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Differential Acquisition of Automatic Responses Among High and Low Hypnotizable Subjects

Teeya Blatt

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ABSTRACT

Differential Acquisition of Automatic Responses Among High and Low Hypnotizable Subjects

Teeya Blatt

The present thesis attempted to answer some current questions regarding the relation between hypnotizability and perceptual automaticity. The major issues discussed included the convergence of subjective reports from high hypnotizable (HH) subjects regarding the nonvolitional or automatic nature of hypnotic responding. The nature of these experiences contrasts with the hypnotic experiences of low hypnotizable (LH) individuals, which are typically described as willful, deliberate actions in accord with the provided suggestions. This difference in subjective experience corresponds to currently investigated differences in perceptual automaticity between high and low responsive individuals, where automaticity is defined as quick, mandatory processing that does not rely on cognitive resources (Posner & Snyder, 1975). The procedure of the present experiment replicated and extended those of MacLeod and Dunbar's (1988) study. HH and LH groups were provided with 2,304 practice trials naming four novel shapes, called RED, BLUE, GREEN AND YELLOW. The automaticity with which these shapes were processed was assessed in a Stroop-like task, where red, blue, green and yellow colors constituted the second stimulus dimension. Interference and facilitation effects from both colors and shapes were assessed following 288 and 2,304 shape-naming trials. Response time data indicated that relative to the LH group, the HH group was quicker to display symmetrical interference from both dimensions of the stimuli. Based on these and additional results, it was cautiously concluded that HH subjects are quicker than LH subjects to acquire automatization of the shape-names. The implications of these results are discussed in terms of contemporary theories of hypnotizability differences.

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Differential Acquisition of Automatic Responses Among High and Low Hypnotizable Subjects

Since first coined by Franz Anton Mesmer in the late eighteenth century as Animal Magnetism, the phenomenon now identified as hypnosis has invariably been enveloped in mystery, mysticism, and myth. This is true of most early academic treatments of hypnosis, as well as its representation to the general public (Laurence & Perry, 1988). To the layperson, hypnosis stirs up images of intense, staring eyes, of gently swaying pocket watches, or trance-like automatons obeying each of the hypnotist's requests; a mysterious and powerful ritual. These images persist to this day; however, current propagation of these myths is due more to the self-proclamations of stage and lay hypnotists than to investigative procedures.

In contrast, historical scientific treatment of hypnosis has varied from indifference or even disdain to substantial interest and inquiry. Laurence and Perry (1988) described how the history of hypnosis was characterized by cycles of enthusiasm and scepticism which reflected the scientific climate of the time. These cycles were characterized by periods of academic antipathy for hypnosis, during which the phenomenon seemed to disappear from scientific inquiry, followed by a resurgence of interest in hypnosis leading to active experimentation (Laurence & Perry, 1988; LeCron & Bordeaux, 1949). As a consequence, conceptualizations of the phenomenon developed through distinct phases, in accordance with the zeitgeist of the era. For example, Mesmer attributed the cures he obtained with the use of animal magnetism to the transmission of a universal invisible fluid, a popular concept in science and medicine at the end of the eighteenth century (Laurence & Perry, 1988); at the start of the nineteenth century, the Marquis de Puységur described the phenomenon as a form of artificial somnambulism from which subjects emerged spontaneously amnesic for the events that had occurred while in the state; and Charcot in the late nineteenth century considered it a process analogous to hysteria.

Contemporary theories, however, encompass more numerous aspects of the hypnotic context. Presently, hypnosis is described as a social situation involving the subject, who displays alterations in memory, perception and action in response to suggestions provided by the hypnotist (Kihlstrom, 1985). Also, with the evolution of more sophisticated theorizing and experimentation, hypnosis has proven useful in applications within fields as diverse as dentistry (Gerschman, Burrows, Reade & Foenander, 1979), clinical psychology (Crasilneck & Hall, 1975), anaesthesiology (Marmer, 1959) and forensic investigations (Orne, Soskis, Dinges, Carota Orne & Tonry, 1985). Thus, from a past prominent with innovative thinkers and despite controversial precedents, hypnosis emerged gradually as a valid and rich area of scientific inquiry.

Notwithstanding the changes in the conceptualizing of hypnosis, there have been two consistent observations related to this phenomenon. First, as early as 1775, Mesmer wrote that not all of his patients were equally responsive to magnetism. This was the first known report of hypnotic susceptibility (or hypnotizability) as a distributed trait-like characteristic, an observation that has since been and continues to be repeatedly corroborated (Laurence & Perry, 1988). The second point regards the involuntary nature of magnetic or hypnotic responding. Laurence and Perry (1988) provide an account of the 1784 secret report of the Benjamin Franklin Commission to the king of France, the first known to describe the apparently involuntary nature of the responses of susceptible subjects. Involuntariness has consistently been described as a characteristic of hypnotic responding, and remains a central issue in current investigations (P. Bowers, 1978, 1982; P. Bowers, Laurence & Hart, 1988), including the present one. The first of these two issues will be discussed next; the issue of involuntariness will be referred to throughout this thesis and will be developed as an important premise for the hypotheses of this experiment.

The present thesis will summarize three current theoretical perpectives of hypnosis, while providing special consideration to their respective explanations of hypnotic involuntariness. These will provide the reader with a framework with which to assess the experimental investigations discussed in this thesis. Subsequently, the present thesis will critically examine empirical attempts to uncover correlates of hypnotizability. This will provide the background for the purpose of the present experiment. First, however, the scales used to measure hypnotizability will be described.

Hypnotizability Scales

Although reported by Mesmer as early as 1775 (Laurence & Perry, 1988), the importance of individual differences in responsivity to suggestions was first systematically emphasized by the Abbé di Faria in the nineteenth century. Faria's observation that only a limited number of individuals were capable of responding to "lucid sleep instructions"[1] has stood the test of time, and with the development of hypnotizability measures, has also been repeatedly substantiated (e.g. Piccione, Hilgard & Zimbardo, 1989). These measures will be described next as they bear directly on the issue of individual differences in hypnotizability.

The standardization of hypnotizability categorization scales in the second half of this century (see E. Hilgard, 1965 for a review) was instrumental in the resurgence of investigations of hypnotic phenomena within the last 30 years. Contemporary assessments of hypnotizability consist of relaxation instructions followed by a series of hypnotic suggestions. The suggestions range from simple ideomotor movements (e.g., asking subjects to hold out their arm and imagine it getting heavier), to items that challenge subjects' initial response (e.g., following suggestions for arm rigidity, asking subjects to "try to bend your arm, just

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[1] Faria's change of nomenclature was largely due to his observation that somnambulism or magnetism was a naturally-occurring phenomenon. In his 1819 book, Faria dismissed the mysterious "causes" and rituals surrounding animal magnetism as "extravagances", and so preferred to use a more common term of lucid sleep in reference to the phenomenon (Laurence & Perry, 1988).

try"), to yet more difficult[2] suggestions requiring alterations in cognition or perception (e.g., suggested posthypnotic amnesia).

Two of the most widely used scales are the Harvard Group Scale of Hypnotic Susceptibility: Form A (HGSHS:A) of Shor & Carota-Orne (1962) and the Stanford Hypnotic Susceptibility Scale: Form C (SHSS:C) of Weitzenhoffer & E. Hilgard (1962). As its name implies, the HGSHS:A is administered in groups and is generally considered an initial assessment, verified with more stringent, individually administered scales, such as the SHSS:C (Register & Kihlstrom, 1986). Both scales consist of a relaxation induction followed by a standardized series of twelve suggestions. Although the SHSS:C includes more difficult cognitive items, objectively verifiable responses to suggestions on both scales are weighted equally, yielding scores that range from 0 to 12.

Repeatedly, these instruments have been subjected to statistical tests of validity and reliability, which have yielded consistent results. For example, several studies found correlations of approximately .60 between the HGSHS:A and the SHSS:C (Coe, 1964; Evans & Schmeidler, 1966; E. Hilgard, 1978; Register & Kihlstrom, 1986). This relation in all likelihood reflects convergence of the ideomotor and challenge items contained in both scales. Test-retest reliability coefficient of .85 was obtained for the SHSS:C (E. Hilgard, 1965), indicating that it is a valid measuring device. Ten, fifteen and twenty-five year follow-ups of an original 1960 study have revealed stability coefficients of .64, .82 and.71, respectively, on SHSS:C scores of 50 subjects (see Piccione et al., 1989). These scales thus present valid and reliable indices of hypnotizability.

Using these and similar scales, it has been demonstrated by numerous independent studies that hypnotic abilities are stratified within the population. Repeatedly, it has been found that 10 to 15% of the

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2 "Difficult" here is referred to in the statistical sense. Difficult items are those to which only a relatively small proportion of subjects respond successfully. For example, only approximately 30% of subjects respond successfully to the HGSHS:A amnesia item (Laurence & Perry, 1982).

population are highly responsive, (i.e., they are capable of experiencing most suggestions including post-hypnotic amnesia). Similarly, 10 to 15% of the population are either unresponsive, or minimally so. The remaining majority of 70 to 80% are moderately responsive, and to varying degrees (E. Hilgard, 1965). Furthermore, hypnotizability appears to be a relatively stable characteristic of the individual (E. Hilgard, 1965; Piccione et al., 1989; Perry, 1977), apparently not subject to long-lasting change by modification or deepening procedures (Gill & Brenman, 1959; Shor, Orne & O'Connell, 1962), although current attempts have been made to challenge this latter point (see Spanos, 1986; Spanos, Cross, Menary, Brett & de Groh, 1987, see Bates & Brigham, 1990 for a rebuttal).

Given that individual differences in hypnotic abilities are a fundamental aspect of this research area, a pertinent line of inquiry is the delineation of underlying mechanisms that differentiate individuals of varying hypnotizability levels. Indeed, the search for correlates of hypnotizability is germane to the present thesis. Therefore, a description of past studies of correlates of hypnotizability will follow. However, prior to this, contemporary theories of hypnosis and hypnotizability will be outlined, to provide the reader with a framework with which to understand the implications of such studies.

Current Theories of Hypnotizability

Contemporary theories regarding the mechanisms underlying hypnotic responding have been subsumed under two contrasting perspectives (see Spanos, 1986). At one extreme is the *special process* view, (a term coined by Spanos, 1986), which emerged from the *state* view that characterized the hypnotic experience as an altered state of consciousness. This theoretical framework is contemporarily represented by E. Hilgard's (1974) structural *Neo-dissociation* theory. On the other hand, the *social-psychological* perspective (Spanos, 1986) emphasizes that hypnosis is a situation not any different from other social situations, where subjects strive to behave in a manner which they believe is expected of them. The contrast between the mechanisms proposed by these two schools of thought have been the subject of vigorous debate in the literature. However, there exists a third, more recent position that represents a consolidation of the above two, termed a *synergistic* view (Nadon, Laurence & Perry, 1990). Proponents of the synergistic perspective take into consideration the contextual demands of the hypnotic interaction, but also recognize the primary importance of the individual abilities that subjects bring into this setting. Further elaboration of these three positions should clarify certain issues basic to the investigation of correlates of hypnotizability.

Neodissociation Theory: A Structural Perspective

E. Hilgard's (1974/1977) Neodissociation theory reflects a structural model of daily cognitive functioning. The neodissociation model consists of a central controlling structure and multiple interacting subsystems. Normal cognitive functioning is exemplified by the interaction of an executive and monitoring systems, both under central control. The executive function is responsible for planning, initiating and sustaining action commensurate with some goal. The monitoring function acts as a feedback mechanism, attending to the progress of the execution of some task and modifying behaviour if necessary for its completion. The interplay between these two normally well-balanced systems is responsible for day-to-day reality-monitoring and, when necessary, directs appropriate behaviourial and/or perceptual modification.

According to the neodissociation model, hypnosis represents a situation during which the interaction of executive and monitoring systems is temporarily suspended. Normal cognitive functioning is divided into executive and monitoring fractions by an amnesia-like barrier (E. Hilgard, 1974, 1977, 1978). The monitor continues to function but is blocked from awareness by the amnesic barrier. This division effectively diminishes the monitor's ability to modify executive functioning. Researchers holding this view argue that persons able to experience hypnotic suggestions possess essential cognitive abilities that lead to this fractioning, what E. Hilgard

(1974) calls dissociation. Persons unresponsive to hypnosis, on the other hand, either lack some or all of these abilities (E. Hilgard, 1977) or for some as yet unagreed upon reason, are unwilling to use them when the context is defined as hypnosis (Spanos, 1986).

Although dissociative processes are not ordinarily at the forefront of cognitive functioning, they are effectively tapped using hypnotic procedures (Sutcliffe, Perry & Sheehan, 1970). Proponents of this theory maintain that the dissociative process is important to the subjective experiencing of hypnotic responses as involuntary. E. Hilgard proposes that while reality monitoring processes are blocked from phenomenological awareness, control of the executive function is temporarily relinquished to the hypnotist (the extent of the control that is relinquished is constrained by the degree of hypnotic abilities). Consequently, able subjects are susceptible to responding to suggestions provided by the hypnotist, who acts as an agent of the monitoring function. Executive control, then, may be directly activated by the verbal suggestions provided by the hypnotist, which are experienced as nonvolitional hypnotic responses (Miller & Bowers, 1986). By thus postulating that the psychological connection between an activating suggestion and its subsequent enactment is dissociated from phenomenological awareness, this theory accommodates the subjective experience of nonvolition that is characteristic of highly responsive subjects' reports, (Lynn, Rhue & Weekes, 1990).

A basic tenet of neodissociation theory is that the dissociative process mediates successful responses to suggestions requiring cognitive or perceptual alterations (e.g., hypnotic suggestions for analgesia). Specifically, the theory holds that hypnotic suggestions for analgesia are unencumbered by higher executive processes and therefore directly activate the relevant cognitive subsystems that results in a dissociation of the perception of pain.

E. Hilgard (1977) proferred the "hidden observer" suggestion as a metaphor for information that is dissociated but continues to be processed. Following hypnotic analgesia suggestions, responsive subjects report experiencing reductions in pain. It is then suggested to these subjects that a hidden part of them is aware of pain that is experienced out of consciousness. The experimenter attempts to communicate with this hidden observer to access dissociated pain. Subjects who respond to such suggestions report levels of hidden pain that are similar to the levels of non-analgesic pain.

The hidden observer phenomenon is a fundamental component of neodissociation theory, it is experienced by only approximately 50% of high hypnotizable (HH) subjects (E. Hilgard, 1978; Laurence & Perry, 1981), and not by medium or low hypnotizable (LH) subjects (Knox, Morgan & Hilgard, 1974; Hilgard, 1977, Nadon, D'Eon, McConkey, Laurence & Perry, 1988), or simulators (Nogrady, McConkey, Laurence & Perry, 1983), unless task motivated to do so (Spanos, 1986; Spanos & Hewitt, 1980). Access to dissociated experiences are available to only 50% of HH individuals, although these subjects, as a group, are distinguished by their ability to experience cognitive alterations and distortions (Orne, 1980).

The findings of Laurence and Perry (1981) bear directly on this conundrum. These authors report that the incidence of hidden observer experiences in their studies was predicted by reports of duality during an age regression item, duality referring to the experience of feeling simultaneously as adult and child during the age regression suggestion, as opposed to feeling solely as a child. In view of this, the authors proposed that different cognitive styles are represented within HH group, and that differing responses to the hidden observer suggestions reflects such differential cognitive styles rather than a direct index of cognitive structures. It follows that subjects capable of manifesting the hidden observer may have an attentional capacity for simultaneously representing two conflicting states of affairs in awareness (Kihlstrom, 1985), while subjects who do not experience the hidden observer may achieve a different degree of involvement in the suggestion, absorbing all of their attention. Such individual differences in response styles is a more parsimonious explanation of the differential behaviours of HH subjects than is dissociation or related mechanisms.

Although Hilgard noted the rarity with which hidden observer reports occur, and indeed suggested that the hidden observer was "a finding of more theoretical than practical interest" (E. Hilgard, 1982, p.38), the heuristic value of the theory has been contended (Spanos, 1983; 1986). Specifically, the amnesic barrier and hidden observer are essential but unfalsifiable concepts of the theory. For example, it has been asserted that positive responses to hidden observer instructions validate the concept of dissociated pain, while negative responses are attributed to an impenetrable amnesic barrier (E. Hilgard, 1977). Thus, the theory is circular without the benefit of elucidating substantial variance in behavior. Notwithstanding its usefulness in capturing the nonvolitional aspect of subjective hypnotic responses, neodissociation theory awaits empirical ratification. Nonetheless, Hilgard's theory represents an initial step towards an increasingly cognitively-oriented view of hypnotic abilities.

Social-Psychological Perspective

A second, social-psychological or cognitive-behaviourial position places more emphasis on contextual variables to explain hypnotic behaviour. Social psychological proponents maintain that the ability to respond to suggestions reflects a combination of situational variables that include; defining the situation as hypnotic, a tendency to comply, positive attitudes and expectations regarding the nature of hypnotic responding and appropriate interpretation of the suggestions. Proponents of this perspective argue that subjects who score low on susceptibility scales, have, for example, negative attitudes and expectations, or are unaware of how to interpret suggestions.

An important tenet of this argument is that implicit and explicit demands in the hypnotic situation influence the behavior of responsive individuals. Consequently, these subjects are likely to actively engage in cognitive strategies, such as becoming absorbed in imagining the suggested effect, which assist them in responding appropriately. This argument further maintains that in the process of initiating and sustaining behaviours consonant with a good hypnotic role, subjects may come to misattribute or erroneously interpret their behaviour or responses as involuntarily instigated (Spanos, 1986). In other words subjects voluntarily instigate processes by which they will come to experience their responses as occurring involuntarily. By contrast, subjects who interpret suggestions literally, or wait passively to experience the suggested effects, are consequently likely to fail suggestions. Failure to respond to suggestions reinforces pre-existing negative expectations of future hypnotic responsivity (Council, Kirsch & Hafner, 1986). Negative expectancies, in turn, moderate responsivity to implicit demands for nonvolitional responding. Thus, differences in hypnotic behaviour are attributed within this perspective to individual differences in expectations and in compliance.

These contrasts in suggested subjective experiences are considered by proponents of this position to be context-dependent. Council, Kirsch, Vickery & Carlson (1983), for example, argue that the obvious demands of the hypnotic context to behave appropriately, as well as subjects' expectations of their hypnotic responsivity are diminished when the context is not defined as hypnotic. These authors maintain that when these antecedent factors are removed, differences in reports of subjective experiences are reduced. This theorizing led to the contention that altering inappropriate interpretational sets and/or preconceived attitudes regarding hypnosis is sufficient to modify measured hypnotizability. According to proponents of this position, substantial gains in responsivity can be obtained following appropriate training procedures. A training program, aimed at inculcating positive expectations and attitudes regarding responsivity, as well as instructing subjects on how to interpret suggestions, has been developed to demonstrate this point.

The Carleton skill training program consists of three components. The first component consists of providing subjects with positive information about hypnosis. The second component follows, during which appropriate behaviour is modelled by a confederate. During this demonstration, subjects are encouraged to employ imaginal strategies, with emphasis on the importance of becoming absorbed in the imaginings, in order to experience behaviourial responses as involuntary. Lastly, subjects are instructed on how to actively interpret suggestions. For example, subjects can develop the experience of an arm rising by itself by slowly lifting an arm while becoming absorbed in the image that it is being pulled upward by a balloon (Spanos et al., 1987).

Several studies have found substantial increases in responsivity following this training program (Gorassini & Spanos, 1986; Spanos et al., 1987; Spanos, de Groh & de Groot, 1987; Spanos, Robertson, Menary & Brett, 1986; Spanos, Robertson, Menary, Brett & Smith, 1987). In an attempt to replicate this finding as well as to determine which component(s) of the program is most effective, Bates & Brigham (1990) administered in counterbalanced sequence what they termed the information, modelling and instructions components of the program. The results of this study stand as the only independent report replicating the original findings. These results revealed significant increases in objective, behaviourial responsivity scores of initially LH subjects. Subjective scores, however, were unaffected by the intervention. The authors suggested that the application of this training program may encourage behaviourial compliance, but is not successful at effecting corresponding gains in the subjective experiences traditionally associated with hypnosis. Hence, trained subjects were "behaving" hypnotized, but were not experiencing their responses as occuring involuntarily. This differential effect is supported by results of the component analysis of the study, which clearly indicated that the instructional component was the one responsible for the evidenced change in behaviourial scores. Thus, the authors concluded that compliance and not hypnotic ability is increased by the skill training program.

It is certainly conceivable that contextual and instructional factors play certain roles in the hypnotic experience, and indeed, under some circumstances (e.g., real-simulator designs, see Orne, 1959) they may play determinative roles in the nature of subjects' responses. However, the critical components of the context that lead HH subjects to claim that their responses are involuntary and to apparently believe in this aspect of their experience, have not yet been identified. As Nadon, Laurence and Perry (1989) pointed out, the mechanism underlying reports (or misattributions) of involuntariness remains to be explained, as well as how and under what circumstances these reports can be predicted *a priori*.

In summary, while it is well documented that HH and LH subjects differ in terms of their subjective reports of involuntariness, little in the way of consensus has been reached concerning the reasons underlying such attributions. Proponents of Hilgard's divided consciousness position account for reported involuntariness by proposing that the normal monitoring facet of the executive function has been separated from awareness by the dissociative processes that are mobilized in the hypnotic context. Alternatively, advocates of the social psychological perspective assert that highly responsive subjects engage in a form of self deception to arrive at the subjective feelings of involuntariness, while providing instructions to do so is evidently not sufficient to obtain reports of involuntariness. Both explanations focus on relatively sophisticated cognitive processes that are proposed to occur in hypnosis. As such, the mechanism by which subjective experiences of responses to suggestions are felt as involuntary remains unsatisfactorily explained. A third, and perhaps more thorough account of such feelings of involuntariness will be discussed within a framework that to date most comprehensively accommodates existing results.

Synergistic Perspective

The synergistic perspective represents a methodological and statistical philosophy that advocates an interactionist approach to studying hypnotic suggestions (Nadon et al., 1989). These authors emphasize the efficacy with which this approach can be used to reconcile current controversies in the field. Specifically, this position represents an integration of the special process and social-psychological viewpoints, with emphasis placed on the combination of skills required for the emergence of hypnotic responsivity in a given situation. As such, the synergistic interpretation attempts to accommodate the roles played by: a) dispositional variables (such as absorption or imagery); b) moderating variables (especially those identified by proponents of the social psychological perspective, such as attitudes, expectations and motivation); c) situational variables (such as implicit or explicit contextual demands); and d) the effects of these variables in combination.

This multidimensional approach to the investigation of hypnotizability is supported by results from studies assessing the impact and interrelations of several variables. This multivariate approach permits the investigation of complex effects without unduly complicating experimental designs. For example, the effects of independent variables with and without the inclusion of moderating variables on some criterion variable can be examined with a manageable sample size. Overall, these studies indicate that interaction effects provide significant amounts of information over and above that obtained from main effects alone (e.g., Button, Blatt, Lamarche, Laurence, Nadon & Perry, 1991; Dixon, Labelle & Laurence, 1991; Labelle, Laurence, Nadon & Perry, 1990; Nadon, Laurence & Perry, 1987). Furthermore, studies that use multivariate approaches may serve to elucidate not only differences between hypnotizability groups but additionally, the long-observed (E. Hilgard, 1965; Perry, 1977) considerable within-group variability displayed by HH subjects (Nadon et al., 1990). This possibility in conjunction with significant multivariate findings in the literature constitute support for an interactionist or synergistic approach.

This synergistic perspective asserts that hypnosis is a context-defined construct, but that hypnotizability can be understood in terms of individual abilities that are apparent within as well as outside of the hypnotic context (Nadon et al., 1989). For example, in a memory retrieval task, absorptive ability, which has been demonstrated to be significantly related to hypnotizability (see Nadon, Hoyt, Register, Kihlstrom, 1991 for the most recent findings) had a significant influence on nonhypnotic performance. When hypnosis was introduced, however, hypnotizability became an influential variable alone, as well as in interaction with absorption (Button et al., 1991). These findings suggest that the effects of hypnotizability and other individual differences are better understood in light of the context of testing (Nadon et al., 1989). Thus, the synergistic interpretation accords importance to contextual factors, although primary emphasis is placed on the influence of pre-existing individual differences.

Furthermore, it is maintained that to the extent that individual abilities are related to hypnotizability, they should be apparent outside of the hypnotic context as well (also, see Nadon et al., 1991). However, these pre-existing individual differences between HH and LH subjects may be exacerbated by variables within the hypnotic context (Nadon et al, 1990). This possibility provides a basis for the mechanism by which imagery plays a role in the modification of hypnotizability (e.g., Spanos et al., 1987). For example, the goal of skill-training is to maximize motivational variables, attitudinal factors, or interpretational sets to increase responsivity to suggestions in an hypnotic context. This may produce increments in responsivity in LH subjects by way of increasing the likelihood that these subjects mobilize requisite cognitive skills such as imagery. The proportion of LH skill-trained subjects that consequently appear behaviourially similar to HH individuals (e.g., Spanos et al., 1987), may in fact come to utilize such skills strategically. However, HH subjects do not require instructions as to how to behave, nor do they spontaneously use strategies to help them respond (Sheehan, Donovan & MacLeod, 1988). Hence the nature of responses for HH and LH subjects remains intrinsically different. This difference may in turn attest to inherent differences in underlying processes, despite the behavioral similarities in HH and skill-trained LH responses. Synergistic proponents maintain that these are the differences that are tapped in standard hypnotic sessions.

In sum, although synergistic and social-psychological theories recognize the importance of individual differences and contextual variables in hypnotic responsivity, they assign different levels of importance to each. The social-psychological position holds that the hypnotic context is essential in eliciting differences in hypnotic responsivity whereas the synergistic position holds that individual differences between HH and LH subjects are not limited to hypnotic contexts. A paradigm that assesses individual abilities that are not obviously related to hypnotizability, outside of the hypnotic context may shed a light on this debate. In such a paradigm, any resulting differences between HH and LH subjects may not be attributed to hypnotic context effects or to differential tendencies for compliance on the parts of naive subjects.

Correlates of Hypnotizability

To date, attempts to identify correlates of hypnotizability have varied in focus, with many studies yielding inconsistent findings or small relations. A brief description of these investigations follows.

Personality and Physiological Correlates

Given the stability of hypnotic susceptibility, early theorists offered the reasonable postulate that a "hypnotic or hypnotizable personality" might exist. To this end, investigators, starting with Hull (1933), searched for relations between hypnotizability and numerous personality inventories. Hull correlated various personality characteristics such as acquiescence, hysteria and neuroticism with hypnotizability, but was unable to find substantial or consistent relations (Barber, 1964; K.S. Bowers, 1976; E. Hilgard, 1965). Subsequently, researchers used pencil and paper inventories such as the California Personality Inventory, the 16 Personality Factor Scale, the Minnesota Multiphasic Personality Inventory, and others in an attempt to define the "hypnotic personality" (see E. Hilgard, 1965), but these correlations were also either small or unreliable. Eventually, it became clear that hypnotic responsivity could not be understood simply in terms of traditional personality characteristics.

Attempts to find physiological correlates of hypnotizability or hypnosis also met with little success. For example, following hypnotic suggestions to experience fear, guilt, anxiety or depression, Galvanic Skin Response (GSR) and heart rate alterations of hypnotized individuals were comparable to those of a LH comparison group who were instructed to simulate being HH (Damaser, Shor & Orne, 1963). Correlations with other physiological indices (e.g., electroencephalogram activity, see Crasilneck & Hall, 1959 for a review, and more recently, Nadon, Laurence & Perry, 1987) also proved unfruitful.

Cognitive Correlates

Research focus then turned to the relation between hypnotic responsivity and indices of cognitive functions. Shor (1960; Shor, Orne & O'Connell, 1962) and later, Evans (1982), for example, proposed that the apparent ability of hypnotized subjects to experience subjective alterations of consciousness may be evident *out* of the hypnotic context, in the natural occurrence of "hypnotic-like" experiences. One example that was intensively investigated was the ability to voluntarily control various aspects of sleep processes. In a series of studies, Evans and his colleagues (Evans, Gustafson, O'Connell, Orne & Shor, 1966; 1969; 1970) investigated the relation between hypnotizability and response to suggestions administered to sleeping subjects. Overall, these studies found small but positive correlations (but see Perry, Evans, O'Connell, Orne & Orne, 1978). In a related line of inquiry, results from investigations of voluntary control of dream processes were generally positive. Gibson (1985) found that women who enjoyed dreaming, reported having creative ideas in their dreams in addition to reporting the feeling that their future was foretold in their dreams were on average, more hypnotizable than women who reported the opposite pattern. Additionally, a significant relation between hypnotizability and voluntary control of dreams in response to presleep instructions was reported by Belicki and P. Bowers (1982). Finally, in the statistical prediction of hypnotizability scores, Nadon, Laurence and Perry

(1987) found that the inclusion of a"sleep-dream" score added significant discriminatory power to their test. These findings lend support to Shor's (1960) and Evans' (1982) postulate that abilities related to hypnotizability can be found in contexts outside of the hypnotic setting.

In general, however, the nature of hypnotic experiences was studied for clues as to what abilities may underlie hypnotic responsivity. For example, in light of the fact that many standard hypnotic items request subjects to "imagine" the outcome of a suggestion, such as an arm getting heavier and heavier, it was reasoned that subjects with good imaginative abilities were more likely than subjects poor in these abilities to become involved and consequently respond to such suggestions. Moreover, it was proposed that imaginative activity plays a role in responses to suggestions for hallucinations or age regression in some hypnotized subjects (Sheehan, 1979).

Imaginative and Absorptive Correlates

An agreement exists in the literature regarding importance of imaginative abilities to hypnotic experiences. Numerous researchers agree that hypnosis is characterized by the setting aside of critical judgment, (without abandoning it) and indulgence in make-believe and fantasy (Gill & Brenman, 1959; E. Hilgard, 1977). From this viewpoint, hypnosis has been referred to as "believed-in imaginings" (Sarbin & Coe, 1972); "involvement in suggestion-related imaginings" (Barber & Ham, 1974) and "imaginative involvement" (J. Hilgard, 1979) and HH individuals have been called "fantasy addicts" (Wilson & Barber, 1982), who are "deluded" in a descriptive, non-pejorative sense (Sutcliffe, 1961). Based on their extensive interviews with subjects scoring very high on the hypnotizability continuum, J. Hilgard (1979) and Wilson and Barber (1982) emphasized the importance of vivid imaginal activities as indicative of hypnotic responsivity. In the lab, however, the relation between imaginative ability and hypnotizability has proven less straightforward than expected.

Various aspects of imaginative activity have been investigated in relation to hypnotic susceptibility. Sutcliffe, Perry and Sheehan (1970) investigated the relation between vividness of imagery, assessed by Sheehan's (1967) shortened version of Betts Questionnaire Upon Mental Imagery (QMI) and hypnotizability, assessed by SHSS:C. The resulting correlation was significant for males but not females. Upon closer inspection of their data, however, Sutcliffe et al. (1970) found that the pattern of the relation in their study was nonlinear; subjects with low scores on the QMI were almost invariably low hypnotizable whereas higher ranges of hypnotic ability were not differentiated by imagery scores. This nonlinear pattern was later replicated by Perry (1973) and by other independent investigators (J. Hilgard, 1979). It should be noted that nonlinear relations are generally underestimated by linear assessment techniques, especially with small samples that are more likely than large samples to represent a truncated distribution of population scores. This may be one reason for the discrepant results found in past studies of imagery vividness. Nevertheless, it appears that the inability to vividly imagine suggested items predicts insusceptibility to hypnosis better than the converse (Sheehan, 1979).

Extending this line of thought, Isaacs (1982) reasoned that if vivid imagery does not differentiate high hypnotizability from the lower levels of the spectrum, subjects' *preference* to become involved in imaginative abilities may play an important role. Using such a distinction, Isaacs (1982) developed a measure of preference for imagery, as opposed to ability for or involvement in imaginative activities. The Preference for an Imagic Cognitive Style (PICS) was designed to measure not only imagic thinking style, but also relative engagement in verbal, absorptive and effortful styles of mentation when thinking about a number of suggested scenes. The Effortful subscale of this questionnaire represents an attempt to distinguish the involuntary nature of HH subjects' experiences from the more effortful responses of LH subjects. Not surprisingly, Isaacs found that HH subjects (assessed by HGSHS:A) tended to prefer imagic and effortless thinking styles while LH subjects tended to score higher on the verbal and effortful subscales of the PICS. Corroborating these results are those of Nadon, Laurence and Perry (1987), who found that the PICS related significantly to SHSS:C measures of hypnotizability in two independent samples.

Another aspect of cognitive experiences that has been proposed to account for high hypnotic responsivity is subjects' degree of absorption in their subjective experiences. To this end, the questionnaire yielding the most reliable correlations with hypnotizability to date is Tellegen and Atkinson's (1974) scale (TAS) of openness to absorbing and self altering experiences (or simply, absorption). According to Tellegen (1981), the TAS taps a disposition, penchant, or readiness to enter states characterized by marked cognitive restructuring that involves a motivational-affective component and utilizes considerable attentional resources (Tellegen & Atkinson, 1974). The TAS is comprised of 34 statements to which subjects respond as true or false of their experiences, for example, "if I wish, I can imagine some things so vividly that they hold my attention as a good movie or story does".

Initial studies of the relation between the TAS and hypnotizability (assessed by HGSHS:A) produced significant correlations ranging from .27 to .42 (Tellegen & Atkinson 1974)[3]. The relation between absorption and hypnotizability has subsequently been replicated (Finke & Macdonald, 1978; Roberts, Schuler, Bacon, Zimmerman & Patterson, 1975; Spanos & McPeake, 1975a). However, Roche and McConkey (1990) report in their review of the literature on absorption, that although consistently significant, the size of the correlations between absorption and

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[3] Construction of the TAS was based on data from all female samples, a characteristic of the questionnaire that may possibly account for subsequent findings that females tend to score higher on the TAS than males (Crawford, 1982; Farthing, Venturino & Brown, 1983; Spanos, Brett, Menary & Cross, 1987). Alternately, these findings may reflect either a greater disposition on the part of females to engage in experiences tapped by TAS or a greater willingness to acknowledge such experiences. It has been suggested that interpretation of results concerning TAS data should consider the possible moderating effects of gender (K.S. Bowers, 1971), although this relation requires further empirical substantiation.

hypnotizability vary greatly ranging from $r = -.19$ to $r = .89$ (Roche & McConkey, 1990). Several possible mediating factors have been proposed to account for the variability of the absorption-hypnotizability relation. The studies examining these mediating effects will be discussed later, in the section on psychosocial influences.

With the use of sophisticated multivariate statistical techniques, a number of investigators have attempted to delineate the relative importance of the above cognitive components in their relation to hypnotizability.

Multivariate Approach.

Nadon et al. (1987), used a multivariate approach to determine the relative importance of vividness of imagery, absorption, cognitive style preference (as measured using the QMI, TAS, and PICS, respectively) and other questionnaires, to predict hypnotizability. In two separate experiments, the predictor variables were entered into a stepwise discriminant analysis to classify subjects of high, medium or low hypnotizability levels as assessed by the SHSS:C. In the first of these experiments, the QMI and PICS significantly accounted for unique variance at their respective steps, together correctly predicting 57% of sample grouping, but the TAS failed to significantly contribute to the equation.

In a second experiment, designed to replicate and extend these initial results, the QMI failed to account for significant amounts of unique variance and was dropped from the equation. Results from the second experiment indicated that TAS in the first step and PICS scores in the second, together correctly classified 49% of the subjects. The equation served primarily to classify subjects of LH and HH groupings (55% of each compared to 37% of mediums). Examination of the data led the authors to conclude that LH subjects as a group possess less abilities for absorption in imagery-related activities than do HH subjects. Alternatively, the authors suggest that LH subjects may prefer not to use these abilities under attendant circumstances.

The pattern of these results was replicated in a study by Dixon, Labelle and Laurence (1991). Using multiple regression analyses, these authors found that PICS scores predicted significant amount of HGSHS:A variance over and above that predicted by TAS, both in original and cross-validated samples (17% of hypnotizability variance was predicted by the second step for both samples), indicating internal consistency and reliability of the equation. In predicting the more stringent SHSS:C scores, the TAS accounted for significant amount of variance, while the PICS failed to add predictive power (accounting for only an additional 1% of SHSS:C variance). Significant zero-order correlations between PICS and SHSS:C led the authors to suggest that the absorption component of the PICS may be responsible for its previous predictive power (in the first experiment)[4]. Thus, although previous studies have identified several interesting relations between various individual abilities and hypnotizability, a complete understanding remains elusive.

Psychosocial influences

Several possible psychosocial variables (such as contextual variables, including defining the situation as hypnotic, attitudes towards hypnosis, and subjects' expectations regarding responding to suggestions) have been proposed to mediate the relation between various cognitive factors and

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4 Dixon, Labelle & Laurence, (1991) reported reservations regarding the validity of the PICS as a psychometric instrument. PICS scores are obtained by subtracting the Imagery and Absorption subscale scores from the sum of Effort and Verbal scores. Resulting scores can theoretically range from -22 to +24. In practice, however, this study found that of 748 subjects, not one scored below -7, suggesting that the range of possible PICS scores is actually truncated. Furthermore, a high score on the PICS represents a style of mentation characterized by high absorption and effortless imagery, with little preference for verbal thoughts. The medium range of scores, on the other hand, can represent numerous thinking styles, for example, a subject indicating a high preference for verbal as well as imagery style, with little effort involved can obtain an overall PICS score identical to that of a subject indicating little preference for verbal or imagery style, but high absorption. Thus, the distribution of PICS scores is skewed, reflecting some asymmetry in the computational process.

hypnotizability. Several investigators claim that these uncontrolled variables establish the nature of the relation between hypnotizability and some of the cognitive variables discussed above. Council and his associates (Council, Kirsch, Vickery & Carlson, 1983; Council, Kirsch & Hafner, 1986) for example, adopted an expectancy model of hypnotic responding in arguing that the relation between absorptive and hypnotic abilities is "face obvious" and that responses on the TAS influence subjects' subsequent hypnotic performance. According to these investigators, the results of their experiments indicated that the absorption-hypnotizability relation is context-dependent, mediated by expectancies of hypnotic response (i.e., the power of absorption to predict hypnotizability became insignificant when variance due to expectancy was accounted for). Based on their critique of the statistical procedures used in these studies, however, Nadon et al., (1991) questioned the validity of this conclusion. Nadon et al. found that when erroneous statistical procedures were accounted for, context effects failed to achieve significance. On the contrary, significant correlations between absorption and hypnotizability were found even when absorption was measured in a context different from the one in which hypnotizability was assessed. In light of these latest findings, it is apparent that further experimentation is required to establish the mediating role of context demands in hypnotizability relations.

Methodological and statistical considerations aside, several studies have found that unfavourable attitudes toward hypnosis (Spanos & McPeake, 1975b; Spanos, Brett, Menary & Cross, 1987; Yanchar & Johnson, 1981) and negative expectancies regarding hypnotic response (Council et al., 1983; Council et al., 1986) result in deflated correlations between various cognitive and hypnotic abilities. These findings are consistent with psychosocial explanations of hypnotizability and hypnotic phenomena in general, and have been offered as a reason for the variability of hypnotizability - absorption correlation coefficients (Roche & McConkey, 1990). Various investigators contend that the mediating role of psychosocial variables indicate that hypnotizability is a context-specific concept and not applicable outside the hypnotic situation.

As was discussed in an earlier section describing the main theoretical positions taken by investigators of this area, this argument and the emphasis placed on possible mediating variables is currently being strenuously debated a (also see Spanos & Chaves, 1989, and a rebuttal by Nadon, Laurence & Perry, 1989). The finding of objectively verifiable hypnotizability differences outside of hypnosis may provide a resolution to this debate. To this end, possible perceptual and attentional correlates of hypnotizability have been examined.

Information Processing Factors

Recently, investigators have assessed attentional and speed of processing variables in relation to hypnotizability. Because these studies have traditionally used visual stimuli (e.g., Ingram, Saccuzzo, McNeill & McDonald, 1979; Saccuzzo, Safron, Andersen & McNeill, 1982; Friedman, Taub, Sturr, Church & Monty, 1986), their generalizability to similar processes in other sensory modalities (e.g., auditory) remains open to question. However, the findings from such studies are nevertheless important because they employed tasks administered in contexts removed from the hypnotic one, an issue pertinent to the debate between synergistic and social-psychological theories of hypnotic responsivity.

Attentional factors have been implicated as important components of the hypnotic process, especially because they appear to relate to absorption. Various investigators have proposed that individual differences between HH and LH subjects may be accounted for by differences in attentional capacities (e.g., Graham & Evans, 1977; Karlin, 1979). This postulate stems from the necessary cognitive processing of the verbal hypnotic suggestions, the speed of which may rely on attentional factors. Underlying differences in speed of processing hypnotic instructions or in attention to these instructions may manifest as differential hypnotic responsivity.

Ingram et al., (1979) investigated whether HH subjects process information at a faster rate than LH subjects using a backward masking paradigm. Backward masking involves presenting a target stimulus, in this case, letters of the alphabet, followed after a brief time interval by a non-informational pattern mask (e.g., XXXXX). Subjects are required to name the target stimulus as fast as they can. In comparison to unmasked stimuli, however, the mask interferes with the speed and/or accuracy with which the preceding target stimulus is named. The critical component in this paradigm is the time duration, in milliseconds (ms.) between target offset and mask presentation, which is referred to as interstimulus interval (ISI). At very short ISIs, identification of the target is very difficult, but with increasingly longer ISIs, naming the target becomes easier. The initial ISI used in this study was increased in regular steps until the mask no longer interfered with recognition of the target. It follows that the shorter the ISIs associated with correct recognition of the target, the faster the rate of information transfer. A significant difference was found with HH subjects having lower mean critical ISI scores than LH. The investigators proposed that HH subjects process information at a higher or more efficient rate than their LH counterparts[5]. However, as the authors acknowledged, these results, although significant, may be unreliable because only one measure of ISI data was obtained for each subject, leaving ample room for measurement error.

A later study (Saccuzzo et al., 1982), in an attempt to replicate Ingram et al.'s, (1979) findings, used both forward and backward masking of target letters. No differences between the hypnotizability groups were found in the forward masking conditions. However, in the first of two sessions of backward masking tasks, HH subjects demonstrated faster

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5 The data for HH and LH subjects revealed no differences in the threshold of stimulus duration required for perception. Thus, the amount of time necessary for the stimulus to achieve perceptual awareness was similar for HH and LH subjects. This finding was interpreted as reflecting a comparability in the information intake capabilities of HH and LH subjects.

speed of processing than LH subjects.[6] The authors concluded that this constituted evidence that HH subjects showed a superior ability to evade the effects of the mask because they were faster or more efficient at processing information than were LH subjects. They suggested that a possible explanation of the findings is that HH subjects do not evaluate input as carefully as do their low hypnotizable counterparts at early stages of processing. Interpretation of these data, however, is limited by possible ceiling effects, and as pointed out by others (Friedman et al., 1986) by possible differential motivation.

The authors of both the above studies attributed their findings to differences in attentional capacities of HH and LH subjects. These findings are inconsistent with context-specific interpretations of hypnotic behavior because the differences between HH and LH were found in a context removed from the hypnosis. However, the interpretation of these results need to be qualified in light of results from Friedman et al.'s, (1986) study. These investigators were unable to find significant differences between HH and LH subjects in speed of processing. The stimuli used in this experiment was a target test flash (presented prior to a larger bright masking stimulus), whereas verbal stimuli were used in the two previous studies (Ingram et al., 1979; Saccuzzo's et al., 1982). Friedman et al. (1986) proposed that the discrepancy in their more recent results may be due to the different levels of processing required of verbal and test flash target stimuli, whereby recognition of letter-stimuli may require more complex processing than that required by the more neutral test flash stimuli. This possibility is corroborated by findings in the attentional literature (e.g., Posner & Snyder, 1975; Shiffrin & Schneider, 1977) which indicate that the speed of processing of stimuli that had been submitted to long-term learning (e.g., letters) is substantially faster than the processing of fairly novel stimuli, (e.g., test

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[6] Although these authors noted that LH subjects showed a nonsignificant increase in correct responses from Session 1 to Session 2, a possibility not considered by the investigators is that LH subjects obtained practice during Session 1 that equated their performance to that of HH group by the second session.

flashes).

The expectation that the two types of stimuli would yield differential effects gains further support when one considers the verbal nature of hypnotic instructions and suggestions. A compelling argument proffered by Dixon, Brunet and Laurence (1990) is that the verbal aspect of the instructions may tap differences with which HH and LH subjects process verbal information. Dixon et al., (1990) proposed a parallel distributed processing model of information processing whereby HH subjects process verbal information more automatically than LH subjects. In order to fully appreciate their theory and findings, elaboration of the nature of automaticity is required.

It has been well documented that highly practiced acts, such as the fine motor movements of a touch typist, can take place automatically. The automaticity with which these acts are performed can, in some situations, also lead to responses that cannot be inhibited, and are, in this sense involuntary. For example, although nonsense syllables such as "erd", must be voluntarily processed, when the letters are rearranged as "red", one involuntarily processes these letters as a lexical whole, automatically registering that this lexical item has semantic meaning (Dixon, 1990). In fact, according to Posner and Snyder, (1975) one of the hallmarks of such automatic processing is that it occurs involuntarily. Automatic processes are considered involuntary by virtue of their being rapid and not requiring the use of cognitive resources. By contrast, controlled processes are considered slower, dependent on processing strategy and require cognitive resources (Schneider & Shiffrin, 1977). Performance of novel tasks is typically considered to rely on controlled processing. However, with extensive practice, performance of some controlled tasks can become automatic (e.g., playing a video game) (Logan, 1985; Schneider & Shiffrin, 1977).

Many theories of skill acquisition, of which automaticity is a major factor (Logan, 1988a), are based on the notion that the nature of underlying cognitive processes undergoes qualitative changes in the transition from non-automatized or controlled activation to one characterized by some degree of automatization (Logan, 1988b; Schneider & Shiffrin, 1977 and see Ackerman, 1988). Many of these theories identified three phases to this process (see Ackerman, 1988). Schneider & Shiffrin (1977) labelled these phases controlled, mixed controlled and automatic, and automatic processing. Automatization of a novel process necessarily requires an ordered progression through these phases.

The progression through these phases has been conceptualized in two separate models of automatization. One view conceptualizes automatic and controlled processing as dichotomous, independent cognitive procedures. Logan points out that the dichotomy is between *automat-is* and *automat-isn't* (1985, p.372), that is, the acquisition of automaticity occurs without degrees, and relies on the speed of processing. A second view stresses that the contrast between automatic and controlled processes may be artifactual of a style of theorizing rather than a theoretical necessity demanded by the data (Logan, 1985). Logan (1985) argued that these processes need not be considered mutually exclusive, and indeed, findings that automaticity can be achieved gradually through practice attest to its continuous nature (Logan, 1985; MacLeod & Dunbar, 1988; Posner & Snyder, 1975). Using a variant of the frequently utilized Stroop task, MacLeod and Dunbar (1988) constructed a task to quantitatively assess these competing theories. This task will be described next.

The classic Stroop task involved presenting either color words (BLUE, or RED) or control stimuli (e..g., a series of Xs) in different colors (Stroop, 1935), and measuring reaction times to naming the color. A robust finding is that when the word and color are incongruent (e.g., BLUE in red ink), reaction time to naming the color is slower than when naming the color of a series of Xs. The automatic, involuntary processing of the word thus interferes with naming the color, even when attention is focused on the color rather than the word (Posner & Snyder, 1975). Similarly, automatic processing of the word results in faster reaction times for congruent trials (when the word and color are the same, e.g., RED in red ink), relative to control trials, although this facilitation effect is more elusive than the interference effect.

In their studies, MacLeod and Dunbar (1988) emphasized the asymmetry of the Stroop effect, whereby words interfere or facilitate the naming of colors, but never vice versa. They exploit this characteristic of the phenomenon to demonstrate that automatic processes conform more to a continuous rather than dichotomous conceptualization. The model of a continuum of automaticity is rivalled by the *relative speed of processing* theory, which has come to be known as the "horse-race" model. Speed of processing theory predicts that the faster of two processes will interfere with the slower one, by virtue of speed alone. Although the difference between automaticity and the relative speed theory is not immediately evident, the theories can be contrasted by the predictions they make regarding the effects of the manipulation of certain stimulus parameters.

Using an analog of the Stroop task, MacLeod and Dunbar (1988) provided their subjects with practice naming four unfamiliar shapes (from the set of random polygons of Vanderplass & Garvin, 1959) presented in one of four colors; green, blue, orange and pink. Unfamiliar stimuli were used to equate subjects on level of automaticity (or the lack of it), in order to trace the development of automaticity as practice increased. The shapes were also called GREEN, BLUE, ORANGE and PINK, to permit the construction of congruent, incongruent and control stimuli. During congruent trials, shape-name and color were the same, and during incongruent trials, shape-name and color were not the same. Control trials during shape-naming tasks consisted of a white shape and during color-naming tasks, consisted of a colored square.

In their first experiment, four groups of subjects were provided with either 16, 192, 288 or 576 shape-naming trials, in an attempt to determine the point at which shape-naming begins to interfere with color-naming. Data consisted of reaction times to naming colors on shapes (the critical task during which shape-name may interfere with color-naming) and also to naming shapes in color. The investigators found no evidence that shape affected color-naming (i.e., no facilitation or interference effects were found during color-naming trials) but that colors both facilitated (on congruent trials) and interfered (on incongruent trials) with shape-naming irrespective of the amount of practice obtained. The authors noted that the finding that color-naming appears to be an automatic process in this first experiment is inconsistent with findings during standard Stroop tasks where color-naming appears to be a controlled process. This point is important, the authors argued, because it conflicts with a strict all-or-none view of automaticity. However, further evidence is necessary to convincingly rebut the all-or-none theory of automaticity. For example, the question of whether these results were due to the relative speeds of processing colors and shapes, as opposed to the automaticity with which the stimuli were processed, was not addressed by the experimental design.

The second experiment reported by these authors addressed these questions by providing subjects with considerably more practice naming shapes. Subjects in this experiment were provided with 2,304 shape-naming trials spread over 5 days (288 trials per day). Tests of automaticity were administered only at the end of the first and fifth day, and at follow-up 3 months later. The investigators reasoned that training in shape naming without concomitant practice in color naming would speed up the process of naming shapes with little change in the rate of naming colors, thereby permitting a contrast of the automaticity of the two processes. Results showed consistent interference and facilitation effects in shape-naming trials (i.e., colors interfered or facilitated shape-naming). Interference effects of shapes on color-naming emerged only on Day 5 and these effects persisted at follow-up. The results of experiment 1 and 2 taken together indicate that 2 days of training were not enough to equate the two processes, but 5 days were. These findings are accommodated by both continuum of automaticity and relative-speed theories. Both theories predict that interference and facilitation effects should be evident in both dimensions after sufficient practice. Thus, it remained to be determined whether shape naming had become as automatic or as fast a process as color-naming.

A third experiment was conducted, providing subjects with 20 sessions of shape-naming practice, to determine whether colors would stop interfering with shape-naming. Results of this experiment indicated that as shape-naming practice progressed through 20 sessions, the potential of the shapes to cause interference in color naming increased. The reverse was true for the effect of incompatible colors on shape-naming; interference effects of colors on shape-naming that were apparent on Day 1 diminished by Day 20. This indicates that the automaticity with which shape-names were processed increased with practice, relative to the automaticity of the color-naming process, thus refuting the argument that automaticity is an all-or-none phenomenon. Moreover, the processing times of control stimuli of both colors and shapes were equivalent at Day 20, (i..e., it took just as long to name a white shape as it did to identify the color of a square). The prediction of relative speed of processing theory concerning the effects of processing two dimensions at roughly equal rates is straightforward. This theory predicts that two dimensions processed at the same rate would result in equivalent interference effects. The asymmetry of interference effects apparent in the present study contradicts relative speed of processing predictions, but is consistent with the continuum of automaticity account that shape-naming had become more automatic than color-naming.

The results of these studies establish the continuous nature of automatic processes. This characteristic of automaticity is pertinent because, within a Stroop-like task, it allows two processes to be compared in terms of their *relative degree* of automaticity. This in turn permits the quantification of automaticity in terms of interference, and sometimes facilitation effects (MacLeod & Dunbar, 1988).

Dixon, Brunet and Laurence (1990) proposed that HH and LH subjects differ in the automaticity with which they process verbal information. The authors reasoned that the likelihood of triggering a behaviourial response to a verbal suggestion increases in relation to the automaticity with which the verbal content of the suggestion is processed.

As such, subjects who display more automaticity in processing words may also be more responsive to verbal hypnotic suggestions. Because automatic processes do not require cognitive resources, automaticity may also account for the mechanism by which hypnotic responses are subjectively experienced as occurring involuntarily. Based on this, these authors postulated that what may distinguish HH from LH subjects is the relative degree of automaticity with which they process verbal cues.

To test their hypothesis that HH subjects have greater automaticity in processing words than LH subjects, Dixon et al. (1990) compared their performance under various parameters of verbal stimuli in a Stroop-like task. These investigators predicted that compared to LH subjects, HH subjects would show larger automaticity effects[7]. A first experiment compared the performance of 5 HH and 5 LH subjects in a paradigm described by Cheesman and Merikle (1986). The results indicated that HH showed larger Stroop effects than LH under conditions where the word stimuli were clearly visible. The findings of this experiment thus suggested that HH subjects showed more automaticity in the processing of verbal information than did LH subjects. A second experiment was conducted using a larger sample of 27 subjects (9 subjects in each high, medium and low hypnotizability groups) which corroborated the results of the first. High but not medium or low hypnotizable subjects showed significant differences between congruent and incongruent trials under visually degraded conditions, where differences between congruent and incongruent reaction times were due exclusively to differences in automatic processing (and not to strategic processes). As the authors asserted, this represents one of the few replicated findings concerning such perceptual differences between HH and LH subjects in an experimental situation that is actually removed from the hypnotic context. The authors concluded that the results of their experiments constitute evidence that HH subjects

7 Automaticity was defined as greater differences between reaction times for congruent (word and subsequent color patch are the same) and incongruent (word and subsequent color-patch are not the same) trials.

process verbal information more automatically than their low hypnotizable counterparts.

This conclusion was consistent with results from a study that separated automaticity effects from possible strategic processes (Dixon & Laurence, 1991, in press). In this study, subjects were instructed to implement performance optimization strategies to decrease reaction times. HH subjects were more adept at implementing these strategies relative to LH subjects. However, under conditions that controlled for the implementation of strategies, HH subjects continued to show significantly more automatic verbal processing than LH subjects. The previous contention that HH subjects process words more automatically than LH was thus supported.

These findings are pertinent to the question of the importance of context effects in hypnotized subjects' responses. Consistent with predictions from a synergistic position, Dixon and his associates (Dixon, Brunet & Laurence,1990; Dixon & Laurence, 1991, in press) found that cognitive differences in HH and LH subjects are apparent outside of hypnotic contexts. While consistent with a synergistic viewpoint, social-psychological interpretations, on the other hand, would have difficulty explaining the hypnotizability effect on an objective criterion such as the Stroop task, out of the hypnotic context.

Moreover, verbal automaticity may underlie the nonvolitional aspect of hypnotic experiences. Automatic processing, it will be remembered, relies very little on cognitive resources. Hence, HH subjects may subjectively experience responses to hypnotic suggestions as occurring without volition because little cognitive resources are devoted to processing the verbal instructions. Indeed, verbal automaticity may be the mechanism by which absorption and imagery are linked to hypnotizability. Cognitive resources not used for processing verbal instructions in HH subjects can be devoted to skills such as imagery and absorption, which in turn may contribute to hypnotic responsivity. For those subjects adept at imaginative and absorptive involvement, then, the automatically processed instructions may initiate images that contribute to sustained responsivity. Responding would thus be characterized by effortlessness rather than by willfulness. In the context of hypnotic analgesia, Miller and Bowers (1986) found just such an effect when they manipulated various conditions and found that only the HH subjects who were hypnotized and received analgesia suggestions experienced reduced pain without the use of cognitive strategies. Dixon, Brunet and Laurence (1990) note that this theory accommodates the findings of previous studies, (such as Ingram et al.,1979; Succuzzo et al., 1982) and also may represent the mechanism underlying differences in the ability to respond to verbal suggestions when hypnotized.

Differences in automaticity may be confined exclusively to verbal domains, or alternatively HH subjects may have a more general automatic information processing capacity. It may be tempting to investigate various other cognitive processes that may be more automatic in HH than LH subjects, but a more methodical question is whether HH subjects simply achieve automaticity at a faster rate than their LH counterparts. In other words, the speed at which novel information becomes processed automatically may be different for HH and LH subject. In practical terms this question becomes, can HH subjects achieve automaticity of some novel task with less practice than is required for the same end by LH subjects? The resolution of this question is the primary aim of the present study.

The present experiment investigated whether HH subjects acquire automaticity faster than LH subjects. The type of stimuli employed in such an inquiry is necessarily limited to stimuli which are entirely novel, in order to equate subjects at baseline. Ideally, both HH and LH groups should have had no exposure to the stimuli at initial baseline measures. In their study, MacLeod and Dunbar (1988) provided their subjects with novel stimuli in an attempt to evaluate the effects of practice on automaticity. This paradigm is particularly appropriate to the question at hand, and was adopted for the present thesis.

Stimuli were obtained from low-association-value random polygons selected from the set developed by Vanderplass and Garvin (1959). Subjects were thus equated in terms of initial automaticity. As well, the experimenter was blind to hypnotizability grouping in order to avoid any uncontrolled influence on subjects' performance on the task. HH and LH subjects in the present experiment were provided with five shape-naming practice sessions, in replication of MacLeod and Dunbar's (1988) second experiment, which indicated that shape-naming had become automatic by day 5 of training.

There are several hypotheses in this experiment. First, it is expected that shape-names will interfere with color-naming for all subjects by the fifth training session. Second, it is hypothesized that the HH group will achieve greater automaticity of processing shapes and have more difficulty inhibiting the responses to these stimuli than their LH counterparts. It is expected that this effect will be evident by way of larger interference effects during color-naming tasks for HH subjects than for LH subjects. In addition, because shape-naming is originally the less practiced task, it is expected that colors will interfere with naming shapes at Day 1, but that this effect will be attenuated with 5 days of shape naming practice. Finally, this attenuation effect is expected to be magnified for the HH as compared to the LH group, because although both groups of subjects have had a lifetime experience of naming colors, it is hypothesized that the HH group will display a more automatic response.

Method

Subjects.

Ten male and ten female subjects (mean age = 24.05 years, s.d. = 4.37) were selected from a pool of undergraduate students who had undergone hypnotizability assessment using the Harvard Group Scale oof Hypnotic Susceptibility: Form A (HGSHS:A) of Shor and Carota-Orne (1962) and the Stanford Hypnotic Susceptibility Scale: Form C (SHSS:C) of Weitzenhoffer and E. Hilgard (1962) as part of standard laboratory procedure in the previous year. Subjects were selected based on their SHSS:C scores, (HH, mean = 9.1, s.d. = 1.2; LH, mean = 1.4, s.d. = 1.08). Twenty subjects (ten in each group) were tested. Subjects were contacted by phone and asked to participate in a study conducted by the Cognition Laboratory that involved naming colors and unfamiliar shapes. Subjects were told that their task would be to play a "video game" as fast as possible, without making errors, and try to beat their own score each time they played. No mention was made of hypnosis or hypnotizability. Subjects signed a consent form prior to testing that informed them that they would be paid $50 at the end of the experiment.

Apparatus.

All stimuli were displayed on an Electrohome Color Monitor that was interfaced to an Apple II+ computer via an Electrohome Supercolor board which allowed higher resolution graphics to be presented in color. Trials were initiated by pressing a button on a button box. A voice activated relay recorded reaction time, defined as the interval between stimulus onset and the subject's vocal response, for trials in all phases of the experiment. Accuracy was scored by the experimenter who observed every trial and added the accuracy information to the data file. The button box and the voice activated relay were interfaced to the computer by a John Bell Board which afforded +2 ms accuracy. Stimuli were observed through a 1 meter viewing tube.

Stimuli. Color patch stimuli consisted of 8 cm by 2 cm rectangles.

The colors were red, blue, green and yellow. Shape stimuli were four low-association-value random polygons selected from the set developed by Vanderplass and Garvin (1959), with the restriction that they be highly discriminable from each other (see Appendix A for visual characteristics of the stimuli). The shapes were presented in white for control trials during shape-naming phases and during all shape-training sessions. For color-naming sessions, shapes were filled in red, blue, green or yellow color. The shapes were presented in the same spatial location as the color patches. A small centrally located fixation dot cued subjects to press the button that initiated each trial.

Procedure.

The procedure of the present experiment is a replication of experiment 2 of MacLeod and Dunbar's (1988) study, with minor modifications. Where more considerable deviations from the original experiment occur, they are noted.

Phase 1: Color-naming baseline. Prior to baseline trials, subjects were shown each of the four color patches and told the color's name, in case of ambiguity in identification. After this familiarization, two blocks of 32 color-naming trials were conducted, each color appearing on a square 8 times per block. This procedure deviates from that in MacLeod and Dunbar's study. In their study, colors in phase 1 were presented on the random shapes that were subsequently named, whereas the present study presented colors on neutral squares. The reason for this modification is to avoid idiosyncratic associations that subjects may make to the shapes, thus ensuring that the shape-stimuli remain equally novel across subjects.

Phase 2: Shape-name training. At the outset of this phase, subjects were shown the four shapes one at a time and told the shape's name. Subjects were informed that they could take this opportunity to study the shapes at their leisure and associate each shape with its name. The shapes were called RED, BLUE, GREEN and YELLOW and the same shape-names were used across subjects. Each shape was presented for study 4 times, so that the first 16 trials of this phase were acquisition trials and did not contribute to the data. All subjects were able to identify the four shapes by the end of the acquisition trials.

Shape-naming practice began following acquisition trials. Phase 2 consisted of 9 blocks of 32 trials each. Each shape was presented an equal number of times in a random sequence, so shapes were presented a total of 8 times each per block. On each trial, one of the shapes was presented in white on a dark background. Subjects were instructed to name the shapes as fast as possible without making mistakes.

Phase 3: Naming colors on shapes. The stimuli used in phases 3 and 4 were two-dimensional in that shapes were presented in color, so that interference and facilitation effects could be evaluated. MacLeod and Dunbar (1988) did not find any effect of counterbalancing the order of these phases, so the same order was used across subjects in the present study.

Phase 3 evaluated the effects of shapes on naming colors. During phase 3, each of the four colors appeared on each of the four shapes and, for control trials, on a square. Two blocks of 36 trials each, contained equal numbers of control, congruent and incongruent trials (12 trials of each type). Control trials consisted of the presenting each color on a square 3 times; congruent trials consisted of presenting each color on the shape with the corresponding name 3 times; and incongruent trials consisted of presenting each color on each shape except the one with the corresponding name once. Trial sequence was random and subjects were asked to ignore the shape and name the color as fast as possible, avoiding errors. To reduce error variance due to orienting effect, subjects were provided with 4 familiarization trials at the outset of this phase. These data were not included in analyses.

Phase 4: Naming shapes in color. Phase 4 evaluated interference and facilitation effects of colors on naming shapes. Again, two blocks of 36 trials each were presented, where each of the four shapes could appear in each of the four colors, and in white for control trials. Each block consisted of 12 control trials, where the shapes were presented in white 3 times each;

12 congruent trials, where each shape appeared only in the color that corresponded to its name, 3 times each; and 12 incongruent trials, where each shape appeared once in each color except the one that corresponded to its name. Trial sequence was random and subjects were instructed to ignore the color and name the shape. The same speed-accuracy instructions applied.

Throughout the experiment, feedback was provided by a beeping sound from the computer that indicated that the subject had made an error. The experimenter provided the correct response orally only for the first block of trials in Phase 2 to reinforce the need for accuracy, because there was no way to determine at the start of this phase whether errors indicated that accuracy had been traded for speed. The experimenter also reinforced all subjects' performance at the end of each block to sustain motivation.

The experiment consisted of 5 sessions, spread over 5 days. All 4 phases were conducted on Day 1. Days 2, 3 and 4 consisted solely of shape-naming practice. On these days, phase 2 was conducted twice, with rest periods provided between blocks to reduce fatigue and tedium. Day 5 was identical to Day 1, except that phase 1 was omitted. Overall, subjects received 2,304 shape-naming practice trials.

Results

Error and response time data were first screened for violations of ANOVA assumptions using Bartlett's test of homogeneity of variance. Two variables, Phase 2 error rates of Day 5 and Phase 4 incongruent error rates for Day 1, showed violations of homogeneity.

Examination of standardized data showed that two high hypnotizable subjects had errors with z scores greater than 3.0 on both these variables. The mean error score for Day 5, Phase 2 was 8.0, s = 2.8, but this variable had outlying values of 33 and 27. Additionally, the mean error score for Day 5, Phase 4 incongruent trials, was 1.4, s =.74, with outlying values of 12 and 9. To the extent that these outlying scores indicated that the two subjects had implemented a strategy of responding that decreased their accuracy, their data reflected processes different from those used by other subjects and from that instructed by the experimenter. As such, the data of these two subjects are not representative of the target population and were therefore excluded from subsequent analyses.

A third, low hypnotizable subject had an outlying score in Day 1, Phase 2 errors (29, mean = 7.8, s = 3.2). Day 1 Phase 2 represents the subject's first exposure to the shapes, and errors made during this phase reflect this fact. All of this subject's data, with the exception of the errors made in first naming the shapes, fell within normal distributions. With this in mind, it was intended that the offending score be changed to one unit higher than the next extreme score in the distribution (i.e., from 29 to 12), in order to maintain the integrity of the rank of the score. However, further perusal of this subjects data showed that her Phase 2 error data for the fifth day was missing due to computer malfunction. Consequently, it was decided that her Day 1 Phase 2 error mean score be omitted from the analyses but permit the inclusion of this subject's otherwise homogenous data. Thus, Phase 2 error data consist of one mean score less than the number included in the analyses of data from other Phases.

Finally, examination of raw data showed that one subject in the low hypnotizable group demonstrated increased Phase 4 control trial response times from the first to the fifth day. Control trials during this phase are composed of shapes in white colors and are intended as a baseline measure of response times to the shapes. Thus, the difference between Day 1 and Day 5 response times for this type of trial reflect practice effects of shape-naming training. It follows that Day 5 response times that are greater than corresponding Day 1 scores imply an effect not due to practice alone. Therefore, this subject's data may not have been sampled from the target population and was also deleted from subsequent analyses (Tabachnick & Fidell, 1989). Following these case deletions, low and high hypnotizability cells remained with n=9 and n=8, respectively.

Organization of the present results follows the order of those presented by MacLeod and Dunbar (1988) with the added inclusion of data from the hypnosis grouping variable. The primary data to be discussed are mean response times for correct responses of each phase. These are displayed separately by Phase for both hypnotizability groups in Table 1.

INSERT TABLE 1 ABOUT HERE

Response time data

Phases 1 and 2 (baseline measures).

As can be seen from the table, HH and LH groups, with means of 517 ms., s.d.=44.8 and 495 ms., s.d.=69, respectively, displayed similar response times to naming colors on squares (in Phase 1). An independent t-test for Phase 1 data failed to reveal a significant difference between hypnotizability groups [$t(15)=0.77$, $p>.05$]. Similarly, in a 2X2 analysis of variance (ANOVA) on Phase 2 shape-naming baseline measures, where Hypnotizability (high and low) was the between group variable and Day (1 and 5) was the within group variable, no significant hypnotizability differences emerged [$F(1,15)=.05$, $p>.05$]. Consequently, further discussion of baseline results refer to data collapsed on the Hypnotizability variable.

The ANOVA for Phase 2 data indicated that the decline in Phase 2 mean shape-naming time over 8 blocks of practice (over 5 days) was highly

Table 1. Mean Response Times (RT, in milliseconds) and standard deviations (s.d.) for Days 1 and 5 of Training for High and Low Hypnotizability Groups.

Day	Phase 1: Baseline Colors	Phase 2: Baseline Shapes	Phase 3: Naming Colors on Shapes Con	Ctl	Inc	Phase 4: Naming Shapes in Color Con	Ctl	Inc
1								
High								
RT	517	631	542	561	603	606	648	764
s.d.	44.8	40.5	92.9	116.5	156.3	95.3	88.8	172.0
Low								
RT	495	634	518	527	537	574	634	692
s.d.	68.9	62.0	68.5	84.7	103.8	75.3	81.1	91.4
5								
High								
RT		493	502	510	564	530	562	635
s.d.		40.6	55.1	67.8	126.5	84.7	66.0	151.6
Low								
RT		480	462	475	500	488	527	559
s.d.		59.5	65.0	71.4	84.2	66.8	76.5	67.7

Note: Con, Ctl and Inc, respectively, denote congruent, control and incongruent Color-Shape relations for Phases 3 and 4.

significant [F(7,105) = 47.79, p<.001]. This drop from mean=633 ms., s.d.= 51.4 to mean=486 ms., s.d.=50.3, indubitably reflects the effect of practice naming (white) shapes.

Table 1 also displays the mean response times to Phase 3 and Phase 4 stimuli. It will be remembered that these stimuli consisted of two dimensions, colors and shapes. Response times to these stimuli were obtained on Days 1 and 5 as indicators of the relative automaticity with which colors and shapes are processed. Response time data for Phase 3 (naming colors on shapes) and also Phase 4 (naming shapes in color) were analyzed using 2X2X3 ANOVAs with Hypnotizability grouping (high and low) as the between group variable, and Day (1 and 5), and color-shape Relation (congruent, control and incongruent) as two repeated measures.

Phase 3

Two significant main effects were found for color-naming data (Phase 3), (see Appendix B for source table). First, a significant main effect of the Day variable emerged at F(1,15) = 11.94, p<.005. As can be seen from Table 2, which presents mean response times to the stimuli of all phases collapsed on the Hypnotizability variable (thus paralleling MacLeod & Dunbar's tables, for ease of comparison), this effect indicated that, irrespective of color-shape Relation, naming colors on shapes was significantly faster at Day 5 (means = 481, 491, 530 msec. for congruent, control and incongruent trials, respectively) than at Day 1 (means = 529, 543, 568 msec. for congruent, control and incongruent, respectively).

INSERT TABLE 2 ABOUT HERE

The second significant main effect was of color-shape Relation [F(2,30) = 9.253, p<.001]. This effect indicated that the means for incongruent trials at Day 1 (mean=568 ms., s.d.=131.2) and Day 5 (mean=530 ms., s.d.=107.9) were larger than the congruent response time means of the respective day.

Table 2. Mean Response Times (RT, in milliseconds) and standard deviations (s.d.) for Days 1 and 5 of Training, pooled on Groups.

Day	Phase 1: Baseline Colors	Phase 2: Baseline Shapes	Phase 3: Naming Colors on Shapes Con	Ctl	Inc	Phase 4: Naming Shapes in Color Con	Ctl	Inc
1								
RT	506	633	529	543	568	589	640	735
s.d.	58.2	51.4	79.2	99.1	131.2	84.2	82.4	139.1
5								
RT		486	481	491	530	508	543	595
s.d.		50.3	62.2	70.0	107.9	76.4	71.8	117.8

Note: Con, Ctl and Inc, respectively, denote congruent, control and incongruent Color-Shape relations for Phases 3 and 4.

Tukey's HSD test confirmed that pooled on the grouping and Day variables, subjects were significantly slower to respond to incongruent trials than they were to congruent trials [$q_{0.05}(3,30)=37.7$]. Interestingly, the Day X Relation interaction was not significant. This suggests that the pattern of response times responsible for the main effect of color-shape Relation, persisted over the 5 days of the experiment while response times systematically decreased. Although discussed later, it is notable that these findings differ from those reported by MacLeod and Dunbar (1988), who found significant incongruent-control differences at the fifth day's testing. The Hypnotizability variable failed to reach significance either as a main effect, or in interaction with other variables for Phase 3 response time data.

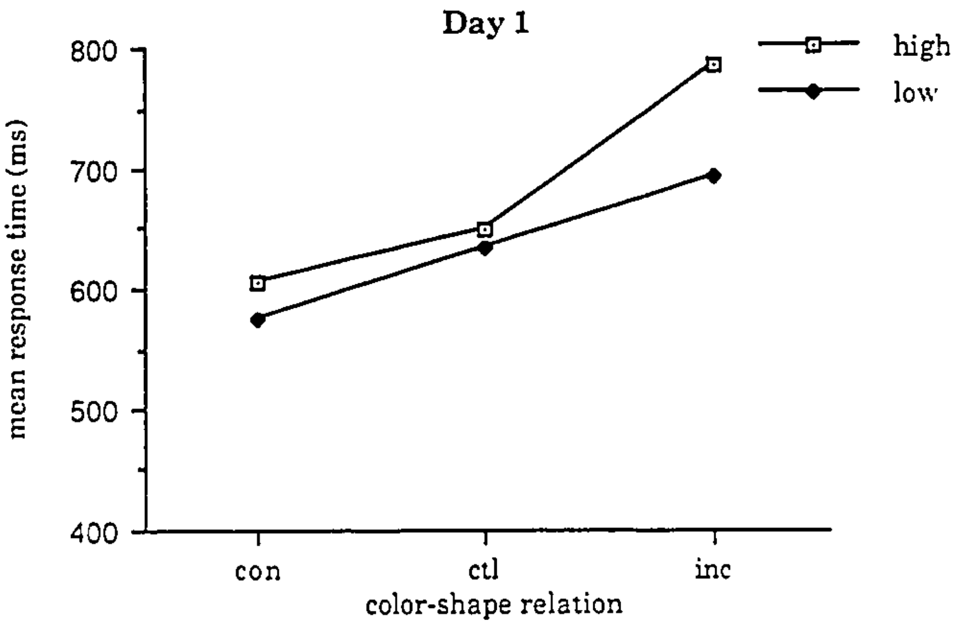
Phase 4

Phase 4 results revealed a different pattern (see Appendix C for source table). 2X2X3 ANOVA results revealed a main effect of Day [$F(1,15) = 81.37$, $p<.001$], that indicated that response times to naming shapes decreased by Day 5 irrespective of the color the shapes were presented in. This finding corresponds to a decrease in response times for Phase 2, baseline shape-naming data. Also, a main effect of color-shape Relation was found at $F(2,30) = 47.15$, $p<.001$. These main effects replicate those found by MacLeod and Dunbar (1988). Tukey's HSD test revealed that the main effect of color-shape Relation, pooled on the Day and Hypnotizability variables, reflected significantly slower response times to incongruent trials than to control trials, which in turn were significantly slower than congruent response times [$q_{0.05}(3.30)=36.2$]. This main effect, however, was qualified by a significant interaction effect of color-shape Relation and Hypnotizability grouping [$F(2,30) = 3.19$, $p=.055$]. This interaction effect indicated that HH subjects responded significantly different from than LH on one or more of the three possible color-shape relations. Although the 3-way interaction of Relation X Hypnotizability X Day failed to achieve significance, in accordance with the original hypothesis that HH and LH would respond differently across days, two 2X3 ANOVAs were performed for Day 1 as well as for Day 5 Phase 4 response time data. The variables involved in the analysis included two levels of grouping variable (high and low hypnotizability) and 3 levels of the repeated measure (congruent, control and incongruent trials). Figure 1 presents the mean response times of HH and LH groups for congruent, control and incongruent shape-naming trials separately for Days 1 and 5. As can be seen from the figure, the Hypnotizability X Relation interaction was evident at Day 1 [$F(2,30) = 4.07$, $p<.03$] in the steeper line from control to incongruent response times of HH relative to LH subjects. However, by Day 5, this interaction had apparently disappeared [$F(2,30) = 1.12$, $p>.3$].

INSERT FIGURE 1 ABOUT HERE

Tukey's HSD test for Day 1 data indicated that HH and LH groups experienced both facilitation and interference from the color dimension of the stimuli when they were naming shapes. However, these subjects differed significantly in response times to incongruent trials, but not to control or congruent trials [$q_{0.05}(6,30)=42.7$]. As is apparent from the response times in Table 1, HH subjects were significantly slower at correctly responding to shapes in incongruent colors than were their LH counterparts. At Day 1 HH group's mean response time for incongruent trials was larger than that of low's by 92 ms., for control response times by 14 ms. and for congruent response times by 32 ms. On the other hand, Day 5 differences varied less; HH subjects responded with means of 76, 35 and 42 ms. larger than LH's for incongruent, control and congruent response times, respectively.

Another interesting point to note from the data in Table 1 is that although both groups were comparable with respect to baseline measures for both Phase 1 and Phase 2, the LH group were consistently faster when the task involved 2 stimuli dimensions (Phases 3 and 4). A 2X2X3X2 ANOVA was performed with the purpose of testing the significance of this pattern. Variables were Hypnotizability grouping (high and low), Day



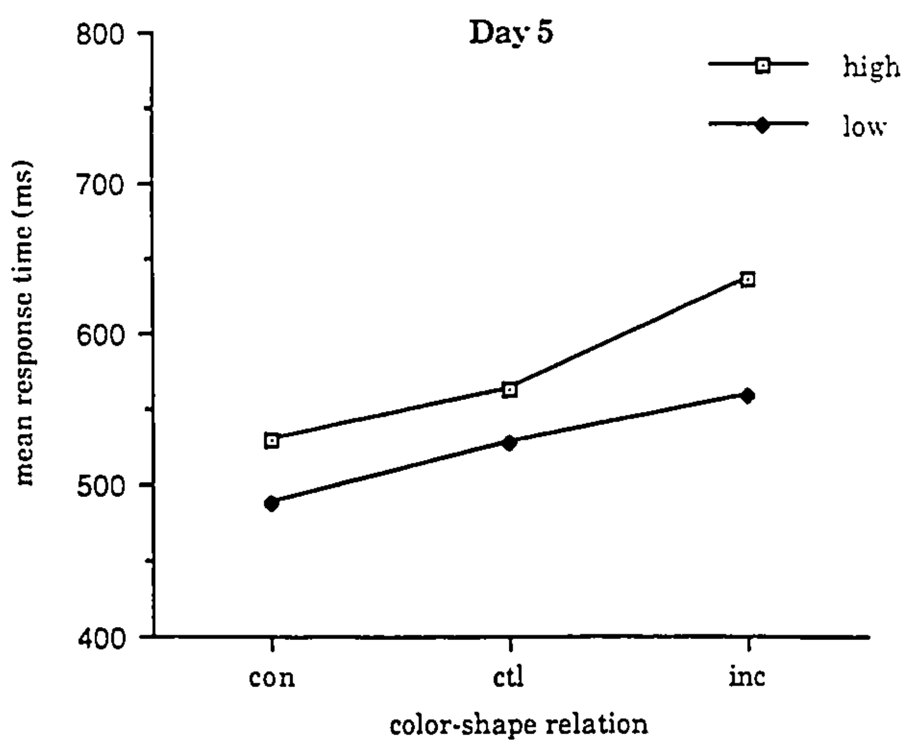


Figure 1. Response times for high and low hypnotizable groups to Phase 4 (shape-naming) congruent, control, and incongruent stimuli for Days 1 and 5, separately.

(1and 5), color-shape Relation (congruent, control and incongruent) and Phase (3 and 4). The hypnotizability variable failed to reach significance [F(1,15)=1.33, p>.2], probably because of the large variation in response times among subjects in groups, which in statistical analyses is considered variation due to error.

Error data

Phase 1 and 2 (baseline measures).

Error rates were low for all phases of the experiment as can be seen in Table 3, which presents mean proportions of errors for Days 1 and 5 of all phases for high and low hypnotizability groups. For Phase 2 error data, a 2X2 ANOVA with one between-subjects variable (high and low Hypnotizability) and one repeated measure (Days 1 and 5) failed to reveal any significant effects.

INSERT TABLE 3 ABOUT HERE

Phase 3

Error data for Phase 3 (naming colors on shapes) and Phase 4 (naming colored shapes) were analyzed separately using 2X2X3 ANOVAs with one grouping variable (Hypnotizability - high and low) and two repeated measures; Day of testing (1 and 5) and color-shape Relation (congruent, control and incongruent). For both phases of the experiment, a main effect of Day and a main effect of shape-color Relation were qualified by the interaction of these two factors (see Appendices D and E for source tables). An interaction of Day X Relation was significant at F(2,30) = 16.4, p<.001 for Phase 3 errors. Tukey's HSD post hocs indicated that significantly more errors were made on incongruent trials than on congruent or control trials during either day, and that the increases in

Table 3. Proportions of Errors (E) for Days 1 and 5 of Training for High and Low Hypnotizable Groups.

	Phase 2: Baseline	Phase 3: Naming Colors on Shapes			Phase 4: Naming Shapes in Color		
Day	Shapes	Con	Ctl	Inc	Con	Ctl	Inc
1							
High							
E	.018	.002	.009	.014	.002	.005	.019
Low							
E	.030	.005	.002	.014	.003	.006	.020
5							
High							
E	.028	.002	.010	.042	.002	.009	.045
Low							
E	.025	.006	.009	.063	.003	.009	.057

Note: Con, Ctl and Inc, respectively, denote congruent, control and incongruent Color-Shape relations for Phases 3 and 4.

errors by Day 5 was significant only for incongruent trials [$q_{0.05}(6,30)=.455$].[8]

Phase 4

A significant Day X Relation interaction was also found for Phase 4 error data [$F(2,30) = 5.23$, $p=.011$]. Tukey's HSD post hocs for this interaction [$q_{0.05}(6,30)=1.65$] also indicated that significantly more errors were made during incongruent trials at Day 5 of naming shapes in color than during other trials. Thus, not surprisingly, it appears that there was some interference from the incongruent dimension of the tasks in question as responses to incongruent trials were the least accurate, especially following 5 days of shape-naming training.

Response time by Blocks

As an addendum, Phases 3 and 4 response time data were reanalysed to include the investigation of possible carryover effects. Phase 3 was a color-naming task, and on both Days 1 and 5, immediately followed Phase 2, which was shape-naming practice. The dimension of interest was reversed yet again during Phase 4, a shape-naming task which followed the color-naming task of Phase 3.[9] Reversals in the dimension to be attended to necessarily required some alterations in attentional focus. The possibility that the time required for this adaptation had an effect on response time was investigated, as it may reflect confounding influence that would need to be considered in future experimentation.

It will be remembered that Phases 3 and 4 each consisted of 2 blocks of trials. Reasoning that adaptation requires only a limited number of

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8 No formal analyses of error data are reported by MacLeod & Dunbar (1988), however, the patterns of errors among their experiments and the present one are comparable.

9 The ordering of the tasks in the present experiment was not counterbalanced because MacLeod and Dunbar (1988) found no effect of order in either of their three experiments.

trials, it was expected that the first blocks of trials for both Phases 3 and 4 but not the second blocks would show evidence of an adaptation effect by way of larger response times. Therefore, a within group variable of Blocks (with 2 levels) was created and included in a 2X2X3 ANOVA, in which color-shape Relation (congruent, control, incongruent) was the second within factor and Hypnotizability (high and low) was the grouping variable. Phase 3 and 4 data were analyzed for Day 1 and day 5 separately (see Appendices F to I for source tables).

Phase 3

For Phase 3, Day 1 data, a main effects of Block [$F(1,15)=12.9, p<.01$] indicated a possible adaptation response. However, this effect as well as a main effect of Relation [$F(2,30)=5.8, p<.02$] were qualified by a 3-way interaction of the Block, color-shape Relation and Hypnotizability variables [$F(2,30)= 3.0$, $p=.06$]. Mean response times for the two Blocks across color-shape Relation for HH and LH subjects are presented in Figure 2. Post hocs in reference to this interaction reveal an interesting picture. At Block 1, HH respond significantly slower than lows across trials, but at Block 2,they respond significantly slower than LH subjects during congruent and incongruent, but not control trials [$q_{0.05}(12,30)=26.4$]. It will be remembered that control trials during this phase are meant as baseline measures and so consist of colored squares, requiring the response of identifying the color. It follows then, that relative to LH, HH subjects are more affected by two-dimensional stimuli, such as those presented during congruent and incongruent trials.

INSERT FIGURE 2 ABOUT HERE

Supportive of this contention is the additional finding, as revealed by post hocs, that the second block of response times for HH subjects was significantly faster than their first on congruent and control trials. By comparison, incongruent response times were not significantly faster,

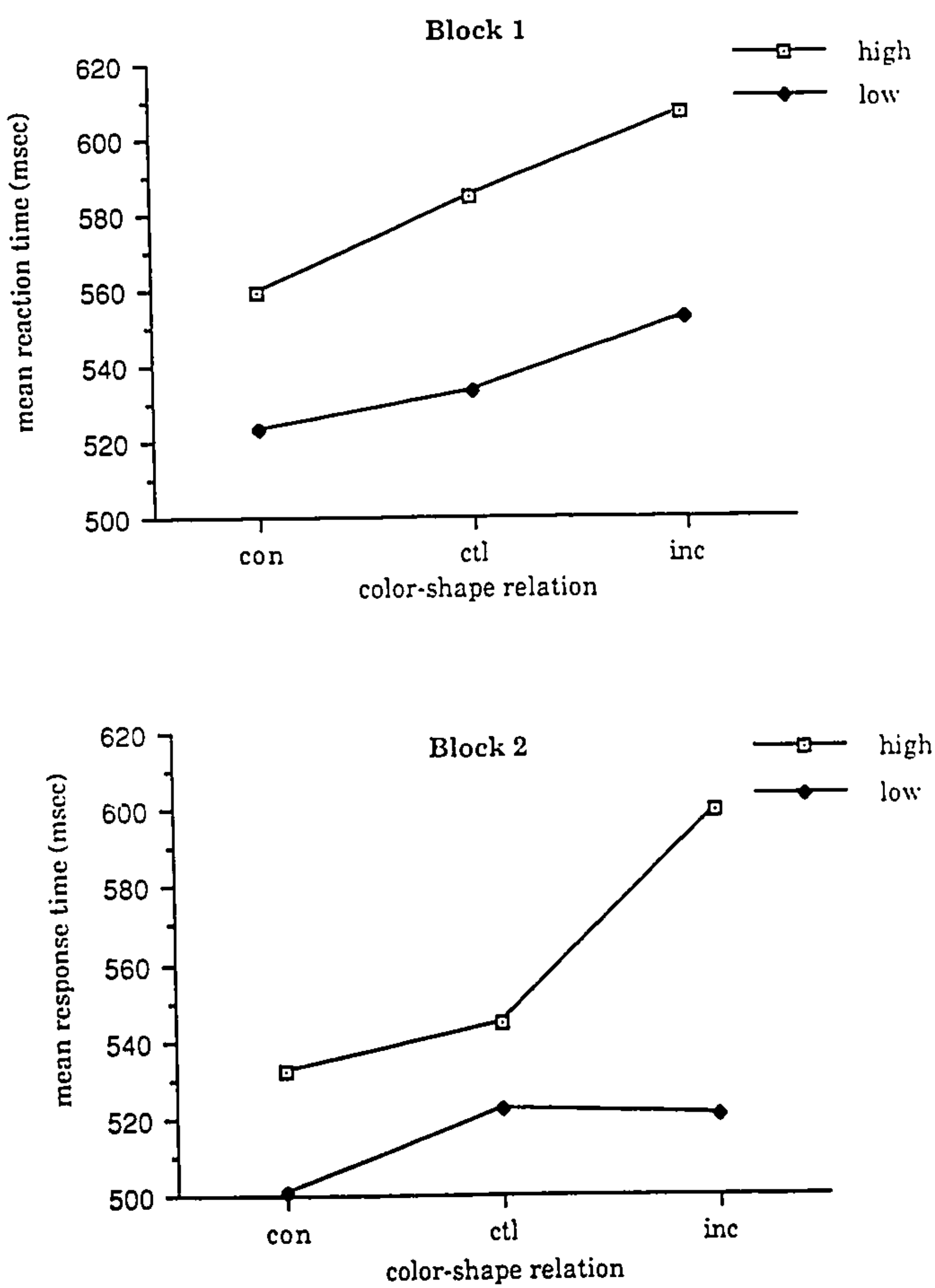


Figure 2. Interaction of Block X Relation X Hypnotizability for Day 1, Phase 3 (color-naming) data

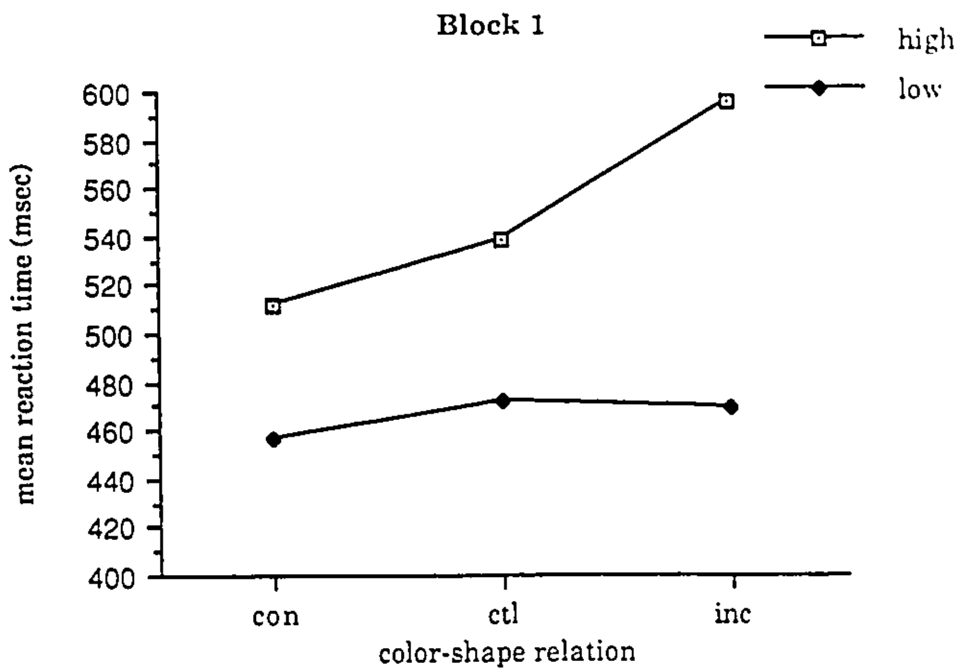
indicating that the incompatible shapes continued to interfere. For LH subjects, on the other hand, incongruent trials were the only ones that decreased significantly from Block 1 to Block 2. This pattern of results suggest that relative to LH, HH subjects were distracted by the addition of a second dimension to the stimuli. Their response times to the second block showed an adaptation by way of an increase in response speed to congruent and control trials, but in so doing also exacerbated the interference from the incongruent dimension. Indeed, HH subjects showed significant interference from incompatible shapes relative to congruent trials at Block 1 and relative to control trials at Block 2. By comparison, LH subjects showed significant interference from incompatible shapes only relative to congruent trials at Block 1.

At Day 5, the main effect of Block failed to achieve significance [$F(1,15)=0.28, p>.05$]. This argues against a simple adaptation of response explanation. The 3-way interaction effect of Day 1, on the other hand, persisted to Day 5 [$F(2,30)=3.6, p<.04$]. Figure 3 presents the mean response times of HH and LH subjects across color-shape trials at Blocks 1 and 2 for Day 5, Phase 3 stimuli. Post hocs revealed that, at Day 5, the HH group showed significant interference of incompatible shapes relative to control trials at Block 1 and Block 2, whereas the LH group showed this effect at Block 2 only [$q_{0.05}(12,30)=35.3$]. LH continued to respond significantly faster than HH subjects across all trials during this day's testing.

INSERT FIGURE 3 ABOUT HERE

Phase 4

For Phase 4, the Block variable failed to achieve significance either as a main effect or in interaction with other variables for Day 1 data, but achieved significance as a main effect at Day 5 [$F(1,15)=14.4, p<.002$]. Figure 4 presents the pooled mean response times to Blocks 1 and 2 across color-shape Relation for Day 5 Phase 4 data. As can be seen from the figure, Block 1 response times are consistently larger than Block 2, which may



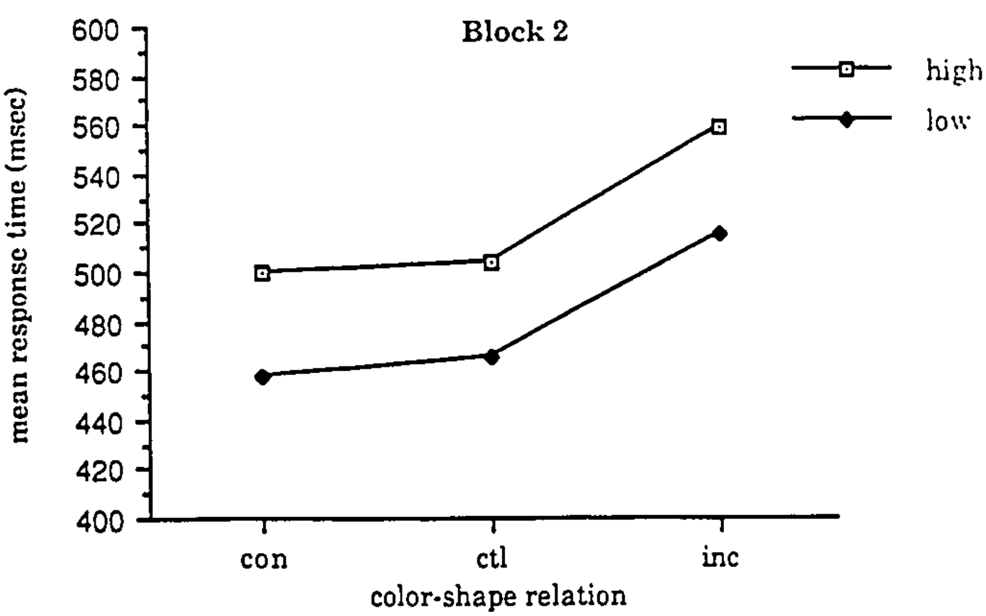


Figure 3. Interaction of Block X Relation X Hypnotizability for Day 5, Phase 3 (color-naming) data

reflect an adaptational response to the switch of the stimulus dimension of interest. This possibility, however, raises the question of why this adaptational response was not evidenced in Day 1 data as well.

INSERT FIGURE 4 ABOUT HERE

These analyses that include the Block variable are cautiously offered as explorations of possible underlying processes that are discriminated by hypnotizability grouping. They are *post hoc* investigations in response to the large within group variance that may have obscured real group differences and therefore should be circumspectly evaluated[10].

10 Unfortunately, because these analyses were not planned, the calculation of errors by Block was omitted from the computer program. Thus, it is impossible to compare these response time by Block data to their corresponding error data. This precludes the assessment of whether a speed-accuracy tradeoff occurred.

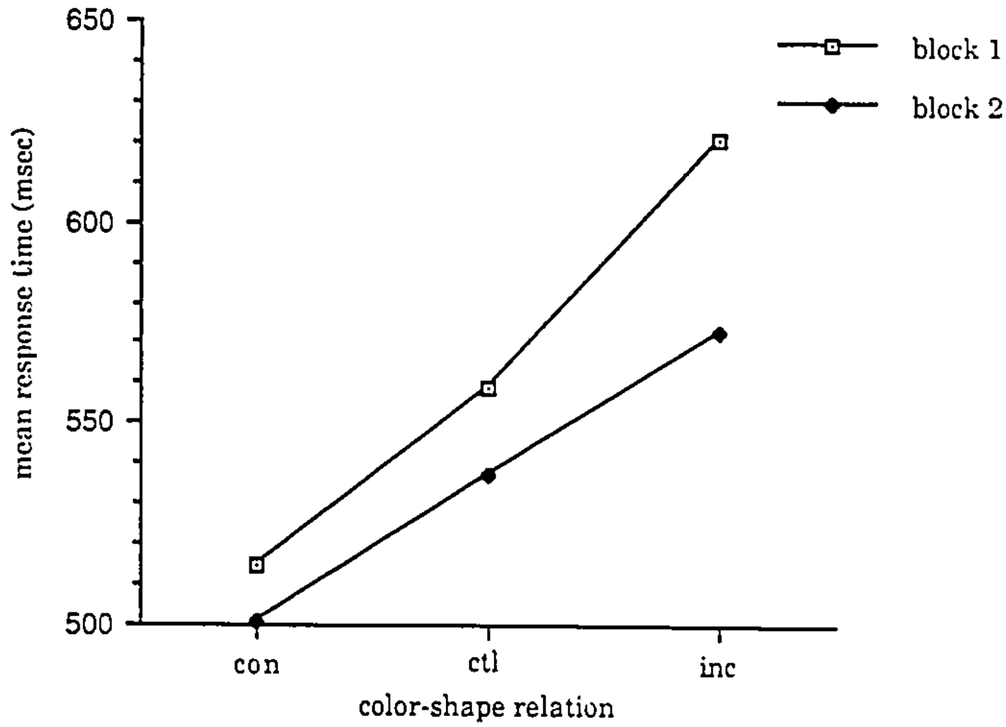


Figure 4. Main effect of Block in Day 5, Phase 4 (shape-naming) data

Discussion

The results of the present experiment revealed some interesting findings. Consistent with the findings of MacLeod and Dunbar (1988), the present results revealed that the presence of incompatible shapes interfered with color-naming. A main effect of color-shape relation for naming colors on shapes (i.e., in Phase 3 data) indicated that response times to incongruent trials were significantly slower than to congruent trials for all subjects. This corresponded to the significantly higher number of errors made during the incongruent trials of this phase on both days.[11] As noted in the literature, automaticity of a process manifests itself not only in a faster speed of response to the stimuli in question, but, within a Stroop-like task, also as relatively large incongruent response times and a greater number of incongruent errors (Cohen, Dunbar & McClelland, 1990; Dixon et al., 1990). Thus, these results suggest that the shape-naming process achieved some level of automaticity.

However, the point at which this automaticity emerged in the present experiment differs from MacLeod and Dunbar's (1988) experiments. In the first of MacLeod and Dunbar's (1988) three experiments, no effect of shape-naming practice on color-naming emerged following 288 or 576 trials, and their second and third experiments revealed interference of incongruent shapes only following 2,304 (i.e., 5 days of) shape-naming trials.[12] By

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[11] At first glance it may appear that the increase in errors from Day 1 to Day 5 that accompanied overall decreases in response times for both Phases 3 and 4, reflects a speed-accuracy tradeoff. However, it must be noted that errors increased significantly from Day 1 to Day 5 only for incongruent trials for both phases. Thus, although the possibility of a speed-accuracy tradeoff cannot be dismissed, the specificity of increased errors can alternatively be understood as one aspect of interference effects. Further experimentation is required to accurately interpret such effects.

[12] Actually, the interaction of day with color-shape relation in MacLeod and Dunbar's (1988) third experiment only achieved marginal significance ($p<.09$), despite a relatively large increase in incongruent response times from Day 1 to Day 5 (70 ms.). This may be due to large

contrast, the present results indicated that interference associated with incompatible shapes emerged following 288 shape-naming practice trials, that is, on the first day of practice.[13] This interference persisted to Day 5 despite a concomitant decrease in overall response times during the task, thus attesting to the reliability of the effect.

However, it must be noted that at Day 1, the interference effect in the present study reflected a 38 ms. difference between incongruent and congruent response times. Although this difference achieved significance, it is associated with comparatively larger within group variance of approximately 131 and 79 ms. for incongruent and congruent response times, respectively. The corresponding response times reported by MacLeod and Dunbar (1988) are 15 and 12 ms. for their second and third experiments, respectively. Variance estimates were not included in their report, so precludes comparison with the present results. However, these interference effects in MacLeod and Dunbar's experiments failed to achieve significance, suggesting that the effect in the present study is statistically greater than theirs. Nonetheless, the large variance displayed by subjects in the present study undermines the reliability of these results and therefore necessitates that they be replicated.

Notwithstanding this possibility, it appears that although subjects were quicker to name colors on the fifth day, a surprising finding in light of

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within group variance in the data, although this possibility is inferred because variance estimates were not included in the report.

[13] The present study tested a larger sample than MacLeod and Dunbar's (1988) second and third experiments (N=17 in comparison to N=4 of MacLeod & Dunbar's studies), which may have afforded more power to the present statistical tests and may therefore account for this inconsistency. Alternatively, this inconsistency may reflect differences in the samples tested by the two studies. The present study sampled a truncated distribution, whereby medium hypnotizable subjects were not represented. Given that medium hypnotizable subjects represent 70-80% of the general population (E. Hilgard, 1965), it is highly likely that MacLeod and Dunbar's sample included subjects from this group.

the fact that they had not practiced color naming,[14] they could not overcome the interference resulting from incompatible shapes.

MacLeod and Dunbar (1988) asserted that it is counterintuitive to propose that 5 days of practice in shape-naming is sufficient to compensate for a lifetime of color naming. However, it appears from the present results that even 1 hour is sufficient to do so. An explanation of this unexpected finding may be that, unlike reading or using words, as is the original task in the Stroop phenomenon, color naming is not an integral part of daily activity and therefore is not as automatic a process. As such, relatively little but intensive practice at a novel task appears to be sufficient to interfere with the color naming process.

This interference effect was displayed by subjects across hypnotizability groups, and so appears not to support the predictions regarding hypnotizability differences. However, examination of Phase 4 results indicates that such a conclusion may be premature, as these results revealed more discriminating effects. First, however, the results of Phase 4 data will be evaluated within a more general automaticity framework.

The theory of automaticity as a continuum predicts that as the distribution of response times of a non-automatic process moves closer to the distribution of response times of an automatic process, equivalent interference effects will be manifested. In other words, interference effects can be conceptualized on a continuum (Cohen et al., 1990). Therefore, as the distribution of shape-naming times moves closer to that of color-naming times, the interference from the two dimensions should become increasingly similar. This increasing symmetry was evidenced in the present results as well as in those of MacLeod and Dunbar (1988). While responses to shapes accelerated by the end of shape naming practice, both in Phase 4 and (baseline) Phase 2 measures, the magnitude of the interference from incompatible colors decreased by Day 5, becoming more

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14 This may simply reflect increased familiarity with the apparatus and the tasks involved. It is an interesting finding that needs to be replicated.

proportional to the interference from incompatible shapes. This, in conjunction with the finding that incongruent shapes interfered with color naming in Phase 3, constitutes evidence consistent with the original hypothesis of this study, namely that the process of naming shapes would become automatized.

More importantly, however, is that Phase 4 results differentiated HH from LH groups, as predicted. While the color dimension of the stimuli interfered with and facilitated shape naming for both HH and LH groups, HH subjects were significantly slower than LH to name a shape if it was presented in an incompatible color. In other words, HH subjects were less able than LH to overcome the interference from incongruent colors when they were naming shapes. This supports the original hypothesis that the color naming process is more automatic for HH subjects than for LH. Moreover, the magnitude of the interference displayed by the HH group decreased from 136 ms. at Day 1 to 73 ms. at Day 5, a drop that statistically diminished the influence of hypnotizability. Thus although HH subjects demonstrated more automaticity of processing colors than LH subjects at Day 1, HH subjects also showed a greater reduction in interference from this process by Day 5, perhaps because the processing of shapes became more automatic for them. Thus, it appears that the performance of HH subjects is responsible for the finding that incongruent colors interfered less and less with shape naming as shape-naming practice progressed. As an indirect indicator of the automaticity with which shape names are processed, then, this effect supports the hypothesis that HH subjects would automatize shape-names faster than LH. Future experimentation may verify this initial finding by providing subjects with more practice in shape-naming as well as by increasing the number of testing days. Such additional data may also serve to elucidate differences between groups in the process of automatization.

Confirmatory albeit tentative support for hypnotizability differences is obtained from the analyses of Phase 3 data by blocks. These results indicated that HH and LH subjects responded differently to the experimental instruction to ignore a second dimension of the stimuli. Response times at the first block of Day 1 for Phase 3 stimuli were statistically different from responses to the second block and more so for HH subjects than for LH. Specifically, relative to LH subjects, by the second block, HH displayed significantly greater decreases in response times; significantly increased interference effects; and significant decreases in control response times. By block 2, these became statistically indiscriminate from the corresponding data of LH subjects. This may reflect an adaptation response on the part of the HH group. Day 5 response times were also discernible by block but for LH more so than for HH. While HH subjects displayed interference effects both at Block 1 and Block 2, LH displayed interference from incompatible shapes only at Block 2. These differences between HH and LH responses suggest that HH subjects experienced an interference from incompatible shapes by the first block of Phase 3 testing, and that LH subjects only experienced the same degree of interference by the last block. In other words, the HH group appeared to progress in the automatization of shape-names faster than did the LH group.

Shiffrin & Schneider (1977) recognized that automatic processes are contingent upon several mechanisms. Specification of the aspects responsible for automatic processing requires a systematic delineation of input functions, output-response functions and intermediate associational functions. Unfortunately, whether the automaticity of processing shapes that developed in the present study as well as in MacLeod & Dunbar's, reflects automaticity of input (in the form of perception), automaticity of responding (by way of naming the shape), or automaticity of the connection between these two functions, is a rhetorical question because the nature of the tasks in the present study does not permit the delineation of these aspects of automaticity. The findings of Ingram et al. (1979), however, are suggestive.

In a preliminary study, these authors measured the minimum stimulus duration at which HH and LH subjects could correctly identify target stimuli, and found no differences between groups. On the other hand, significant differences between groups were found on interstimulus interval (ISI, i.e., the interval between offset of the target and onset of a masking stimuli) required to correctly identify the target. The authors cautiously concluded that HH and LH groups did not differ in information intake capabilities, as indicated by equivalent stimulus duration data, but that HH subjects were faster than LH at processing the information, based on their quicker response as indicated by ISI data. Thus, although in need of replication, it appears that the motor-response aspect of the task in this experiment is responsible for the apparent faster processing of information displayed by HH relative to LH subjects.

This conclusion generalizes to the hypnotic context where response is certainly a distinguishing factor of HH and LH subjects' experience. This postulate gains support from the findings that performing a Stroop task during hypnosis exacerbates the interference from incompatible words significantly for HH but not for LH groups (Sheehan et al., 1988).

The possibility that motor-response functions underlie differences in HH and LH subjects' performance could be examined in a paradigm where two or more automatic responses compete for output. A cognitive resource view of automaticity posits that as processes become increasingly automatic, not only are less cognitive resources required for activation and perception of the stimuli, but that these become mandatory reactions to stimulus presentation. Perception of two automatized stimuli therefore does not require cognitive resources (Schneider & Shiffrin, 1977). Consequently, competition between two roughly equivalent automatic processes is more likely to occur at the stage where a decision is required, which in a Stroop-like task, for example, is at the overt motor response stage. Similarly, Shiffrin and Schneider (1977) contended that studies utilizing compound stimuli of which one dimension was to be ignored (the Stroop task, for example), do not demonstrate any processing interference short of motor responses. It follows, in support of Ingram et al.'s (1982) postulate, that the motor-response aspect of perceptual tasks is responsible for the differential performance of HH and LH subjects.

In a related line of inquiry, it may be interesting to explore at what point in the process of automatization differences between HH and LH subjects occur. Contemporary models of skill acquisition identified three stages[15] to the automatization process. As described by Ackerman (1988), the progression through these stages is continuous and results from consistent practice (see also Schneider & Shiffrin, 1977). Different abilities are involved at each of the three stages, each of which must be mastered to progress to the next stage. Individual differences may emerge in automaticity acquisition at any one stage due to potential differences in these underlying abilities (Ackerman, 1988).

Individual differences in the first stage result from differences in underlying strategic abilities, that is, the cognitive strategies formulated and tested by subjects to learn the task at hand. Relevant to this point are Dixon & Laurence's (1991, in press) and Sheehan et al.'s (1988) findings that HH are more able to implement strategies in and outside of hypnosis than are LH subjects. With regard to the present study, differences between HH and LH groups in automaticity acquisition may begin at this stage by way of differences in the efficacy with which they implement strategies to associate the shapes with their respective names.

The second stage of automatization involves the strengthening and refinement of the stimulus-response connection. The task in question may at this stage be characterized as generally simple but still cognitively involving. Ackerman (1988) attributes individual differences at this stage to underlying perceptual speed abilities. Individual differences during this stage represent differences in the speed of associations between perceptual and motor abilities. These abilities determine performance efficiency. Relevant to this point are the findings that supported Dixon et al.'s (1990,

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15 Ackerman (1988) refers to the *phases* of skill acquisiton. However to avoid confusion between this reference of the word and the *Phases* referred to in the procedure of the present experiment, Ackerman's (1988) phases will be referred to as *stages*.

1991 in press) proposition that relative to LH, HH subjects have stronger connection strengths between the input of verbal information and output by way of motor response. With reference to the present results, it would be predicted that HH show greater speed in the strengthening of the shape-name connection than LH subjects. Taken together, the findings of the present experiment and those of Dixon et al.'s (1990, 1991 in press) may indicate that the speed with which stimulus-response connections in general are strengthened differ between these hypnotizability groups. Stronger verbal connections or quicker rates of automatization would be manifestations of this broader difference.

Finally, the third phase is characterized as automatic, accurate performance based on an amalgamation of related abilities subsumed under a general psychomotor ability. Individual differences in this phase are mostly independent of information processing per se (Ackerman, 1988), but represent differences in speed of motor responses that are demarcated by psychophysical limitations of the human subject. Thus, asymptotic performance at this phase may be representative of either automaticity or physical boundaries, although Logan (1985) contends that automaticity has no discrete end points (also see Ackerman, 1988). Thus, by inference, the burden of asymptotic performance is placed on the physical limitations of the subjects.

The findings of Ingram et al. (1982) seem to designate this last phase as one occasion for hypnotizability differences in automaticity acquisition to emerge. It must be noted, however, that the phases comprising the process of automatization are orthogonal to the components that may become automatized and hypnotizability differences may emerge in any combination of components and phases. Although this is an interesting topic worthy of study, the present data do not permit statements to be made regarding the point(s) at which automaticity manifests itself. Empirical inquiries may yet delineate where and when hypnotizability differences in automatization emerge, but the focus of the present study must be on the acquisition of automaticity as a unitary phenomenon, in relation to hypnotizability differences. Specification of the mechanisms that underlie differences in automaticity acquisition must thus remain the object of future investigations.

Dixon (1990) points out that results such as those found in the present study can be explained within a Parallel Distributed Processing (PDP) framework. Although a detailed summary is beyond the scope of the present discussion, it is worth noting that one hypothesis of the framework is that HH subjects have stronger verbal connection strengths than do LH and that this manifests itself in larger interference effects for HH than for LH groups during Stroop-like tasks. A corollary to this may be a diminished ability on the part of HH subjects to inhibit a response of an activated verbal process. Thus, when two responses compete during incongruent trials of a Stroop task, more effort is required to inhibit the response to the verbal dimension of the stimuli than to the color dimension. Consequently, reaction time to naming the color (contingent on inhibiting the word) is affected more substantially than when naming the word (and inhibiting the color name). Dixon (1990) and his associates (Dixon, Brunet & Laurence, 1990) point out that the differences between HH and LH subjects' reaction time data to date, are for the most part in the domain of verbal processing (e.g., Ingram et al., 1979; Succuzzo et al., 1982; and the lack of differences found by Friedman et al., 1986 were based on non-verbal test flash stimuli), and interpretable within a PDP framework.

In an hypnotic context, the greater automaticity with which HH subjects process verbal information relative to LH may conceivably be the basis for differences in responses to verbally administered hypnotic suggestions (Dixon et al., 1990). The verbal content of the suggestions administered in an hypnotic situation would be processed more automatically by HH than by LH subjects, that is, more quickly, involuntarily and effortlessly. The nature of automatic processing thus presents great correspondence with the subjective reports provided by HH subjects regarding the experience of responding to hypnotic suggestions. The greater automaticity with which suggestions are processed may in turn function to free cognitive resources for higher-level aspects necessary for hypnotic responsivity, such as absorption or imagery (Dixon et al., 1990).

This theory, although consistent with observed differences in HH and LH, must be qualified by the present findings. Although in need of further verification, the present results suggest that not only do HH and LH subjects differ in the automaticity with which they process verbal information, but that this difference may constitute a segment of a more substantive dissimilarity in the rates with which automaticity is acquired. In other words, the greater verbal automaticity displayed by HH relative to LH subjects in Dixon et al.'s (1990) study may reflect HH subjects' faster ability to acquire automaticity, one aspect of which was tapped by the present experiment. Further empirical results are required to validate this possibility.

Nevertheless, the results of this study have implications on extant conceptualizations of underlying differences between HH and LH subjects. Inconsistent with social-psychological accounts of hypnotizability differences, the present study obtained complex hypnotizability effects in a context outside of the hypnotic one. Subjects were tested under the auspices of a cognition laboratory and no mention was made of hypnosis until after the experiment was completed. Indeed, subjects' reports from informal questioning subsequent to the 5 days of testing, revealed that not one was aware of the hypnotizability aspect of the study. In fact, the demands of the experiment, by way of explicit instructions from an experimenter blind to subjects' hypnotizability grouping, were to respond quickly but accurately. This suggests that any modification of behaviour on the part of HH subjects to please the experimenter would result in a tendency toward homogeneity of data by way of quick and accurate performance overall. Hence, under social psychological lines of reasoning hypnotizability differences would be undermined rather then accentuated.

On the other hand, the finding that both dimensions of the compound stimuli in Phases 3 and 4 were processed despite explicit and repeated instructions to ignore it, the best strategy in the goal of speedy but accurate responding, implies a genuine involuntariness of processing. This notion is consistent with Hilgard's account of dissociation, whereby mental activity goes on outside the usual stream of consciousness, outside normal controls and consequently is experienced as involuntary (E.Hilgard, 1977). It is interesting to note that the group differences uncovered by analyses of Phases by Blocks were obscured in original analyses because of large within group variances. In addition to the possibility that this may have been due to an adaptational response to switching the dimension of interest, the variance in groups is reminiscent of previous findings that HH subjects are characteristically a heterogenous group (e.g., E. Hilgard, 1977; Laurence & Perry, 1981; Nadon et al., 1987). Specifically, Laurence & Perry's (1981) suggestion that dissociation differences in this group may reflect different modes of responding is consistent with the present findings of extensive variability in response times among HH subjects. It may be interesting for future investigations to determine whether differences in cognitive styles relates to individual differences in rates of automaticity acquisition among this group.

The most appropriate framework with which to interpret the results of the present study is provided by the synergistic approach. The basic premise of this approach is that hypnotizability differences are not explicable in a univariate framework. Rather, any differences in hypnotizability probably represent one aspect of a multidimensional construct that is termed *hypnotizability*. To date, individual differences in hypnotizability have been related to underlying differences in styles of mentation, attitudes, responses to situational variables and possibly cognitive processing, among other variables (Dixon et al., 1990). Reasoning that the faster automatization displayed by HH relative to LH groups frees cognitive resources for other processes such as imagery (Dixon et al., 1990), it becomes apparent how differences in rates of automatization are consistent with the previous pattern of findings. More importantly, automatization differences were obtained outside of hypnotic context and were not obviously related to hypnotizability differences. Thus, they cannot be explained solely by compliant behaviour on the part of subjects nor are they solely context-dependent effects. This supports the claim made by proponents of the synergistic approach regarding the need for individual differences as well as situational variables to explain hypnotizability differences.

In summary, the present results indicate that although shape-naming became automatic with only 1 hour of practice, no direct evidence of differential rates of acquisition among hypnotizability groups were found, contrary to predictions. However, the influence of colors on shape-naming diminished in intensity for HH subjects significantly more than for LH. This difference, although in need of replication, leads to the speculation that differences in rates of automaticity acquisition between HH and LH subjects may require more trials to emerge than initially thought. Alternately, the difference between HH and LH subjects' rates of automaticity acquisition may emerge in a paradigm with more power than the present one. Future investigations may expand the present study by providing subjects with more practice shape-naming, interspersed with a larger number of Stroop-like testing. Within a multivariate approach, the inclusion of individual differences variables that are related to hypnotizability (e.g. absorption), in addition to automaticity data may serve to extend current understanding of the mechanisms underlying hypnotizability differences.

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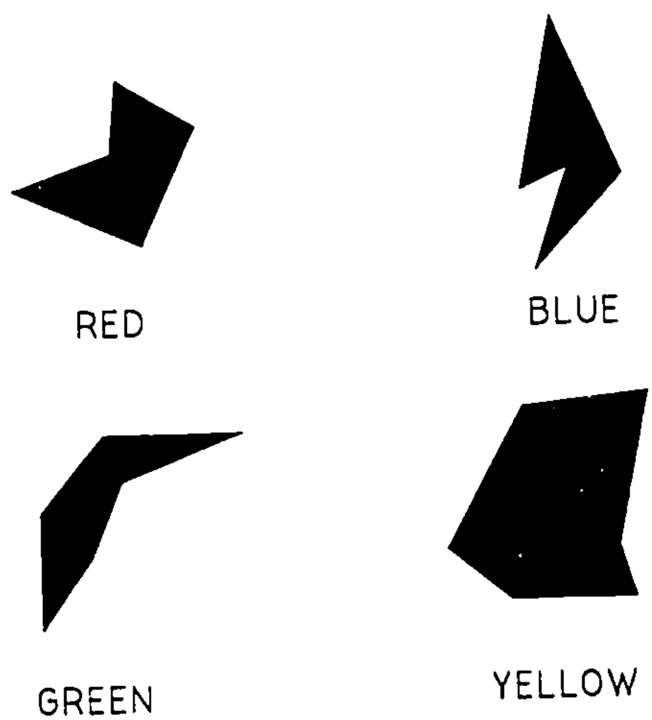
Appendix A

Visual characteristics of the four polygons used as novel stimuli in the present experiment



Shape	Michelson Contrasts	Luminance (foot lamberts)	Shape size (Pixels)
Red	.5888	22.8	196
Blue	.3370	11.9	147
Green	.6346	26.4	202
Yellow	.8525	74.1	463
Box			504
Backgound		5.9	

Appendix B

ANOVA source table for Phase 3 response time data

SOURCE	SS	df	MS	F	p
Grouping	48897.4	1	48897.4	1.1	NS
Ss within Grp	663291.3	15	44219.4		
Relation	36696.3	2	18348.1	9.3	<.001
Rel X Grp	5788.4	2	2894.2	1.5	NS
Error	59491.2	30	1983		
Day	53166.9	1	53166.9	11.9	<.004
Day X Grp	190.9	1	190.9	0.04	NS
Error	66813.4	15	4454.2		
Rel X Day	867.8	2	433.9	0.89	NS
Rel X Day X Grp	357.5	2	178.7	0.37	NS
Error	14694.6	30	489.8		
Total		101			

Appendix C

ANOVA source table for Phase 4 response time data

SOURCE	SS	df	MS	F	p
Grouping	60014.7	1	60014.7	1.3	NS
Ss within Grp	693285.6	15	46219		
Relation	241888.5	2	120944.3	47.2	<.001
Rel X Grp	16359.8	2	8179.9	3.2	0.055
Error	76948.1	30	2564.9		
Day	286925	1	286925	81.4	<.001
Day X Grp	170.8	1	170.8	0.05	NS
Error	52893.4	15	3526.2		
Rel X Day	16338.9	2	8169.5	8.6	<.001
Rel X Day X Grp	1410.8	2	705.4	0.74	NS
Error	28432.9	30	948.8		
Total		101			

Appendix D

ANOVA source table for Phase 3 error data

SOURCE	SS	df	MS	F	p
Grouping	1.559	1	1.6	0.5	NS
Ss within Grp	51.1	15	3.4		
Relation	90.9	2	45.5	25.1	<.001
Rel X Grp	4.9	2	2.5	1.4	NS
Error	54.2	30	1.8		
Day	28.4	1	28.4	15	<.002
Day X Grp	3.1	1	3.1	1.6	NS
Error	28.4	15	1.9		
Rel X Day	37.9	2	19	16.4	<.001
Rel X Day X Grp	2.4	2	1.2	1.1	NS
Error	34.7	30	1.2		
Total		101			

Appendix E

ANOVA source table for Phase 4 error data

SOURCE	SS	df	MS	F	p
Grouping	1.1	1	1.1	0.4	NS
Ss within Grp	44.3	15	3		
Relation	110.9	2	55.5	33.9	<.001
Rel X Grp	0.9	2	0.4	0.3	NS
Error	49.1	30	1.6		
Day	17.7	1	17.7	3.9	<.07
Day X Grp	0.4	1	0.4	0.1	NS
Error	68.3	15	4.6		
Rel X Day	26.4	2	13.2	5.2	<.02
Rel X Day X Grp	0.9	2	0.5	0.2	NS
Error	75.7	30	2.5		
Total		101			

Appendix F

ANOVA source table for Phase 3, Day 1, Block data

SOURCE	SS	df	MS	F	p
Grouping	52972.2	1	52972.2	0.84	NS
Ss within Grp	949323	15	63288.2		
Block	14255.8	1	14255.8	12.9	<.003
Blk X Grp	76.3	1	76.3	0.07	NS
Error	16576.5	15	1105.1		
Relation	28759.9	2	14379.9	5.8	<.007
Rel X Grp	5454.5	2	2727.2	1.1	NS
Error	74379	30	2479.3		
Rel X Blk	188.2	2	94.1	0.2	NS
Rel X Blk X Grp	2844.4	2	1422.2	3	<.065
Error	14184	30	472.8		
Total		101			

Appendix G

ANOVA source table for Phase 3, Day 5, Block data

SOURCE	SS	df	MS	F	p
Grouping	97021.3	1	97021.3	2.6	NS
Ss within Grp	559738.5	15	37315.9		
Block	1178.4	1	1178.4	0.28	NS
Blk X Grp	11203.1	1	11203.1	2.7	NS
Error	62239.5	15	4149.3		
Relation	52342.5	2	26171.3	10.5	<.001
Rel X Grp	6979	2	3789.5	1.4	NS
Error	74775	30	2492.5		
Rel X Blk	2711.4	2	1355.7	1.6	NS
Rel X Blk X Grp	6100.6	2	3050.3	3.6	<.04
Error	25419	30	847.3		
Total		101			

Appendix H

ANOVA source table for Phase 4, Day 1, Block data

SOURCE	SS	df	MS	F	p
Grouping	63453.6	1	63453.6	1	NS
Ss within Grp	951804	15	63453.6		
Block	4517.6	1	4517.6	1.7	NS
Blk X Grp	651.1	1	651.1	0.25	NS
Error	39861	15	2657.4		
Relation	371755.1	2	185877.5	65.9	<.001
Rel X Grp	24257.2	2	12128.6	4.3	<.03
Error	84618	30	2820.6		
Rel X Blk	2047.4	2	1023.7	0.74	NS
Rel X Blk X Grp	4426.9	2	2213.4	1.6	NS
Error	41502	30	1383.4		
Total		101			

Appendix I

ANOVA source table for Phase 4, Day 5, Block data

SOURCE	SS	df	MS	F	p
Grouping	83367.4	1	83367.4	1.9	NS
Ss within Grp	658164	15	43877.6		
Block	19540.2	1	19540.2	14.4	<.002
Blk X Grp	464.1	1	464.1	0.34	NS
Error	20354.4	15	1356.96		
Relation	135541.4	2	67770.7	17.1	<.001
Rel X Grp	3511.4	2	1755.7	0.44	NS
Error	118896	30	3963.2		
Rel X Blk	5430.9	2	2715.4	1.3	NS
Rel X Blk X Grp	2418.8	2	1209.4	0.58	NS
Error	62664	30	2088.8		
Total		101			