perspective, it provides partial support for the dominant-response perspective. In this perspective, social presence would indeed facilitate response speed on simple stimuli on which there is no response competition. More generally, some might claim that color naming rather than word reading is the dominant response tendency in the Stroop task, an assumption that might succeed in fitting the present pattern of results to the dominant-response hypothesis. However, this would imply ignoring the fact that word reading is a dominant tendency, at least at an early stage before response output. As such, word reading should be enhanced by the presence of others.4

Taken together, these preliminary findings seem more consistent with a distraction/cue utilization view of social facilitation: Attention that, in isolation, could be allocated to competing cues (the words) was consumed in the monitoring of relatively unpredictable audiences. Because of the lack of distraction data, however, we cannot decide whether our findings were due to distraction rather than to something else. Measures of distraction were therefore included in Experiment 1, in which participants were also faced with a recognition memory test of the words in the Stroop list.

If attention affects Stroop interference at an early stage where the degree of semantic processing can be altered, we reasoned, then a decrease in Stroop interference should be associated with a decrease in recognition memory for the Stroop list words. If attention affects Stroop interference after meaning extraction, at the stage of response output, then changes in Stroop interference would not be associated with a corresponding change in memory for the Stroop list words (see also MacKinnon et al., 1985, for a similar reasoning). It is interesting that a disruption of automatic verbal processing in the critical social conditions would run against the dominant-response perspective, which leads to an opposite prediction. Social presence, by facilitating participants’ dominant word reading tendency, should indeed increase recognition memory for the Stroop list words in the critical conditions.

Experiment 1

Method

Participants. Eighty-six undergraduates (48 women) from Université Blaise Pascal volunteered to take part in the experiment, which was presented as in the pilot work. Again, all had normal vision and were naive concerning the purpose of the experiment. Likewise, participants received no credit for taking part in this experiment. They participated as a means of helping postgraduates and of learning more about experimental research in psychology (following their teachers’ advice). This is a typical incentive for psychology participants at Université Blaise Pascal.

Procedure and materials. Participants were met either by a male or a female experimenter, according to their own gender, and received three pieces of information intended to reduce evaluation on the Stroop task. First, they were informed that technical, computer-related problems had just emerged on the main perception task and that another task would be performed instead. Second, they were informed that the computer on which this new task is run was not yet programmed to record their responses. Finally, they were told that the goal of this session was to give their general impression about this new task. Although they were given the opportunity not to continue if they so desired, all participants opted to continue with the session.

As before, participants were given a general description of the Stroop task and participated in five training sessions of 20 trials each in which only neutral color words were used. On each trial, a color-neutral word (e.g., table) was presented in the center of a light grey computer screen, in one of four colors typically used in the Stroop task (blue, green, red, and yellow, which also were used in the pilot work). Participants were asked to select the key corresponding to one of these four colors. The word was removed from the computer screen as soon as participants responded. As suggested by Fazio (1990), the task instructions emphasized both speed and accuracy. The keys K (for blue), F (for green), S (for red), and M (for yellow) were used as correct responses. Participants had no difficulty learning these keys correctly.

Participants were then faced with the Stroop task either alone or in presence of an inattentive—busy, invisible, or attentive audience (a same-sex confederate), as in the pilot work. As previously, several criteria were satisfied regarding the concept of mere presence (Zajonc, 1965, 1980). There was no emphasis on evaluation by the instructions; the confederate was supposedly naive to the nature of the task; his or her presence was inscribed in the task; and participants were truly alone in the alone condition, not with the experimenter partially concealed.

The Stroop list included the 4 color words used previously and 16 color-related words generated in one of the four target colors, excluding congruent colors (see Appendix A). Inclusion of color-related words was required for the recognition task, which could not be run on the basis of only the four color words used in the pilot studies. These new words were taken from MacKinnon et al. (1985). Twenty colored plus signs varying in length (++++ vs. ++++) were used as control patches. Each item was generated twice by the computer, resulting in 80 test trials (40 incongruent words and 40 control items). As before, latencies were measured in milliseconds.

Once the Stroop session had ended, participants were asked to rate the extent to which (a) they felt they had thought about something other than the task while they performed it (internal distraction) and (b) they spent some time away from the task—turning the head or body—during the Stroop session (external distraction). Each of the 7-point scales accompanying these questions was anchored by not at all (1) at one end and very much (7) at the other. Participants had exactly 2 min to give their answers.

They were then asked to recognize the 20 words previously generated by

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4 One may also wonder whether the Stroop task became less complex toward the end of the 60 trial series. There was in fact no practice effect between the early and late trials on the Stroop task, as showed by appropriate analyses performed on latencies and errors (e.g., an error consisted of selecting the response “red” for the word red printed in blue ink).

Although the error rate was extremely low (<5%) in each study (as in most Stroop studies), it was affected by item type and social presence. In Study 1, the main effect of item type was only marginally significant, F(1, 7) = 4.58, p < .07 (η² = .40): Participants tended to produce more errors on the incongruent words (M = .03, SD = .03) than on the control items (M = .01, SD = .02), providing further evidence for the strength of word reading at an early stage before response output. In Study 2, the main effect of social presence was significant, F(1, 7) = 15.29, p < .006 (η² = .69): More errors were made in the social condition (M = .04, SD = .03) than in the alone condition (M = .03, SD = .03). In Study 3, the Item Type × Social Presence interaction was significant, F(1, 7) = 8.61, p < .02 (η² = .55). On the incongruent words, fewer errors were made in the social condition (M = .02, SD = .03) than in the alone condition (M = .03, SD = .03). On the control items, more errors were made in the social condition (M = .02, SD = .02) than in the alone condition (M = .01, SD = .02). These effects are problematic for Zajonc’s perspective. Regardless of whether the dominant response tendency is color naming or word reading, this tendency should have been always facilitated by social presence (reducing or increasing the error rate, respectively).
the computer. All were faced in isolation with a yes–no recognition test involving 40 distractors (see Appendix B). Both the Stroop task, including the training sessions, and the recognition memory test were run on a Power PC Macintosh using Blake Made’s (1988) microexperimental laboratory Mindlab software system.

Results

Latencies. Latencies were analyzed with a 2 (item type: incongruent words vs. control items) × 4 (audience presence: none [alone], inattentive, invisible, attentive) × 2 (gender: male vs. female) mixed ANOVA, with item type as the within-subjects variable. Again, the main effect of item type was significant, F(1, 78) = 93.85, p < .0001 (η² = .54). Latencies were longer for the incongruent words (M = 1013 ms, SD = 215 ms) than for the control items (M = 898 ms, SD = 173 ms; interference = 115 ms).

More interesting, however, was the appearance of a significant Item Type × Audience Presence interaction, F(3, 78) = 3.04, p < .03 (η² = .10). The means and standard deviations are reported in Table 2. To better understand the overall interaction, we broke it down into three orthogonal contrasts with the interference as the dependent variable (see Figure 1). The first contrasted the average of the alone and inattentive-audience conditions with the average of the attentive and invisible-audience conditions. The second contrasted the alone and inattentive-audience conditions. Finally, the third contrasted the attentive and invisible-audience conditions. If the degree of uncertainty about the behavior of the audience is indeed a key factor in mere-presence effects, only the first contrast should be significant. As predicted, only this contrast was significant, t(82) = 2.41, p < .02.

Errors. Only the main effect of item type was significant, F(1, 78) = 11.22, p < .001 (η² = .13). More errors were made for the incongruent words (M = .03, SD = .04) than for the control items (M = .02, SD = .03). As in the pilot studies, the error rate was extremely low (2.73% overall).

Recognition performance. The three orthogonal contrasts used previously for examining latencies were made for the recognition data. For clarity, this new dependent variable was also analyzed in a 4 (audience presence: none, inattentive, invisible, attentive) × 2 (gender: male vs. female) ANOVA with both variables as between-subjects factors.

Only the main effect of audience presence was significant, F(3, 82) = 2.84, p < .04 (η² = .10). The means and standard deviations are presented in Table 2. As shown by the orthogonal contrasts, (a) the average of the alone and inattentive-audience conditions differed significantly from the average of the attentive and invisible-audience conditions, t(82) = 2.11, p < .04; (b) the difference between the alone and inattentive-audience conditions was only marginally significant, t(82) = 1.87, p < .07; and (c) the attentive and invisible-audience conditions did not differ from each other. No effects on false alarms were found.

Self-reports of distraction. Because participants’ ratings of internal and external distraction were reasonably intercorrelated (r = .45, p < .0001), we combined them to form an index of distraction, which we then analyzed with the same 4 (audience presence) × 2 (gender) ANOVA as the one used for the recognition data. No effects were found on this index. Separate analyses of internal and external distraction yielded the same conclusion. Overall, the level of reported distraction was low (M = 2.47, SD = 1.36).

Correlational findings. Stroop interference predicted recognition of the Stroop list words, F(1, 84) = 9.26, p < .004 (β = .32; R² = .10): The smaller the interference, the lower the recognition performance. The index of distraction correlated with neither the interference (or errors by item type) nor the recognition data. It did correlate, however, with latencies on the control stimuli (r = .24, p < .03).

Discussion

The present results are entirely consistent with the preliminary findings. Compared to the participants who worked alone, those who worked in presence of an attentive or invisible audience were faster at identifying the letter color cues of the incongruent color words. Consequently, Stroop interference decreased in the critical-audience conditions, compared to the alone and inattentive-audience conditions. As expected, participants’ recognition memory of the Stroop list words was especially low in the critical social conditions, suggesting that attention affected Stroop interference at an early stage where the degree of semantic processing could be altered. Taken together, the present findings provide further evidence that the mere presence of others can be associated with a reduction in cue utilization, at least when this presence is relatively unpredictable. Several points must be made here.

First, at a purely descriptive level, Figure 1 suggests that the most meaningful contrast is between the alone condition and all of the audience conditions. Unlike what happens in each of the critical-audience conditions, however, the apparent decrease of the interference in the inattentive-audience condition is not due to faster latencies on the incongruent words; it is due to longer latencies on the control items, and this makes a difference. This alternative contrast also implies that each social condition differed from the alone condition in the pilot work. Instead, the alone and inattentive-audience conditions did not differ from each other in Pilot Study 1, and this still holds in the present experiment (the second contrast was not significant). Likewise, contrasting the alone condition and all of the audience conditions would not really be justified for the recognition data. A decrease in recognition performance was expected in the social conditions where response speed on the incongruent words was significantly facilitated, relative to the alone condition, and this occurred only in the attentive- and invisible-audience conditions both in the pilot work (see Pilot Studies 2 and 3) and in the present experiment.

Second, in Pilot Study 2, participants responded faster regardless of item type when faced with the invisible audience, an effect that explains why Stroop interference did not decrease in the social condition. In the present experiment the interference decreased in the invisible-audience condition despite faster latencies on the control items, providing further support for the cue utilization hypothesis. As suggested earlier, the only way to make the overall pattern of results consistent with the dominant-response hypothesis is to deny the fact that word reading is the dominant tendency at an early stage before response output. This idea, however, runs

5 In their meta-analytic review of social facilitation, Bond and Titus (1983) found that females were slightly more facilitated than males by social presence on simple performance quantity. We tested here whether this applies to the Stroop task.
Table 2
Mean Latencies (in Milliseconds) for Both Types of Items and Recognition Rate as a Function of Audience Presence in Experiment 1

<table>
<thead>
<tr>
<th>Measure</th>
<th>Audience presence</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>None (alone) (n = 18)</td>
<td>Inattentive (n = 22)</td>
<td>Invisible (n = 22)</td>
<td>Attentive (n = 24)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incongruent words</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
</tr>
<tr>
<td>Control items</td>
<td>1.065</td>
<td>229</td>
<td>1.082</td>
<td>239</td>
<td>936</td>
<td>209</td>
</tr>
<tr>
<td>Recognition rate</td>
<td>895</td>
<td>177</td>
<td>963</td>
<td>200</td>
<td>835</td>
<td>145</td>
</tr>
<tr>
<td>Distraction index (self-reports)</td>
<td>0.87</td>
<td>0.13</td>
<td>0.77</td>
<td>0.18</td>
<td>0.75</td>
<td>0.16</td>
</tr>
</tbody>
</table>

against hundreds of articles on Stroop interference. If it were accurate, Stroop interference would never occur.

Third, because the stimuli were removed from the computer screen as soon as participants responded, participants who responded faster had a shorter exposure to the words. Consequently, poorer recognition of the Stroop list words could simply reflect briefer exposure to the words. This is why stimulus duration was controlled in the next experiment.

Finally, although our findings support the distraction/cue utilization perspective, there is no evidence in our data that distraction increased in the critical-audience conditions. The lack of audience effects on self-reports of distraction is not necessarily surprising, however: Individuals may be unable to reliably report on their attention allocation strategies, especially when self-reports are made retrospectively (see Nisbett & Wilson, 1977). However, whereas doubts have been raised as to the validity of direct verbal measures of distraction (e.g., “How distracted were you during the task?”; see Baron, 1986, p. 14), indirect measures, such as those used here, have been found to be sensitive to social presence manipulations (Baron, Moore, & Sanders, 1978; Sanders et al., 1978). Sanders et al. (1978), for example, used self-reports of attention (asking participants where they directed their attention) to assess distraction and found it to be higher in coaction conditions where social facilitation—impairment occurred. Thus, it may be that distraction did not play a significant role in the present findings.

Of particular interest here is the coaction paradigm, which is especially appropriate to examine the role of socially induced distraction in the context of the Stroop task. Competitive pressures are indeed high in most coaction situations. As suggested by Baron (1986), these pressures typically force the individuals to attend to their coactor(s) to gain social comparison information about their relative performance (see also Sanders et al., 1978). If distraction explains the previous effects, then distraction arising from the comparison checks on one’s coactor(s) should cause attention to focus regardless of whether social comparison is downward, lateral, or upward. Put differently, when coaction is associated with forced social comparison it should consistently facilitate Stroop performance. In previous studies, however, coaction facilitated performance only when participants engaged in lateral (Rijsman, 1974, 1983) or slightly upward (Seta, 1982; Seta et al., 1991) social comparison. No effects were found when forced social comparison was either downward or strongly upward. Although the role of distraction was not investigated in these studies, it seems that the motivation to do better in the presence of others, and not distraction per se, explained the performance effects. Likewise, if the motivation to do better than others plays a crucial role in Experiment 2 (i.e., if distraction is not the key process), Stroop interference should decrease only when participants engage in lateral or slightly upward social comparison with the person present.

Figure 1. The effect of audience presence on Stroop interference in Experiment 1.
Experiment 2

Method

Participants. Eighty undergraduates (40 women) volunteered to take part in the experiment, which was presented as before. Again, all had normal vision, were naive concerning the purpose of the experiment, and participated as a means of helping postgraduates and of learning more about experimental research in psychology.

Procedure and materials. Participants were met either by a male or a female experimenter, according to their own gender. They were given a description of the Stroop task and participated in five training, pseudo-Stroop sessions in which only color-neutral words were used. In this experiment, each word was removed from the computer screen after 200 ms. The stimulus duration was long enough for the words to be read, the color to be recognized, or both. It was also short enough that each word was off the screen before the computer key was pressed.

Participants in the coaction conditions performed the last training session in the presence of a same-sex confederate who worked on the task either slower, similarly, or faster than the participants. In the first and third coaction conditions, the confederate completed the task 40 s later versus earlier (on average) than the participants. In the second coaction condition (similar speed), he or she ended the task at the same time as the participants. As in the pilot studies, the presence of the confederate was supposedly incidental because of technical problems on the Stroop task in the adjacent room. In this experiment, however, participants learned that both their response speed and their errors were recorded by the computer. The confederate sat in front of another computer opposite the participants, on the edge of their peripheral vision, and never looked at them.

As in most coaction settings where individuals are working independently and simultaneously on identical tasks, the participants could readily attribute the difference in performance speed to a difference in ability. Several pieces of information, including performance levels and related attributes, were indeed provided to the participants. First, the confederate’s speed of performance throughout the task was made apparent to the participants. The confederate made particularly loud keypresses that could not be easily ignored. Not only did this force participants to compare themselves with the coactor, but it also was a source of distraction in each coaction condition. Second, the participants knew that the coactors had the same amount of practice as they did on the task (an attribute related to performance). Before performing the task, the confederate publicly informed the experimenter that he or she had performed only four training sessions before the computer crashed in the adjacent room. The participants also knew that the task instructions were identical for themselves and the coactor (both were instructed to respond as quickly as possible while minimizing errors). Finally, at the end of the last training session, the experimenter returned to the room with his or her technical assistant (same sex as the participants) to evaluate the participants’ error rate. Participants were told that this information was needed to determine whether they could continue with the Stroop session. Participants were publicly informed that their error rate was small and similar to that of their coactor. This suggested that they and the confederate did not differ in accuracy. Thus, participants working coactively were forced to compare themselves with the confederate, and those faced with a slower or faster coactor could readily attribute the difference in performance speed to a difference in ability.

The Stroop task (designed as before) was then performed, and the confederate behaved as in the last training session (e.g., worked either slower, similarly, or faster than participants). As before, the experimenter left the room both in the alone and in the social conditions in all sessions (including the training sessions).

Immediately after the Stroop session, participants were asked to complete a questionnaire, which included the checks on the manipulation. Participants in the coaction conditions were asked to rate how quickly they performed in relation to the coactor on a 7-point scale ranging from −3 (much slower) to +3 (much faster), including 0 (same speed). These ratings were also used as a measure of distraction. To be accurate, they indeed imply that some attention was allocated to the other person present. The two verbal measures of distraction used in Experiment 1 were also included. To see whether participants in the coaction conditions perceived that they did not differ from their coactor on response accuracy, they were also asked to rate how accurate they were on the task in relation to their coactor. These ratings were made on a 7-point scale ranging from much less errors (−3) to much more errors (+3), including 0 (same number of errors). Participants had exactly 4 min to complete the questionnaire.

Finally, participants were asked to recognize the words previously generated by the computer, as in Experiment 1. They were then debriefed, thanked, and dismissed. Both the Stroop task, including the training sessions, and the memory-recognition test were run using the same equipment as in the previous studies.

Results

Manipulation checks. We analyzed these data using 3 (coaction: slower coactor, similar coactor, faster coactor) × 2 (gender: male vs. female) ANOVAs with both variables as between-subjects factors. Only a main effect of coaction on perceived relative performance speed was significant, F(2, 58) = 114.46, p < .0001 (r = .81; see Figure 2). As revealed by the Tukey honestly significant difference (HSD) test (α = .05), relative performance speed was perceived to be higher in participants faced with a slower coactor than in those faced with a similar or faster coactor. It was also perceived to be higher in participants faced with a similar coactor than in those faced with a faster coactor. As expected, no effects were found on perceived relative performance accuracy (M = −.09, SD = .99, overall).

Latencies. Latencies were analyzed by means of a 2 (item type: incongruent words vs. control items) × 4 (coaction: none [alone], slower coactor, similar coactor, faster coactor) × 2 (gender: male vs. female) mixed ANOVA, with item type as the within-subjects variable.

Again, the main effect of item type was significant, F(1, 72) = 100.68, p < .0001 (r = .58). Latencies were longer for the incongruent words (M = 914 ms, SD = 160 ms) than for the control items (M = 853 ms, SD = 149 ms; interference = 61 ms). This effect, however, was qualified by a significant Item Type × Coaction interaction, F(3, 72) = 4.73, p < .004 (r = .17). The means and standard deviations are reported in Table 3. To better understand the overall interaction, we broke it down into three orthogonal contrasts, with the interference as the dependent variable (see Figure 3). The first contrasted the average of the alone and slower coactor conditions with the average of the similar and faster coactor conditions. The second contrasted the alone and slower coactor conditions. Finally, the third contrasted the similar and faster coactor conditions. If the motivation to do better than others is indeed a key factor in coaction effects, only the first contrast should be significant. As predicted, only this contrast was significant, t(76) = 3.48, p < .0009.

Errors. No effects were found. Again, the error rate was extremely low (2% overall).

6 Individuals are indeed not likely to engage in social comparison when the comparison target differs from themselves on attributes related to the comparison dimension (Goethals & Darley, 1977; Wheeler & Zuckerman, 1977).
Recognition performance. Only the main effect of coaction was significant, $F(3, 72) = 3.16, p < .04 (\eta^2 = .12)$. The means and standard deviations are presented in Table 3. As revealed by the Tukey HSD test ($\alpha = .05$), recognition performance was lower for participants faced with a faster coactor than for participants faced with a similar coactor, or for those who worked alone. As before, no effects on false alarms were found.

Self-reports of distraction. Participants’ ratings of internal and external distraction were again intercorrelated ($r = .47, p < .0001$) and were combined to form an index of distraction. This index was then analyzed with the same 4 (coaction) $\times$ 2 (gender) ANOVA as the one used for the recognition data. As before, no effects were found on this index ($M = 2.26, SD = 1.91$, overall). As suggested by the distribution of means in Table 3, it seems that distraction increased in each of the three social conditions, compared to the control condition. No effects were found, however, when using the Tukey HSD test ($\alpha = .05$). Separate analyses of internal and external distraction yielded the same conclusion.

Correlational findings. As before, Stroop interference predicted recognition hits, $F(1, 78) = 5.60, p < .03 (\beta = .26; R^2 =$

<table>
<thead>
<tr>
<th>Coaction condition</th>
<th>Measure</th>
<th>None (alone)</th>
<th>Slower coactor</th>
<th>Similar coactor</th>
<th>Faster coactor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
</tr>
<tr>
<td>Incongruent words</td>
<td>894</td>
<td>143</td>
<td>992</td>
<td>176</td>
<td>908</td>
</tr>
<tr>
<td>Control items</td>
<td>804</td>
<td>129</td>
<td>915</td>
<td>162</td>
<td>858</td>
</tr>
<tr>
<td>Recognition rate</td>
<td>0.75</td>
<td>0.14</td>
<td>0.72</td>
<td>0.18</td>
<td>0.78</td>
</tr>
<tr>
<td>Distraction index</td>
<td>(self-reports)</td>
<td>1.67</td>
<td>1.52</td>
<td>2.67</td>
<td>2.02</td>
</tr>
</tbody>
</table>

Note. $n = 20$ for each condition.
.07). The smaller the interference, the lower the recognition performance. The index of reported distraction correlated with neither the interference (or latencies and errors by item type) nor the recognition data.

Discussion

As expected, Stroop interference decreased significantly in participants faced with a coactor working similarly or faster than themselves on the task, compared with the two other conditions (alone and slower coactor). This decrease was associated with a reduction in recognition memory for the Stroop list words, at least in one of the two critical social conditions (faster coactor). The fact that this reduction did not occur when participants could engage in lateral social comparison with the coactor may seem surprising. However, the interference did not decrease because of faster latencies on the incongruent words in this condition (unlike what happens when participants could engage in upward social comparison). It decreased because of slower latencies on the control items, and this does not imply that participants screened out the incorrect semantic cues. At least four points can be made here.

First, not only were the means on perceived relative performance speed in the expected direction, but also those corresponding to the slower and faster coactor conditions did not reach the extreme points on the rating scale. This suggests that participants really did engage in social comparison with the confederate. Perceived extreme difference between themselves and the confederate could indeed prevent social comparison from occurring (see Festinger, 1954; Rijksman, 1974; Seta et al., 1991). Likewise, the lack of effects on relative performance accuracy suggests that participants faced with downward or upward social comparison did not attribute the difference in performance speed simply to the fact that they or the coactor did poorly on performance accuracy. Those faced with a slower or faster coactor could therefore attribute the difference in performance speed to a difference in ability.

Second, the idea that coaction increased distraction regardless of whether social comparison was downward, lateral, or upward is supported by our data. The fact that participants who worked coactively were accurate in their ratings of relative performance speed indeed implies that some attention was allocated to the confederate in each coaction condition. To the extent that this allocation of attention was similar in its intensity regardless of the direction of social comparison, distraction does not appear to be the causal mechanism for the present findings. Consistent with the results of previous coaction studies (Seta, 1982; Seta et al., 1991), it seems that participants who were faced with slightly upward social comparison expended more effort on the task, maybe as a means to achieve success. As suggested by Seta (1982), only slightly upward social comparison elevates the level of performance that is necessary to achieve success, avoid failure, or both (e.g., the performance goal or standard; see also Seta et al., 1991).

In this perspective, the fact that Stroop interference decreased in participants who engaged in upward comparison with the confederate is even more interesting. This fact indeed implies that word reading did not become weaker simply as the result of distraction but because it was actively inhibited by the participants. Thus, we believe that social comparison checks on the confederate increased distraction. We do not believe, however, that distraction per se caused attention to focus in the present study.

Third, there was an alternative explanation for the recognition findings in Experiment 1: Participants in the critical social conditions performed poorly on the recognition task because they had a shorter exposure to the words. This explanation is no longer acceptable in this new experiment, in which stimulus duration was made stable across trials. Thus, it can be reasonably assumed that participants who engaged in upward comparison performed poorly on the recognition task because of an early inhibition of word reading.

Finally, the lack of effects on self-reports of distraction is meaningful here. Put in relation with the accurate ratings of relative performance speed, it shows that participants working in the presence of others were unable to reliably report on their attention allocation strategies, as suggested previously.

General Discussion

These studies were designed both to show the dramatic impact that simple situations can have on well-established cognitive phenomena and to distinguish between two alternative explanations of social facilitation. Over the past 60 years, authors in the domain of the Stroop task have suggested that, when they must identify the ink colors of incongruent color words, individuals cannot refrain from accessing the meaning of words despite explicit instructions not to do so. Although this automatic response tendency is dominant only at an early stage, before response output, it is indeed a source of considerable interference that deteriorates response latencies on incongruent words. Our central question was whether this interference increases or decreases in audience and coaction situations. According to the classic view of social facilitation (Zajonc, 1965), the presence of others would enhance word reading and, therefore, increase Stroop interference. According to an alternative, cue utilization hypothesis, the presence of others would allow one to screen out the incorrect semantic cues and, therefore, reduce Stroop interference.

Taken together, the present results provide strong support for the cue utilization hypothesis. Stroop interference decreased in audience situations where the behavior of the person present was relatively unpredictable, compared with situations where this behavior was more predictable or in which participants worked alone. Likewise, Stroop interference decreased in coactive situations, especially when participants engaged in slightly upward social comparison with the person present, compared to situations where social comparison was downward or in which participants worked alone. In most cases, decreased Stroop interference was associated with a reduction in recognition memory of the words in the Stroop list, an effect that attests to the strength of the focusing phenomenon. Not only are these findings consistent with the results of past research on cue utilization (Bruning et al., 1968; Geen, 1976), but they also (a) extend these results in a number of important ways; (b) provide support for an alternative, attentional account of SFI effects; and (c) demonstrate the power of social situations over what has been thought to be invariant automatic processing in more than 500 articles on Stroop interference that have been published over the past 60 years.

Extensions of Previous Results on Cue Utilization

First, past research on cue utilization has examined the effects of being observed by a potentially evaluative audience. Our findings
show that even the mere presence of others can reduce the range of cue utilization, at least when the behavior of the person present seems unpredictable (attentive or invisible audience). The fact that the participants were either really or potentially observed by the person present does not imply that they felt evaluated in our investigation. Not only could the confederate be perceived as naïve about the color-word task, but also his or her presence was clearly incidental. Of course, one may wonder whether participants faced with the attentive or invisible audience experienced evaluation apprehension (e.g., Cottrell, 1968, 1972; Geen, 1980), even if this was not rationally justified. Cottrell's (1968, 1972) hypothesis assumes that evaluation apprehension would facilitate the emission of the dominant response, however. As such, it also predicts that the presence of an audience would increase Stroop interference (as does Zajonc’s [1965] hypothesis) and therefore is inadequate to explain our findings. Clearly, if evaluation apprehension occurred in the critical-audience conditions, it was associated with a reduction in the range of cue utilization, not with a facilitation of participants’ dominant response tendency. It has been sometimes claimed that the mere presence of others is sufficient for social facilitation effects to occur (see Zajonc, 1965; Bond & Titus, 1983). In contrast with this, the predictable audience did not affect Stroop interference, suggesting that mere-presence effects have indeed boundary conditions related to the predictability of the person present (see also Guerin, 1986, 1993; Guerin & Innes, 1982; Zajonc, 1980).

Second, because of its exclusive focus on audience effects, past research on cue utilization has not investigated coaction effects. Our results show that coaction can also cause attention to focus, but only when the individual engages in slightly upward social comparison with the person present. Moreover, it seems that attention focusing did not simply result from the fact that social comparison increased distraction but from participants’ willingness to expend their effort in front of a potentially self-threatening coactor. Collins (1996) argued that upward social comparison only sometimes results in more negative self-evaluations and is in fact frequently self-enhancing. The present findings show that upward comparison can also lead to better performance, even when this requires the inhibition of a powerful automatic, unintended cognitive process (see also Huguet & Monteil, 1995; Huguet, Charbonnier, & Monteil, 1999, for other social comparison effects on individual performance).

Third, the focusing phenomenon was assessed only on the basis of either facilitation or inhibition of performance in past research on cue utilization. The low recognition scores in the critical social conditions heighten our confidence that a reduction in cue utilization occurred in these conditions, in which semantic processing was not completely restricted as the Stroop effect remained. Lower recognition scores in social conditions also help identify the locus of the attentional mechanism by which social presence affected performance. Changes in long-term memory for the words in the Stroop list revealed that this mechanism took place, at least in part, at a stage prior to response output, where the degree of semantic processing could be altered. Once more, the fact that the recognition findings represent a disruption of automatic verbal processing attests to the strength of the focusing phenomenon. And this disruption is hard to assimilate with the dominant-response hypothesis: Facilitation of word reading would have increased recognition memory for the Stroop list words in the critical social conditions.

Fourth, our results show that a reduction in the range of cue utilization can occur even when it conflicts with the dominant-response tendency. In contrast with Zajonc’s (1965) hypothesis, social facilitation occurred in our investigation because of the inhibition (not facilitation) of this tendency. It is true that word reading is not the dominant tendency at the stage of response output, as indicated by the low error rate found in our research (as well as in most Stroop studies). It is dominant at a much earlier stage before response output, however, and this makes quite difficult any attempt to explain the present findings from the classic view of social facilitation. The fact that Stroop interference was reduced but not eliminated in most of the critical social conditions also reveals the strength of word reading at an early stage before response output.

Finally, our investigation also extends the pioneering efforts made by Crandall (1974), Gibbin (1974), and Lohss (1970) in their dissertation studies. As noted earlier, Crandall (1974) obtained consistent effects with the dominant-response hypothesis. He found that an audience group was slower in naming the color of incongruent words and faster in naming congruent words, suggesting that word reading is indeed the dominant response in the Stroop task. Although these effects did not occur in Crandall’s subsequent experiments, they suggest that Stroop interference may sometimes increase in social presence situations. Determining why the time needed to identify the ink color of incongruent words increased in Crandall’s pilot study, whereas it decreased in our investigation, seems difficult. Our audience findings are more consistent with those reported by Gibbin, who showed that the presence of an audience facilitated Stroop performance in young people. Likewise, our coaction findings are consistent with the results of MacKinnon et al.’s (1985) studies (see introductory section of this article). Because coaction covaried with a desired reward in these studies, it was unclear why Stroop interference decreased in the coaction–expected reward conditions (compared to when participants worked in isolation). The present findings suggest that coaction alone could reduce Stroop interference in these earlier studies.

An Alternative, Attentional Account of SFI Effects

The reduction in cue utilization facilitated performance in the present studies. This is not always the case, however. As suggested by Bruning et al. (1968) and Geen (1976), attention focusing can also inhibit performance when the task demands attention to a wide range of cues.7 There is therefore some reason to believe that the reduction in cue utilization is a valuable mechanism for explaining both social facilitation and social inhibition effects. This alternative view of SFI effects must be clarified, however.

First, definitions of central and peripheral cues are needed. In the present studies, we assumed that ink colors and words were the central and peripheral cues, respectively. But it could be assumed that the words were the central cues, in the sense that they are the cues to which attention was naturally drawn. The words were

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7 In contrast with past research on cue utilization, our investigation lacks the nice feature of both facilitating and inhibiting peripheral cues.
peripheral, however, regarding the task instructions. The letter color cues can be said to be central because they correspond to what the individuals were asked to identify; the words are peripheral because they must be ignored. In principle, reduced attention to peripheral, irrelevant, or interfering cues is adaptive and therefore may help explain social facilitation effects. Likewise, reduced attention to central or relevant cues is not adaptive and therefore may help explain social inhibition effects. That attention focusing may occur even when it is not adaptive can seem surprising. Past research on cue utilization provided evidence for this phenomenon, however.

Second, to be really attractive, the cue utilization view must offer predictions consistent with the well-established fact that social facilitation and social inhibition occur on simple and complex tasks, respectively. From Zajonc’s perspective, a simple task is a task in which the dominant response is correct, and a complex task is one in which the dominant response is incorrect. But a basic feature of most simple tasks is also that they require attention to a small number of central cues. On these tasks, the reduction in cue utilization should facilitate performance. Likewise, a basic feature of numerous complex tasks is that they require attention to a wide range of cues. On these tasks, the reduction in cue utilization should inhibit performance. Of course, what can be simple for some people (e.g., experts) can be complex for others (e.g., novices). Consequently, the cue utilization view of SFI effects is compatible with Zajonc’s (1965) fundamental idea that these effects depend on the individual’s prior experience or knowledge about the task at hand (well-learned tasks vs. new tasks). The attentional view, however, does not assume that the individual’s dominant (or more accessible) response is necessarily facilitated by social presence, even within optimal conditions. As the present findings suggest, highly accessible responses can be inhibited (by means of attention focusing) when they are inadequate, suggesting at least that what has been thought to be a rigid mechanism is in fact malleable to some extent. We do not believe, however, that Zajonc’s theory of SFI effects can integrate this malleability. In this theory, the dominant response is said to be socially facilitated because of an increase in the level of generalized drive-arousal that, in turn, multiplies differences in habit strength (at least when the stimulus evokes a hierarchy of mutually exclusive habits). Because this mechanism is theoretically not open to control, it cannot explain why extremely accessible responses can be socially inhibited when they are incorrect.

Finally, the underlying mechanism by which social presence causes attention to focus must be specified. Easterbrook (1959) suggested that increased emotional arousal reduces the range of cue utilization, acting both on perception and other cognitive and conceptual skills. But attention focusing is not necessarily associated with increased arousal. As noted by Cohen (1978), although the evidence seems to bear out that a focusing of attention does occur under conditions that are expected to cause arousal, autonomic indices often find no perceptible physiological changes (there is indeed little evidence that social presence increases arousal). Moreover, many situations that are not expected to induce physiological arousal but are designed to overload attentional capacity also result in attention focusing (see Cohen, 1978, p. 20; Kanarick & Petersen, 1969). Baron’s (1986) included this premise, and this inclusion is consistent with the results of recent research on attention focusing and arousal.

Derryberry and Tucker (1994), for example, reviewed evidence that arousal associated with feelings of failure or anxiety impairs accuracy and speed of response to peripheral targets both in the spatial processing domain (see also Newman et al., 1993) and within the verbal cognitive domain. Derryberry and Tucker even suggested that Spence and associates’ classic studies (see Spence, Taylor, & Ketchel, 1956) support the idea that increased arousal (related to anxiety) leads to a restriction in semantic scope. In these studies, anxious participants performed well in remembering words that were closely related (noncompetitional paired associates), but their performance was poorer than that of nonanxious participants with words that were remotely related (competitional paired associates). It is ironic that these results have been frequently conceived in the social facilitation literature as evidence that high levels of drive-arousal facilitate the emission of the dominant response (e.g., Cottrell, Rittle, & Wack, 1967), which is indeed generally correct on noncompetitional paired associates and incorrect on competitive paired associates. Consistent with the classic view of SFI effects, in the studies in which Spence et al.’s (1956) competitive paired-associate lists were used (see Baron et al., 1978; Berkey & Hoppe, 1972; Cottrell et al., 1967; Cridle, 1971; Kawamura-Recylonds, 1977; Manstead & Semin, 1980), the typical finding is that participants who worked in the presence of others performed more poorly than those who worked alone. If Derryberry and Tucker’s suggestion is accurate, however, it means that this typical finding also provides support for the cue utilization view of SFI effects! Consistent with this, Hartwick and Nagao (1990) noted that there is little empirical support for the prediction that social presence enhances performance on noncompetitional paired-associate lists. Although Baron et al. (1978) found a significant facilitation effect, Berkey and Hoppe (1972), Cottrell et al. (1967), Cridle (1971), Guerin (1983), and Kawamura-Reynolds (1977) all failed to support the prediction. The repeated failure to obtain social facilitation effects on noncompetitive paired-associate lists is quite problematic for the drive–dominant-response perspective. It is less problematic for the cue utilization view of SFI effects. According to this view, social facilitation does not necessarily occur on tasks in which there are no interfering cues to eliminate.

Thus, although more research is certainly needed to specify the way by which social presence produces attention focusing, it seems that it is today legitimate to take a more cognitive, attentional look at SFI effects (see also Geen, 1991, for complementary evidence that social presence increases attention focusing).

Contribution to a Basic Cognitive Issue

The impact that the presence of others may have on Stroop interference, as well as on other cognitive phenomena, is generally neglected by cognitive psychologists. Most experimentalists are aware that cognitive psychological experiments always take place in a social context and can be influenced by social factors. They perceive these factors to be minor in the understanding of cognition, however. In the Stroop literature, both the place where the

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8 Consistent with this, Baron (1986) noted that there are at least three studies in which arousal (e.g., fear) increased speed of response in the Stroop task (Agnew & Agnew, 1963; Calloway, 1959; Tecce & Happ, 1964).
experimenter stands and how he or she behaves during Stroop performance is never reported by authors. This does not help one make a clear interpretation of their findings, especially when the results of different Stroop studies are compared. As shown by our results, even subtle differences in testing arrangements can change performance on the Stroop task.

However, this point is less important than the general conclusion to be drawn regarding the Stroop literature: Our findings are inconsistent with the widespread view reiterated in this literature that lexical and semantic analyses of single words are uncontrollable in the sense that they cannot be prevented. Instead, it seems that it is possible to prevent the computation of semantics, a point suggesting that mental processes operating outside awareness are not necessarily inevitable (see Besner et al., 1997, for a similar argument). There is ample reason to believe, on the basis of the Stroop literature, that a significant amount of semantic processing can be controlled by elements of the task. As noted by MacLeod (1991), if the to-be-named color and the to-be-ignored words are presented in separate spatial locations, or if the color cues are presented 300 ms to 500 ms before the words (by manipulating stimulus onset asynchrony), Stroop interference will be reduced, compared to the standard, integrated version of the task. Our findings tell us a very different story, however. In the present studies, the color and word cues overlapped perfectly over time and space. Although this should make very unlikely any disruption of automatic verbal processing, this disruption generally occurred in the critical social conditions. Thus, automatic verbal processing can not only be controlled by elements of the task, but it also can depend on the social context in which cognition takes place.

The idea that automatic effects in the Stroop paradigm can be altered and overcome by attention is not really new (see Kahneman & Chajczyk, 1983; Logan, 1980; Logan & Zbrodoff, 1979; Logan, Zbrodoff, & Williamson, 1984). Logan and Zbrodoff (1979), for example, showed that when a cue provided advance information about whether the upcoming trial was congruent or incongruent, response time on cued trials was faster than on uncued trials. Such results can be taken as evidence that attentional-allocation policy is a critical element in the Stroop task (see MacLeod, 1991). As suggested by Logan (1980), however, the boundary conditions of attentional effects are well established neither in the Stroop paradigm nor in other major paradigms of cognitive psychology. The present findings indicate that these conditions must also be understood in relation to basic features of the social context in which human performance occurs. The fact that more can be learned about cognition when studying it in social situations is certainly interesting to cognitive psychologists. To the extent that cognitive processes elicited by nonsocial and social stimuli are not completely interchangeable, cognitive theories will be incomplete until theories address elemental and contextual social factors and processes (see also Montel & Huguet, 1999).

The present findings provide evidence that even relatively simple social situations can regulate human cognitive functioning. Of course, future research is certainly needed to understand exactly how this regulation operates. As such, however, our findings offer new reasons to “pay constant attention to the social environment of cognition” (Simon, 1990, p. 16): How people experience their social world, or what they come to believe about it, can play a significant role in determining primitive operations of cognition.

References


Appendix A

Stroop List Words According to the Color in Which They Were Generated

<table>
<thead>
<tr>
<th>Color generated</th>
<th>Blue</th>
<th>Green</th>
<th>Red</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green</td>
<td>Red</td>
<td>Yellow</td>
<td>Blue</td>
<td></td>
</tr>
<tr>
<td>Cherry</td>
<td>Sky</td>
<td>Ocean</td>
<td>Blood</td>
<td></td>
</tr>
<tr>
<td>Sun</td>
<td>Canary</td>
<td>Fir</td>
<td>Lawn</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>Orange</td>
<td>Grey</td>
<td>White</td>
<td></td>
</tr>
<tr>
<td>Tar</td>
<td>Cotton</td>
<td>Coffee</td>
<td>Mouse</td>
<td></td>
</tr>
</tbody>
</table>

Appendix B

Distractors Used in the Memory Recognition Test

apricot, ashes, azure, banana, bean, brown, carrot, chick, chocolate, coal, corn, cornflower, crow, ham, lemon, lilac, lizard, mauve, meat, milk, mint, mud, navy, night, pig, pink, plant, plum, poppy, pumpkin, purple, salmon, sea, smoke, snow, strawberry, sugar, rat, tree, tomato

Received May 18, 1999
Revision received June 11, 1999
Accepted June 11, 1999