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Differential Autonomic Nervous System Activity in Multiple Personality Disorder

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Abstract. The cardinal feature of multiple personality disorder (MPD) is the existence of two or more alter personality states that exchange control over the behavior of an individual. Numerous clinical reports suggest that these alter personality states exhibit distinct physiological differences. We investigated differential autonomic nervous system (ANS) activity across nine subjects with MPD and five controls, who produced "alter" personality states by simulation and by hypnosis or deep relaxation. Eight of the nine MPD subjects consistently manifested physiologically distinct alter personality states. Three of the five controls were also produced physiologically distinct states, but these differed from those of the MPD subjects. A habituation paradigm demonstrated carryover effects at the ANS level from one state to the next for both groups.

Key Words. Skin conductance, respiration, heart rate, reaction time, habituation, multiple personality disorder, dissociation.

Multiple personality disorder (MPD) is a dissociative disorder characterized by the existence of two or more separate and distinct personality states that recurrently exchange full control over the behavior of the individual (American Psychiatric Association, 1987). Clinically these alter personality states behave as if they were semiautonomous entities with separate identities, values, and behaviors. Alter personality states are often easily distinguishable from each other by distinctive patterns of affect, cognition, speech, mannerisms, and behavior (Putnam, 1989).

There are clinical reports suggestive of physiological differences across alter personality states in MPD patients (Putnam, 1984; Coons, 1988). These reports include changes in dominant handedness (Taylor and Martin, 1944; Smith and Sager, 1971; Coons, 1980; Putnam et al., 1986); differential responses to the same medication (Barkin et al., 1986; Kluft, 1987; Putnam, 1989); and differential allergic sensitivities (Braun, 1983; Putnam et al., 1986). While largely anecdotal, these reports are widespread, including some dating back to 18th and 19th century luminaries such as Benjamin Rush, William James, and Morton Prince, and have long intrigued researchers (Putnam, 1984; Putnam et al., 1986).

Attempts to document alter personality state physiological differences in a systematic manner have primarily concentrated on the electroencephalogram (EEG). A number of investigators have reported differences in the EEG, primarily the alpha

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rhythm, across alter personality states (Thompson et al., 1937; Thigpen and Cleckley, 1954; Ludwig et al., 1972; Larmore et al., 1977). Coons et al. (1982) failed to find significant EEG differences in a study of two MPD patients and a simulating control (Coons himself), and Coons (1988) concludes in his review that most of these differences are probably secondary to changes in muscle tension and arousal. Other reported differences in cerebral activity across alter personality states include visual evoked potentials (Ludwig et al., 1972; Larmore et al., 1977; Putnam, 1984) and regional cerebral blood flow (Mathew et al., 1985).

A few investigators have looked at measures of the autonomic nervous system (Putnam, 1984; Coons, 1988). These uncontrolled single case studies include measures of heart rate and respiration (Bahnson and Smith, 1975) and galvanic skin response (Ludwig et al., 1972; Larmore et al., 1977; Brende, 1984).

This study is an attempt to assess the independence and consistency of autonomic nervous system (ANS) activity associated with different alter personality states of individuals with MPD. ANS activity, as assessed by peripheral indices of skin conductance (SC) and heart rate (HR), was evaluated from two perspectives: First, since ANS activity is relatively difficult to bring under voluntary control, it should provide an objective method for differentiating alter personality states. A within-subjects design was used in which the same three alter personality states of each MPD subject or simulating control subject were tested on four to five separate occasions to provide a measure of the consistency of ANS activity within a given personality state with respect to the variability between personality states. Second, a habituation paradigm was included to see if habituation of the orienting response (OR) in one personality state affected the OR in another personality state. Thus, a different sequence of personality states was used in each session.

Methods

Subjects. Subjects consisted of nine MPD patients (6 females, 3 males; mean age = 39.2 years, range 29-52 years) and five control subjects (3 females, 2 males; mean age = 32.2 years, range 21-47). Eight of the nine MPD subjects and all of the controls were right-handed. The patients had received treatment specifically for MPD for an average of 2.13 years, although all patients had received psychiatric treatment before being diagnosed as MPD and all retrospectively reported the existence of alter personalties from early to middle childhood. In each session for the MPD group, the host personality state (defined as the alter with the most executive control over the behavior of the individual) and two alter personality states were each tested on the same protocol. The alter personality states were selected on the basis of willingess to participate in the study procedures and on their stated ability to remain present under laboratory conditions. In most subjects the alter personality states tested included one or more alter personalities who reported themselves to be of a different age (typically a child) or a different gender from the host. The alter personality states were readily identifiable by distinctive differences in facial appearance, speech, and mannerisms.

The same three personality states were tested each day in a pseudorandomized order with the constraint that each alter personality occurred in each sequential position at least once. The control subjects were tested as themselves ("main" personality state), as an "imaginary personality" (IP), and in an "altered" state of consciousness created by hypnosis (in two subjects) or deep relaxation (three subjects). The choice of the type of altered state of consciousness was determined by each control subject. The control subjects were asked to create an IP of their own choosing and to specify name, sex, age, race, height, weight, hair color, eye color, occupation, annual income, place of residence, marital status, number of children, hobbies, interests, important identifying characteristics, and personal attributes. The controls were encouraged to rehearse their simulations outside of the experimental setting.

Procedure. The protocol consisted of recording SC from each hand, HR, and respiration (R) during a 3-min rest period, followed by the presentation of a series of ten 80-dB, 1000-Hz tones, presented 20-30 sec apart through a speaker placed about 2 meters in front of the subject, and a reaction time (RT) task in which the subject responded as quickly as possible to the illumination of a 15 cm^2 green electroluminescent panel. In this task, a small red light was a signal for the subject to depress a telegraph key; the signal stimulus came on after a 4-sec delay and remained on until the key was released. Four practice trials and nine that "counted" were given to each personality on each day. The intertrial interval was randomly distributed between 8 and 14 sec (mean = 11 sec).

Instructions were given before the rest and tones period and before the RT task to each personality on each day by one of the investigators (T.P.Z.). These were somewhat more detailed on day 1 than on subsequent days, but care was taken to give the same amount of detail to each alter personality state on a given day in both MPD and control groups. A person well-known to the subjects (usually F.W.P.) sat quietly in the room with the subject and requested each personality state at the beginning of a new segment. The identity of each alter personality state was confirmed before each testing segment and again after each testing segment by interaction between the observer and the subject.

Data Analysis. Physiological data were digitized on-line by a PDP-11 computer, edited via an interactive program, and analyzed off-line on the same computer. SC responses (SCRs) occurring 1-4 sec after a stimulus were taken to be elicited by the stimulus. These were scored for frequency, amplitude, magnitude, latency, rise time and rate, and half-recovery time and rate. The rationale for including these indices of the speed of the rise and decay of individual electrodermal responses is that they load significantly on a factor of "electrodermal lability" (Zahn et al., 1986), which has been shown to correlate with personality variables. Spontaneous SCRs—those occurring outside the latency window for elicited SCRs—were scored for frequency/min, amplitude and rise time, and half recovery. These were analyzed for all four periods of each segment (rest, tones, RT instructions [including practice trials], and RT task), along with the mean, maximum, and minimum SC level (SCL) and its rate of change (slope) over the period. The mean and variability of HR were also computed for each period. Respiration rate was hand-scored for rest, tone, and RT task periods.

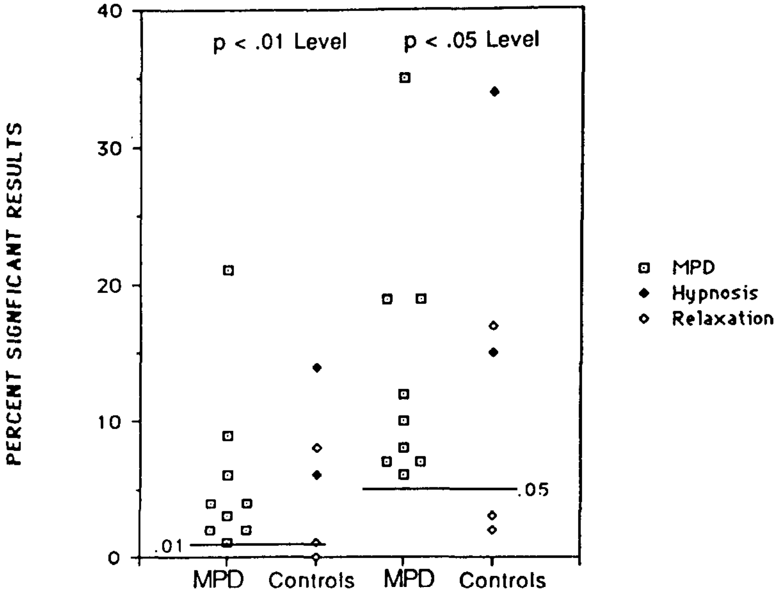
Elicited SCRs were evaluated separately for tones (orienting responses, ORs) and for ready and signal stimuli for the RT task. Elicited HRORs were evaluated by comparing prestimulus and poststimulus maximum and minimum HR for 5- and 10-sec periods for the first trial, the first block of 5 trials, and all 10 trials. The HR change of interest in the RT task was a deceleration during the foreperiod, and this was evaluated by comparing the pretrial minimum HR with that during the foreperiod or just after.

Statistical Analysis. A separate analysis of variance (ANOVA) was performed for each subject on each physiological variable. The purpose of these analyses was to test the hypothesis that the variable under scrutiny was consistently different among the three MPD personality or control states. That is, the null hypothesis was Personality State 1 (P1) = P2 = P3. In these ANOVAs, the three personality states were treated as independent groups, and test day and sequence (first, second, or third trial on a given day) were repeated measures factors. Since sequence and days were confounded, their effects had to be estimated in separate analyses. The analyses to be presented here are for the effects of personality state with the effects of test day removed from the error variance. A significant result indicates that the difference between personality states was consistent with respect to the within-personality state variance from repeated testing.

Results

In view of the large number of statistical tests (196 variables/subject), the first question asked was whether there were more significant effects for personality state than would be expected by chance. For each subject, the number of variables for which the main effect of personality state was significant below the 0.01 and 0.05 levels was tabulated and expressed as a percentage of the total number of tests. Fig. 1 shows that eight of the nine MPD subjects exceeded the "chance" number of significant effects at both the 0.05 and 0.01 levels, while one MPD subject (a different one for each level) was about at the "chance" level. For $p < 0.01$, the values ranged from 1% to 20% of the differences (median = 4%), while for the 0.05 level, they ranged from 6% to 35% (median = 10%). Thus, MPD subjects as a group showed clearly differentiated personality state physiological patterns.

Fig. 1. Percentage of variables significant across alter personality states



Significant between-personality F ratios for multiple personality disorder (MPD) subjects and controls: Solid lines show "chance" levels for $p < 0.01$ and $p < 0.05$ levels.

For controls, three of the five subjects exceeded chance levels. Two of these subjects used a hypnotic state as one of their "personalities," and they showed a degree of differentiation equal to the top three MPD subjects. Two of the three nonhypnotized controls were not able to produce consistent interpersonality state physiological differences above chance levels and had fewer significant differences than any MPD subject. The third nonhypnotized control subject was above the median for the MPD group, however. The personality state created by this control subject was modeled after an acquaintance who suffered from manic-depressive illness.

Similar analyses were done to test the hypothesis that alter personalities would manifest consistent differences in electrodermal laterality. For each variable reflecting spontaneous electrodermal activity during the combined rest and tones period and for the SCRs elicted by simple tones and RT stimuli, we computed a laterality index: (L - R)/(L + R), where L and R refer to the values from left and right hand recordings, respectively. There were 51 such indexes. These analyses show that most MPD subjects had either two or three significant results for personality state—none more than three—and about half (4) had one difference significant at the 0.01 level while the rest had none, which is about what would be expected by chance. Controls had somewhat fewer significant results. Thus, there was little support for the hypothesis that alter personality states would exhibit differential laterality in either group or for any individual subject.

A second way of looking at the results is variable by variable, an approach which addresses the issue of whether some variables are more likely than others to differentiate the alter personality states in the MPD group or the different personality states in the control group. For this analysis, the p values for each subject were combined to test the null hypothesis for each group as a whole using a χ^2 test (Winer, 1971, p. 49).

Table 1 shows the results of this analysis for a few selected variables. The first four are commonly used indices of ANS activity—or "arousal"—during the combined rest and tones periods; the SC measures are from the right hand, but the left hand values were quite similar. Table 1 shows that both groups manifested significant personality state differences for the rate of spontaneous SCRs/min and respiration rate. The

Table 1. Overall tests of the hypothesis of equality of alter personalities: Combined p values for individual subjects and % of subjects showing significant differences

Variable	Group	χ^2	*df*	*p*	% Significant at $p<0.05$	% Significant at $p<0.01$
Spontaneous fluctuations	MPD	56.1	18	0.01	44	33
(rest & tones)	Ctl	35.6	10	0.01	60	40
Skin conductance level	MPD	21.8	18	NS	11	0
(rest & tones)	Ctl	28.4	10	0.01	40	20
Heart rate	MPD	45.9	18	0.01	33	22
(rest & tones)	Ctl	16.0	10	0.10	20	0
Respiration rate	MPD	45.1	18	0.01	33	22
(rest & tones)	Ctl	23.1	10	0.05	20	20
No. of SCORs	MPD	47.8	18	0.01	33	33
	Ctl	24.2	10	0.01	40	40
SCR amplitude	MPD	40.0	16	0.01	25	25
RT stimulus	Ctl	6.9	8	NS	0	0
Latency of SCRs to	MPD	40.3	16	0.01	38	13
RT stimulus	Ctl	12.7	8	NS	0	0
Median RT	MPD	67.7	18	0.01	55	44
	Ctl	13.1	10	NS	20	0

Note. MPD = multiple personality disorder. Ctl = control. SCORs = skin conductance orienting responses. SCR = skin conductance response. RT = reaction time.

controls tended to be more consistently differentiated by SCL, whereas the MPD group showed more of an effect for HR. A similar pattern was found during the more active periods for RT instructions and the RT task itself.

For the ORs to the tones, both groups showed significant differences between their alter personality states in the overall SCOR frequency (Table 1). However, only the MPD group showed significant effects in SCOR magnitude and latency and in the accelerative component of the HROR (not shown). All of these electrodermal effects were shown bilaterally. In ANS responding to the RT task, only the MPD subjects showed significant effects in SCR amplitude (Table 1), latency, and rise rate to the RT stimulus. This may be related to the differences in RT performance shown by this group. The single variable that most reliably distinguished alter personality states in the MPD subjects was the median RT, which showed significant personality state differences in 55% of the MPD subjects. In contrast, the controls showed significant differences mainly on SCR half-recovery time and rate. Of the variables shown in Table 1, however, only median RT produced a significant group difference ($p = 0.05$) in consistency as tested by an F test of the difference between two χ^2's (Winer, 1971, p. 40), although the differences for SCL and SCR amplitudes were of marginal significance ($p < 0.10$).

Thus, the patterns of significant results of this analysis in the two groups are different. This is further bolstered by the result that although one or the other group showed significance on 53% of the variables, only 9% of the variables were significant for both groups—suggesting that differences in ANS activity between alter personality states may be arrived at in different ways for the two groups.

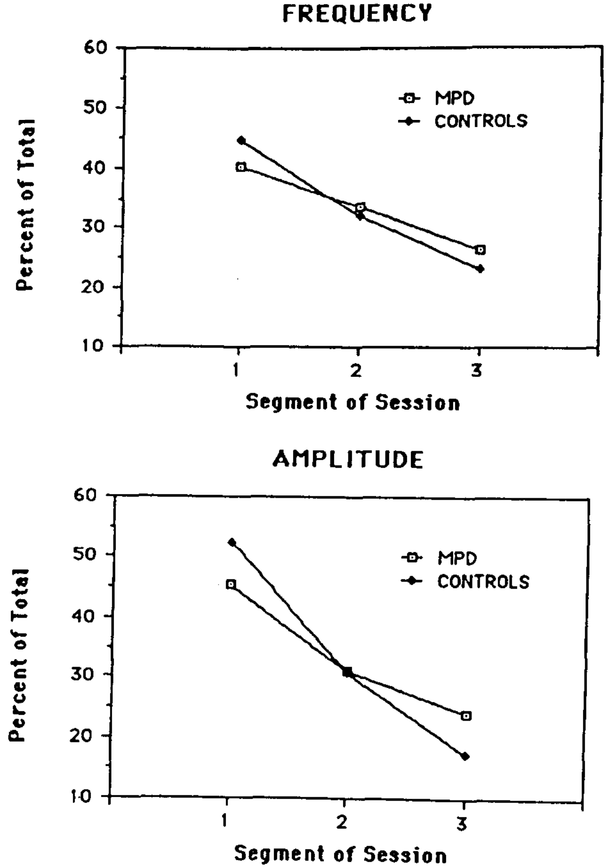
A third analysis was concerned with the question of the degree of carryover at the autonomic level from one personality state to the next. If a person were given three identical paradigms in the same personality state, a systematic reduction in the SCOR would be expected. Thus, one might expect the degree to which the separate personality states lack awareness of one another to be reflected in a slower rate of decline of these measures across segments of a session. In these analyses, the data for the first, second, and third segments of each session were averaged across days. To equalize the contribution of each subject to the total, each individual score was represented as a percentage of the total for that subject.

Fig. 2 shows that the group difference is in the expected direction, with the MPD group showing less intrasession habituation than the controls. Group × Segment ANOVAs on each of these variables showed that group differences in habituation were not significant and that the MPD group did show a significant decline across segments ($p < 0.05$ in each case). Thus, at the level of ANS activity, the experiences of one personality state appear to influence the reactions of others. Whether or not there are pairs of alter personality states in some MPD subjects who do not share a common reactivity at the ANS level cannot be determined from our sample.

Discussion

The finding that most of the MPD subjects were able to produce consistent differences in ANS physiology by changing personality state supports the hypothesis that the alter personalities of MPD subjects are highly organized, discrete states of consciousness

Fig. 2. Mean intrasession habituation of the electrodermal orienting response for multiple personality disorder and control subjects



and have properties similar to other discrete states of consciousness (Putnam, 1988). These complex dissociative states of consciousness are thought to arise in childhood as a defensive response to the childhood trauma known to be associated with the development of MPD (Bliss, 1980; Coons et al., 1988; Putnam et al., 1986).

As complex discrete states of consciousness, the alter personalities differ from each other in variables that define a discrete state of consciousness, including affect, memory retrieval, focus of attention and cognitive style, level of arousal, regulatory physiology, and sense of self (Putnam, 1988). Other evidence supportive of a discrete state of consciousness model of the alter personalties in MPD comes from studies demonstrating state-dependent learning and memory retrieval across alter personality states in MPD subjects (Silberman et al., 1985; Nissen et al., 1988).

Although the MPD subjects as a group showed clearly differentiated personality state-dependent physiological patterns, some control subjects were able to produce "states" with a degree of differentiation equivalent to the "better" MPD subjects. However, while the hypnotized controls had very low arousal compared to their "main" personality state, the psychophysiologically distinct alter personality states of the MPD subjects (and the single "good" nonhypnotized control) showed a pattern of increased arousal compared to the host personality. This suggests that the two groups were producing their physiological differences through different mechanisms or by experiencing qualitatively different types of states of consciousness. A possibly relevant observation in this context is that only the MPD group showed significant differences on the HR accelerative response to the nonsignal tones. This response is considered part of a "defensive" reaction to aversive stimuli (Graham and Clifton, 1966), suggesting that some of these personalities found the tones aversive.

The difference in patterning of the arousal differences—more marked in HR and respiration rate in the MPD group and for SCL in the controls—suggests more involvement of muscle tension (unfortunately not measured here) in the MPD group. Muscle tension, while generally regarded as an artifact in psychophysiological research, may actually be a robust marker of state of consciousness. Switching between alter personalities typically involves changes in facial expression, posture, voice (pitch, rate of speech), and motor activity (Putnam, 1988). All of these changes reflect alterations in motor tone. Electromyographic studies have consistently demonstrated that depressive states can be reliably discriminated from nondepressive states by levels of facial muscle tension (Greden et al., 1986). The speculation by Coons (1988) that many of the differences in EEG across alter personalities may reflect muscle tension differences is consistent with our data. Simple measures of muscle tension such as surface electrode activity may provide a means for reliably discriminating discrete states of consciousness. Future studies of the psychophysiology of MPD should include measures of muscle tension.

The greater consistency of differences in responsivity and habituation to the tones for the MPD group can be explained by increased arousal for some alter personality states. Retarded habituation is also characteristic of patients with anxiety states, agitated depression and, sometimes, schizophrenia (those patients who also exhibit high arousal) (Zahn, 1986). Level of arousal is a potent marker of state of consciousness across a range of types of states including behavioral states in infants (Wolff, 1987; Putnam, 1988). The shifts in level of arousal across discrete states of consciousness are nonlinear, however, and do not simply represent a gradient increase of a continuum function (Wolff, 1987).

The failure to find consistent alter-personality differences in electrodermal laterality in the MPD group as a whole or in any individual patient does not necessarily contradict the assertion that some MPD subjects show consistent differences in handedness among their alter personalities. First, the phenomenon may be relatively rare, making it quite possible to study a group of nine individuals without finding an instance of it. Second, the hypothesis may not have received an adequate test with the present methodology since consistent relationships between handedness and laterality of electrodermal activity have been difficult to demonstrate (Hughdahl, 1984) and may require special procedures such as comparing reactions to "left hemisphere" vs. "right hemisphere" stimuli.

The analysis of the habituation of the OR indicates that the experiences of one personality state influence the ANS reactivity of other alter personality states. Similar carryover or order effects have been noted for the influence of the sequence of alter personality states on the psychophysiology of subsequent alter personality states (Putnam, 1988). This is not necessarily inconsistent with a lack of conscious awareness or amnesia for this influence, but there is some question as to how this influence occurs. Other forms of transmission of "information" across alter personality states have been noted in the studies of learning and memory retrieval in MPD subjects (Ludwig et al., 1972; Silberman et al., 1985; Nissen et al., 1988).

Since the OR reflects the general level of arousal as well as prior experiences with the specific eliciting stimulus, this general background level of arousal may be what is carried over from one personality state to the next—rather than cognitive experiences with the stimulus. This cannot be determined at present. However, none of the indices of tonic arousal (spontaneous SCRs, SCL, or HR) showed monotonic decreases across segments, making a simple explanation involving arousal unlikely. Elicitation of ORs is assumed to depend on preattentive signal processing according to some theories (e.g., Öhman, 1979), which would put some of the process of habituation out of conscious awareness.

Our data suggest that the alter personality states of MPD are physiologically distinct states of consciousness. Equivalent differences can be generated by some control subjects using hypnosis or simulations based on experiential material. Muscle tension and level of arousal appear to play an important mechanistic role in producing differences in ANS activity of MPD subjects and may serve as important state markers for investigating differences among discrete states of consciousness.

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