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FIELD DEPENDENCE AND SHORT-TERM MEMORY[1]

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Summary.—This study examined the relationship between field dependence and short-term memory. It was predicted that relatively field-independent individuals would perform better on short-term memory tests in which a large amount of interference is assumed to be present than would individuals who are more field-dependent. Subjects' appraisals of their own attentional facility, as well as their thoughts and feelings about the experimental tasks, were also elicited, and were looked at in terms of their relationship to field dependence and short-term memory.

The concept of field independence has been developed on the basis of studies of perception carried out by Witkin, *et al.* (1954). In these consistent individual differences were found in ability to detect the upright accurately under a variety of conditions and in the ability to recognize a previously seen simple figure when it was embedded in a complex one. There was a significant correlation between these two abilities and a part of the shared variance of the two tasks was thought to be their common requirement to extract a figure from an embedding context. Witkin and his associates later broadened their conception of field independence, regarding it as a reflection of psychological differentiation (Witkin, *et al.*, 1962).

Two other conceptions of field independence are most crucial in the present study. A motivational dimension, a task vs a social orientation, has been proposed by Goldberger and his collaborators, along which people differ depending upon their particular way of adapting to reality and trying to satisfy their needs. This conception is based upon studies in which it was found that social cues, such as photographs of people (Crutchfield, Woodworth, & Albrecht, 1958) and words relevant to social interaction (Fitzgibbons, Goldberger, & Eagle, 1965), are of special interest to field-dependent individuals, while field-independent people show a predilection for cues which are relevant to the experimental task at hand (Eagle, Fitzgibbons, & Goldberger, 1966) and which are neutral rather than socially relevant (Eagle, Goldberger, & Breitman, 1969).

Gardner, Jackson, and Messick (1960), who use the term field articulation in place of field independence, describe it as the ability to focus attention upon the most relevant aspects of a stimulus, based on the finding that people who are good at extracting embedded items from their contexts also tend to be good at attending to the context, rather than to the embedded item, if that seems more appropriate to the task before them (Gardner, *et al.*, 1959).

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The short-term memory tests used in the present study were derived from those used by Jensen (1964) in a study of individual differences in learning, including one-trial learning, in which he found two distinct factors which accounted for a major portion of the variation in performance of 50 college students on a large assortment of short-term memory tests. One of these, to be referred to here as the interference factor, was thought to represent resistance to interference in consolidation of the memory trace. It included primarily the more difficult tests, such as a retroactive inhibition task and long lists of digits. The other factor, to be referred to as the registration factor, was interpreted by Jensen as measuring the strength of registration of the stimulus trace mainly for tasks like short lists of digits and a proactive inhibition task. It was predicted in the present study that field-independent subjects would perform better on the interference factor tests than would field-dependent subjects; no difference was anticipated on the tests of the registration factor. The basis for this prediction was twofold: first, the field-independent subject's greater ability to focus his attention actively and selectively should enable him to resist interference better and thus should render his performance superior to the field-dependent person's, and second, in all of the short-term memory tests, the field-independent person's greater task orientation and preference for neutral symbols should enable him to do better than the field-dependent person. However, this difference was expected to be statistically significant only on the more complex tests, those loading on the interference factor. A further motivational component, the tendency to try harder to do well on tasks of this kind, even when they are quite difficult, was also expected to enter performance of the more complicated tests.

To explore the question of a relationship between an individual's objective capability to attend to relatively neutral experimental tasks and his subjective sense of the ease with which he is able to maintain sustained attention, subjects were given a portion of the Columbia Attention Scale, developed by Singer and Antrobus (1963) as part of a larger study of the factorial composition of a group of measures of spontaneous mental activity, such as daydreaming.

A subject's motivational style may become evident through his feelings about the tasks he is asked to perform and his subjective responses to the experience of performing them. This issue was explored through the use of a questionnaire designed to elicit information about subjects' experiences and feelings during the experimental tasks, with a major focus on the degree of investment and interest in the various tasks on the part of the subjects, and the extent to which they felt they had difficulty attending to the tasks, with particular emphasis on interpersonal distractions.

The primary hypotheses may be summarized as follows: Field-independent subjects will perform better than field-dependent subjects on the short-term memory tests which comprise an interference factor. This difference will dis-

appear on the short-term memory tests which make up a registration factor. Field-independent subjects will report less difficulty in attending than will field-dependent subjects. Field-independent subjects will describe themselves as more invested in both the field dependence tasks and the short-term memory tasks than will field-dependent subjects, as well as more interested in cognitive tests in general. Field-independent subjects will describe themselves as less curious about peripheral aspects of the experimental situation and less prone to mind-wandering during the experimental procedure than will field-dependent subjects.

METHOD

Subjects

Subjects were undergraduates in psychology courses at New York University. The sample included 41 males and 33 females, ranging in age from 17.17 yr. to 32.92 yr., with a mean age of 19.38 yr. Since no significant differences were found between the performances of the two sexes on the field-dependence measures, data from the entire sample were combined for analysis.

Tests Administered

Vocabulary test.—Each subject was given a vocabulary test of 20 of the 40 words which comprise the Vocabulary subtest of the WAIS (all of the even-numbered words were used). The test was administered orally; the examiner recorded the subject's responses as he gave them, and the test was scored later, following the guidelines in the WAIS manual (Wechsler, 1955). This test was regarded as a measure of general intelligence. The rationale for this is Wechsler's (1958) finding that correlations between the Vocabulary subtest of the WAIS and the total score on the WAIS were consistently between .7 and .9 across a large age range. The short form used in the present study has been found to have high reliability (.90) and validity ratings (.97) with the subtest as a whole (Zytowski & Hudson, 1965).

Rod-and-frame Test.—Each subject was tested on a portable rod-and-frame apparatus, described by Oltman (1968), which is based on Witkin's original test (1954). Oltman found a .89 correlation between scores on the portable apparatus and those on the standard device for 163 college students. The subject is required to instruct the experimenter to adjust a tilted rod, which is within a tilted frame, until the subject perceives the rod to be vertical (the frame remains stationary). The score for each subject is the sum of the absolute deviations from the vertical over eight trials.

Embedded-figures test.—Each subject was given Jackson's (1956) short form of Witkin's Embedded Figures Test (1950). Each of the 12 items on this test requires the subject to look at a simple, geometrical figure and then find it within a larger, more complex figure, in which it has been incorporated in a way which renders it relatively difficult to perceive. The subject's score is the mean time per item.

Short-term memory tests.—Seven tests, based on tests selected from Jensen's (1964) group of short-term memory tests, were given. In the present study, the auditory mode of presentation was employed. The digit series were tape-recorded, to ensure uniform presentation. At a prearranged signal, the subject wrote the recalled digits on a specially prepared answer sheet. Digits were obtained through the use of a random numbers table. Position scoring was used; that is, one point credit was given for each item re-

called in the serial position it occupied in the order of presentation. There was one practice trial for each condition of each test.

On Test I, Immediate Digit Span 4-7 (IDS 4-7), Proactive Inhibition (PI), Retroactive Inhibition (RI), and Delayed Digit Span 4-7 (DDS 4-7) were administered together, i.e., trials of each were interspersed, so that a subject did not know until the time of recall which condition prevailed.

A tone signalled to the subject that a digit series was about to begin. Then a tape-recorded voice recited from four to seven digits at 1-sec. intervals. At the end of the series, one of three things occurred. In IDS 4-7, the sounding of a tone directed the subject to write down as many digits as he could recall. Or, a 3-sec. pause occurred, following which the same tape recorded voice recited another digit series of from four to seven digits. At the end of this second series, a tone sounded either once, indicating that recall of the first series was being requested (RI), or twice, indicating recall of the second series (PI). In Delayed Digit Span 4-7, after the 3-sec. pause, the tape-recorded voice recited the words "plus" and "minus" at 1-sec. intervals, in random order, and the subject was required to write plus and minus signs, in the spaces provided on his answer sheet, as he heard the words. Total delay was 10 sec. Following this, a tone indicated that he was to recall the digit series. In each of the four conditions, the subject had 13 sec. to write down the digits he recalled, before the tone signified that the next series was to begin.

All possible combinations of series length were used, making 16 trials each of retroactive and proactive inhibition. There were also 16 trials of Immediate Digit Span 4-7 and Delayed Digit Span 4-7, making a total of 64 digit series. The series were administered in random order.

On Test II, Long Digit Span (LDS), the subject was informed at the beginning that each series contained 15 digits but that he was to attempt to recall only the first 12. A tone signalled to the subject that a digit series was about to begin. The recorded voice recited a series of 15 digits at 1-sec. intervals. At the end of the series, a tone sounded, and the subject had 13 sec. to write down as many of the first 12 digits as he could recall before a tone announcing the next series was sounded. There were 16 digit series in all.

On Test III, Immediate Digit Span 2-9 (IDS 2-9), and Delayed Digit Span 2-9 (DDS 2-9), a tone signalled to the subject that a digit series was about to begin. The recorded voice recited a series of from two to nine digits at 1-sec. intervals. At the end of the series, if a tone sounded for 1 sec., the subject was required to recall the series (IDS 2-9). If, instead, there was a pause, followed by the voice reading the words "plus" and "minus," he was required to write plus signs and minus signs as he heard the words, at the conclusion of which a tone sounded, signalling recall (DDS 2-9). The delay period was 10 sec. in length. In both conditions, the subject had 13 sec. to write down as many of the digits as he could recall, following which a tone announced the next series.

Each length of series was replicated five times for each condition, making 80 digit series in all. The series were administered in random order.

The following tests are considered to make up the interference and registration factors, respectively:

Interference Factor	*Registration Factor*
Long Digit Span	Immediate Digit Span 4-7
Retroactive Inhibition	Proactive Inhibition
Delayed Digit Span 2-9	Delayed Digit Span 4-7
	Immediate Digit Span 2-9

Attention test.—Each subject was given a list of 30 statements and asked to indicate for each statement whether it was true or false. The statements were selected from the Singer and Antrobus (1963) Columbia Attention Test on the basis of their seeming applicability to issues of interest to the present study.

Testing experience questionnaire.—At the conclusion of the testing, each subject was given a questionnaire designed to elicit information about his thoughts and feelings during the testing experience.

Procedure

Each subject was seen for one testing session which lasted from 2½ to 3 hr. The session began with the administration of the vocabulary test; the rod-and-frame test and the embedded-figures test followed. The short-term memory tests were then administered in counterbalanced order. Following this, each subject was given the attention test and the questionnaire.

RESULTS

The means and standard deviations for each test measure are presented in Table 1.

TABLE 1

MEANS AND STANDARD DEVIATIONS FOR EACH TEST MEASURE (*N*, 74)

Measure	*M*	*SD*
Rod and Frame	5.27	5.14
Embedded Figures	56.96	26.90
Vocabulary	28.84	5.20
Long Digit Span	67.31	17.64
Retroactive Inhibition	39.99	14.33
Delayed Digit Span (2-9)	137.51	33.84
Immediate Digit Span (4-7)	65.96	13.01
Proactive Inhibition	24.14	10.63
Delayed Digit Span (4-7)	36.77	15.74
Immediate Digit Span (2-9)	170.97	22.94
Attention Test	15.24	6.94

Relationship Between Field Dependence and Short-term Memory

Table 2 presented the Pearsonian correlations between each of the field-dependence measures and the short-term memory test scores. Note that the higher the score on Embedded-figures and Rod-and-frame Tests the poorer the performance and hence, the more field-dependent the subject.

All of the interference factor tests were significantly correlated with both of the field-dependence measures, while only one of the registration factor tests correlated significantly with these measures. The test, Delayed Digit Span 4-7, had loaded on both the factors in Jensen's (1964) study, but it had been decided to include it as part of the registration factor in the present study.

TABLE 2

PEARSONIAN CORRELATIONS BETWEEN FIELD DEPENDENCE AND SHORT-TERM MEMORY

Measures	Rod-and Frame	Embedded Figures
Interference Factor		
Long Digit Span	−.63*	−.69*
Retroactive Inhibition	−.63*	−.65*
Delayed Digit Span (2-9)	−.65*	−.74*
Registration Factor		
Immediate Digit Span (4-7)	−.12	−.22
Proactive Inhibition	−.06	−.10
Delayed Digit Span (4-7)	−.66*	−.61*
Immediate Digit Span (2-9)	−.16	−.28

*$p < .001$.

A multiple regression analysis was performed on the data, using the two field-dependence measures as predictor variables and the short-term memory scores as criterion variables. Performance on all of the interference factor tests were predicted by scores on the field-dependence measures, while only one of the registration factor tests, Delayed Digit Span 4-7, was predicted by field dependence. The results are presented in Table 3.

TABLE 3

FIELD-DEPENDENCE MEASURES AS PREDICTORS OF PERFORMANCE ON SHORT-TERM MEMORY TESTS

Measures	F	p
Interference Factor		
Long Digit Span	43.38	<.001
Retroactive Inhibition	36.02	<.001
Delayed Digit Span (2-9)	56.30	<.001
Registration Factor		
Immediate Digit Span (4-7)	1.82	
Proactive Inhibition	.34	
Delayed Digit Span (4-7)	36.27	<.001
Immediate Digit Span (2-9)	3.11	

Thus, the hypothesis that field-independent subjects would perform better than field-dependent subjects on the interference factor tests was confirmed. The prediction that this difference would disappear on the registration factor tests found confirmation in three of the four tests making up the factor. The exception will be discussed later in this paper.

Subjective Feelings of Difficulty in Attending

The correlation between the attention test and the rod-and-frame test was

.71 ($p < .001$), while the correlation between the attention test and the embedded figures test was .66 ($p < .001$). High field dependence also predicted a high score on the attention test ($F = 49.97$, $p < .001$). The more difficulty in attending expressed by the subject, the higher the score he achieved on the attention test. Thus, the hypothesis that field-independent subjects would report less difficulty in attending than would field-dependent subjects was confirmed.

All of the interference factor tests were significantly correlated with the attention test, as was one of the registration factor tests, Delayed Digit Span 4-7, with correlations ranging from .56 to .64 ($p < .001$).

Attitudes About the Study

From the questionnaire concerning attitudes about the study were derived four measures, Task Investment in Embedded-Figures Test and Rod-and-frame Test, Task Investment in Memory Tests, General Interest, and Social/Mind-wandering.

Task Investment in the rod-and-frame and embedded-figures tasks was assessed with eight questions tapping interest in and concern with doing well on the two field-dependence tests administered. The correlation between the rod-and-frame test and this measure was .68 ($p < .001$); between the embedded-figures test and this score, the correlation was .69 ($p < .001$). High field-dependence predicted low task investment ($F = 51.02$, $p < .001$).

Task Investment in Memory Tests was made up of four questions referring to interest in and concern with doing well on the short-term memory tests used in the study. The correlation between the rod-and-frame test and this score was .60 ($p < .001$), between the embedded-figures test and this score, .66 ($p < .001$). Again, high field dependence predicted low task investment ($F = 35.54$, $p < .001$).

The General Interest measure was based on two questions concerning the subjects' interest in and curiosity about tests of the kind they were given. The correlation between the rod-and-frame test and this score was .55 ($p < .001$), between the embedded-figures test and this score, .53 ($p < .001$). Subjects scoring high on field dependence showed relatively low interest ($F = 19.65$, $p < .001$).

Thus, the hypothesis that field-independent subjects would describe themselves as more invested in both the field-dependence tasks and the short-term memory tasks than would the field-dependent subjects was confirmed. Also as was predicted, the field-independent subjects expressed more interest in cognitive tests in general than did the field-dependent subjects.

The Social/Mind-wandering measure had five questions aimed at tapping the subjects' curiosity about peripheral, e.g., social, aspects of the experimental situation, as well as the extent to which their minds wandered to completely ir-

relevant thoughts during the experiment. The measure correlated .67 with the rod-and-frame test ($p < .001$) and .65 with the embedded-figures test ($p < .001$). High field dependence predicted a high score on this measure ($F = 42.76$, $p < .001$), that is, the highly field-dependent subjects were most curious about peripheral stimuli and most subject to mind-wandering, as had been hypothesized.

Intelligence

It had been thought relevant to examine the question of whether intelligence, as measured by the vocabulary test, was related to one or both of the field-dependence measures. In fact, neither the correlation between the vocabulary test and the rod-and-frame test (.04) nor that between the vocabulary test and the embedded-figures test (.01) was statistically significant.

Correlation Between Field-dependence Measures

Scores on the rod-and-frame test and the embedded-figures test correlated .60, which is significant at the .001 level. This is consistent with Witkin's findings, as well as those of other investigators (Adevai, Silverman, & McGough, 1968).

Discussion

The finding that field independence predicted good performance on the short-term memory tests thought to involve extensive interference is quite consistent with the understanding of field independence as the ability to focus attention on the relevant aspects of a field. For example, in the Delayed Digit Span tests, in which the interference consisted of a time interval during which the subject had to write plus and minus signs as he heard the words "plus" and "minus" spoken, it seems plausible that the field-independent subjects were better able to continue to focus their attention on the digits to be remembered (i.e., to rehearse), while the field-dependent subjects may have shifted their attention to the more immediate stimuli, the plusses and minuses, thereby forgetting the digits.

The superior performance of field-independent subjects on the interference-laden short-term memory tests is also consistent with the view that they are generally more task-oriented. It must have been extremely tedious to listen to lists of digits for almost 2 hr. and then try to reproduce them; the only reward for good performance, given the structure of the experiment, was the experience of handling the task well. Thus, only those subjects who were strongly motivated to do well on just about any task were likely to continue even trying to remember the digits, especially when a great deal of effort was required, as on the more difficult tasks, such as Long Digit Span.

In a general sense, a field-independent person's ability to assume a task-appropriate attentional set more readily than a field-dependent person helps

to explain his superior performance on the interference tests. He is able to approach tasks in a manner designed to maximize his performance, while the field-dependent subject is more likely to listen to the digits much as he might listen to the test instructions or to a friend's conversation, and thus find himself quite unable to handle the more difficult tasks.

The one surprising result of the study was the finding that Delayed Digit Span 4-7, a registration factor test, was highly correlated with field dependence, while the remainder of the registration factor tests were not. However, it should be pointed out that in the present study, as well as in Jensen's (1964) study, this test was significantly correlated with *all* of the other short-term memory tests. The fact that it loaded most highly, in the Jensen study, on a factor which otherwise included tests not correlated with field dependence need not be disturbing, if it is remembered that field independence was predicted to be correlated with resistance to interference, not synonymous with it. The results of the present study suggest a possible relationship between field independence and the ability to resist being distracted by the particular kind of stimuli present during the delay condition in both of the delayed digit span tests (a tape recording of a voice saying the words "plus" and "minus" at random). This does not negate the possibility that there are two different sources of interference in the short as compared to the long digit series used (which would be the source of the different factor loading of the two tests).

The very strong relationship found between field independence and the subjective sense of an ability to maintain attention might seem at first glance to have been quite obvious and thus not worth testing, but a closer look suggests that this is not the case. Most of the questions in the attention test deal with the ability to maintain attention over a period of time, which could be quite a different ability than that of focusing attention for short periods. Then, even if identical abilities were being tested, and asked about, a variety of results might be plausible. For example, the field-independent person might describe himself as having trouble maintaining attention, because of his relatively high expectations of himself in this area due to his greater task-orientation, his greater self-awareness, or perhaps a greater propensity for boredom in the face of unstimulating tasks. Perhaps the field-dependent person would tend to complain less about problems of this nature, desiring to present a socially approved front (Elliott, 1961). In any case, the significant correlation is evidence that field-independent people at least think they are good at sustaining attention.

The strong relationship between performance on the rod-and-frame test and all four of the measures derived from the Testing Experience Questionnaire, and the similarly strong relationship found between the embedded-figures task and these measures, supports the concept of field independence as a reflection of a general task orientation. Field-independent subjects were more invested in the embedded-figures test and the rod-and-frame test than were

the field-dependent subjects, and they were also more invested in the memory tasks. Naturally, because all of the experimental tasks were quite neutral (on the neutral-social continuum), we cannot be sure that what we are interpreting as task-orientation is not merely a preference for neutral stimuli. Similarly, the tendency which field-dependent subjects had to allow their minds to wander to the social aspects of the situation, as well as to outside concerns, may have been due to the paucity of social stimuli within the task itself.

In summary, the findings of the present study seem to give strong support to the conceptions of field independence as involving the ability to attend selectively and the tendency to be task-oriented.

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