WE HAVE recently reported that marihuana extract, calibrated for content of (—)-
Al-tetrahydrocannabinol (THC), significantly impaired the serial coordination of cognitive
operations during a task that required sequential adjustments in reaching a goal.\(^1\) Our term for
this mental incoordination is temporal disintegration. From a cognitive standpoint, temporal
disintegration means that the individual has difficulty in retaining, coordinating, and serially
indexing those memories, perceptions, and expectations that are relevant to the goal he is
pursuing. Subjectively, temporal disintegration is experienced as a confusion of past, present,
and future while a person attempts to pursue goals. This paper focuses on the relationship of
temporal disintegration to depersonalization (that is, the experience of the self as strange and
unreal) during marihuana intoxication.

**Hypotheses**

Since the personal past, present, and future constitute a fundamental
subjective framework through which an individual views and identifies himself, we posXulated
that the fragmentation and disorganization of temporal experience induced by THC would relate
to depersonalization. This postulate stems from previous work on temporal distortions during
acute clinical psychoses\(^2\) and from pilot studies of normal subjects given 60 mg of THC. To test
this postulate, two hypotheses were formulated:

**Hypothesis 1:** THC induces temporal disintegration and depersonalization.

**Hypothesis 2:** Changes in temporal disintegration correlate positively with changes in
depersonalization.

We were also interested in the emotional correlates of temporal disintegration and
depersonalization during marihuana intoxication, but because our pilot studies indicated marked
individual differences, no general hypotheses were formulated.

**Methods**

Tests.—Temporal disintegration was measured subjectively by the Temporal Integration
Inventory (TII) and cognitively by a task termed the Goal-Directed Serial Alternation (GDSA).
We predicted that changes in the subjective TII score and the cognitive GDSA score would
co-vary significantly since each is a different way of measuring temporal disintegration.

The TII consists of 14 statements.
1. Sometimes I feel absent from the present, swept into the past and future as if I were really there.

2. My past, present, and future seem quite integrated with each other, and yet I can tell them apart.

3. My past, present, and future seem like separate islands of experience with little relation to each other.

4. Things seem to be happening in the proper sequence, and it is easy for me to tell what comes before or after.

5. My past and future seem to have collapsed into the present, and it is difficult for me to tell them apart.

6. I can keep in mind memories, perceptions, and expectations all at once without confusing which is which.

7. My past, present, and future seem all muddled up and mixed together.

8. When I am remembering my past or imagining my future, I still realize that I am here in the present.

9. Things seem to be happening to me rather than my making things happen.

10. My short-term goals seem to fit my long-term goals.

11. My sense of self-direction seems to be unpaired.

12. My thoughts and actions are organized toward what I want to do or say next.

13. I feel I have little control over what happens to me in the immediate future.

14. I am confident that my plans will accomplish my goals.
Although the items were intermixed during actual testing of subjects, the TII statements are listed above according to its two components: Temporal Distinction and Goal-Directedness. The first eight statements relate to Temporal Distinction—that is, orderly indexing memories as past perceptions as present, and expectations as future, without confusion of these temporal categories. In addition, items 1 and 8 refer to what Minkowski3 termed the "I-here-now" position, meaning that the present is used as a reference point for experience, and the person does not get lost in fantasies of the present and future as though he were "really there." Statements 9 through 14 relate to Goal-Directedness—that is, adjusting plans of action to reach goals and control outcomes. Previous theoretical and review papers have detailed these concepts: Plans of actions are hierarchies of sequential acts4; goals are the desired outcomes of these acts.5

Subjects responded to each statement on a six-point scale, ranging from "not at all" to "extremely." The TII items labeled above with odd numbers reflect temporal disintegration, and, thus were scored positively; even-numbered items were scored negatively. Thus, scoring of the TII in this way gave a total score which reflected temporal disintegration so that, as with the other tests we used (except for the positive emotional factors), higher scores indicate greater psychopathological disturbance.

The cognitive test of temporal disintegration, the GDSA, required that the subject simultaneously hold in mind and coordinate information as well as mental operations relevant to pursuing a goal. After giving the subject a starting number between 106 and 114, we asked him to subtract 7, then add 1, 2, or 3, and repeat such alternate subtraction and addition until he reached an exact goal between 46 and 54 that we specified for each trial. In this way, we randomly varied the starting point and goal from trial to trial so that different cognitive adjustments were necessary for each test session. We asked the subject to recite his mental operations out loud and to work as rapidly and accurately as possible, without using written props. As detailed in another report,7 the overall performance score for the GDSA gives equal weighting to the time taken in second:3 to perform the task and to the number of mistakes made. Higher GDSA scores indicate greater temporal disintegration.

Depersonalization was measured by 12 statements (hereafter abbreviated as the DP inventory) that Dixon° found to have a factor loading of greater than 0.50 on depersonalization. Statements of the DP inventory refer to feelings of estrangement and unreality about the self—for example: "My body seems detached, as if my body and self are separate" and "I feel like a stranger to myself." Subjects responded to each statement on a six-point scale, ranging from "not at all" to "extremely."
We used the Nowlis-Green Mood Adjective Check List (MACL) to measure changes in emotion. Since our pilot studies indicated that the 12 mood factors of the MACL did not precisely reflect some relevant affective changes induced by THC, we added two other factors, termed Confusion and Labile Affect. The words comprising the Confusion factor were "forgetful," "distractible," and "confused." For Labile Affect, the words were "excitable," "changeable," "highstrung," "oversensitive," and "temperamental." As with all the adjectives used in the MACL, the subject responded to each word by choosing one of the following answers: "definitely applies to me at this time," "slightly applies," "cannot decide," or "definitely does not apply."

Nature of Marihuana Extract
.—Tetrahydrocannabinol was extracted from marihuana supplied by the Bureau of Narcotics and Dangerous Drugs. Thin layer and gas liquid chromatography of these extracts showed predominantly (—) -Al-THC, with smaller amounts of cannabidiol and cannabihinol. The oral doses used in this study, quantitatively calibrated according to the content of THC, were 20, 40, and 60 mg of THC. The extract contained 20 mg of THC per 1 ml of 95% ethanol diluted in water to an acceptable degree for oral ingestion. We also employed a placebo, composed of an extract of marihuana from which virtually all of the cannabinoids had been removed. It retained the characteristic disagreeable taste of the active material. The 40-mg and 60-mg doses are probably considerably higher than those obtained from the usual custom of smoking marihuana in social settings. However, previous studies of equivalent oral doses of synthetic THC suggest that the induced psychotomimetic effects are clinically similar to those associated with smoking potent marihuana. Thus, one need not be overly concerned about the relevance of studying the effects of ingested rather than smoked marihuana. The oral route of administration, at least at present, offers a far more precise way of regulating dosage.

Subjects
.—Eight normal male graduate students, who were paid for their participation, had been screened by a psychiatrist to meet the following criteria: good physical and mental health; previous experience with smoking marihuana, but with no greater frequency than once per month; and total abstinence from marihuana (and other psychedelic drugs) for at least one month before starting the experiment. In this way, we avoided introducing novices to an illegal drug whose effects might be unexpected and we also minimized the unresolved issues of tolerance in long-term heavy users. Subjects were all in their early 20's; three were married; their weights ranged between 63 and 85 kg (139 to 187 lb). Subjects were told that the study was concerned with "feelings and attitudes" during the drug experience.
Procedure
—Using double-blind controls, we gave the eight subjects the three oral dose-, of marihuana extract and placebo in randomized order on four different test days separated by at least one week. Doses were ingested after at least an eight-hour fast and subjects were not allowed to eat until 45 minutes after taking the drug; this was done in order to regulate absorption rate. Subjects were tested before drug ingestion (baseline) and thereafter at 1 1/2, 3 1/2, and 5 1/2 hours. Since pilot studies showed that most drug effects dissipated by 5 1/2 hours, each experimental day may be considered as a pre-drug, during-drug, and post-drug experiment. The test sessions took about 15 to 30 minutes. To obtain maximal cooperation, we asked the subject to repeat back the instructions of each task every time it was administered. Also, if the subject's attention waned, he was asked to stand up and walk around the room until he felt ready to perform.

For each subject, the experiment always began at the same time of day so that diurnal variations were avoided. On each of the experimental days, the same psychiatrist tested the same subject in an isolated, somewhat austere room of a Veterans Administration Hospital. The subject's social interaction was largely restricted to the psychiatrist-researcher, who was careful to remain open-ended yet supportive. Both psychiatrist and subject knew that THC was to be given, but they were unaware of the sequence of the various doses and placebo. In the intervals between testing sessions, the psychiatrist conducted brief open-ended interviews about the subject's full range of experiences; at other times, the subject could read, sleep, or listen to any of five taped recordings of folk music.

Statistics
—To analyze the effects of THC (hypothesis 1), we performed a three-way analysis of variance on test scores. Since hypothesis 2 posits co-varying changes for each individual, we also computed correlations between concomitant changes within each subject. Each experimental day yielded three change scores for each factor measured—that is, baseline to 1 1/2, 1 to 3 1/2 hours, and 3% to 5 1/2 hours. Since there were four experimental days, each subject produced 12 change scores per task. For each subject, we computed correlations of changes in one measure with concomitant changes in another, using the 12 change scores for each test. To arrive at the overall significance of the change correlations for all eight subjects for two given tests or factors, we transformed each subject's correlation coefficient using Fisher's z transformation. These transformed correlations were then averaged across the eight subjects, and the uncorrected z values were transformed to find the significance level of the mean sample correlation. By reconverting the average Fisher's z transformation into a correlation coefficient, we obtained what is here termed an "average Pearson r." The hitter, for each hypothesis, summarizes the magnitude of relationships between changes for all eight subjects. Using this approach, we could examine both individual and aggregate processes (related changes) relevant to temporal disintegration, depersonalization, and emotion.
It is important to point out that we did not correlate one "state," such as a given magnitude of temporal disintegration, on a particular test session with another "state," such as the degree of depersonalization reported at that time. Rather, we correlated changes that occurred contemporaneously from one test session to the next, and thereby removed the stochastic dependency between serial measures in the same subject. Change data may be treated as independent observations, even though the magnitudes of the serial measurements may themselves be highly correlated. This use of change data as statistically independent measurements is analogous to the treatment of correlated pairs of observations in the standard "matched-pairs t-test."

Results

Temporal Disintegration and Depersonalization

—Since THC induced significantly greater 'temporal disintegration and depersonalization, hypothesis 1 is confirmed (Table 1). The greater temporal disintegration took place both subjectively (TIT) and cognitively (GDSA). The cognitive temporal disintegration was progressively greater with higher doses. With the subjective TH mid DP measures, however, there were no significant differences between the 40-nog and 60-mg doses.

The greatest degree of temporal disintegration took place 11(2 hours after drug ingestion. 'There was significant 1111(.10(():S1 between dose level and time of u*-ating P < 0.001); this indicates than, higher (lo: ')s prolonged temporal disinteg( atitt in teiteis of both the TH and (1)SA. There was tdsti a significant interaction betweent des., tae ) and time of testing for deder,(ontilittat:tat P < 0.01 ).

As expected, the two components of da: TH, 'Temporal Distinction and Good Direcetdness, changed in relation to one another: the average Pearson r for change correlations between these components was +0.770 < 0.0001). This finding indicates that the process of integrating, yet keeping distinct, events of the past, present, and future is related to goal-directedness.

The construct validity of temporal disintegration is furthr.('r supported in that there was a high
correlation between two different ways of measuring the same construct (Table 2). That is, for the overall findings on the eight subjects, changes in the subjective TIT occurred concomitantly, and in the same direction, with changes in the cognitive CDSA: average Pearson r = +0.719; P < 0.0001.

Moreover, for each separate subject changes in the TH: correlated positively and substantially with changes in the CDSA.

Table 2, also shows that the processes of temporal disintegration and depersonalization are highly interrelated, thereby confirming hypothesis a. The average Pearson r for change correlations between TH and depersonalization was +0.868 P < 0.0001; for the concomitantly changes in the GDSA and DP the average Pearson r was +0.698 P < 0.0011. Furthermore, for each of the eight subjects, the changes in temporal disintegration correlated positively and substantially with changes in depersonalization (Table 2). This indicates that, as each subject become temporally disorganized, he simultaneously became more depersonalized.

**Emotion**—Unlike the uniform relationship between temporal disintegration and depersonalization for all subjects, each subject showed a unique pattern of affective changes in terms of the MALT, factors. With increase in temporal disintegration and depersonalization, four subjects experienced more positive feelings, two reacted with preoccupantly negative effects and two others showed concurrent increases in both positive and negative reactions. From interview material those unique patterns appeared to stem from affected personality dispositions about control and individuality.

Also, at higher doses the four th at the loss of control and identity might not end gave rise to panic experiences in these subjects.

The THC induced state of uncloseness impaired do about that the drug effects would eventually wear off. One subject under the influence of 60 mg of THC, characterized his panic as "helplessly drifting forever," unable to direct his thoughts and actions, "locked in infinity . . . a never-ending slosh, with my mind bouncing like a yo-yo."
In addition, five subjects reported transient episodes of suspiciousness when they felt they were no longer in control of their thinking and actions; this made them feel controlled by others.

Although there were unique within-subject patterns and transient adverse, reaction to THC-induced temporal disintegration and depersonalization was that of euphoria; this is shown in terms of average Pearson r's for changes in MAACL factors (Table 3). The significant positive correlations of MAACL Aggression with TII and DP deserves comment since, in this setting, MAACL Aggression (composed of the words "angry, "defiant," and "rebellious") does not necessarily reflect hostility, as one might assume. Rather, in this setting, MAACL Aggression correlated positively and significantly with MAACL Egotism; both factors reflected a cocky, devil-may-care attitude that commonly characterized the overall THC-induced mood. Subjects often used terms such as "feisty," "whoopy," and "frolicsome" to describe their feelings. Their emotional reactions to THC-induced temporal disintegration and depersonalization, however, were by no means consistent and stable, as indicated by the significant positive change correlations with MAACL Startle, Confusion, and Labile Affect. The variability and lack of a "typical" affective response to THC-induced experiences also has been found by other researchers.

Comment

Since for all eight subjects under the influence of THC changes in temporal disintegration correlated positively with changes in depersonalization, it appears that these processes are dynamically related. The fragmentation of temporal experience co-varies with strange and unfamiliar feelings about the self, perhaps because the person during marihuana intoxication feels less familiar with himself as he loses the perspective of continuity of the self through time. Depending on personality factors, THC-induced temporal disintegration and depersonalization, so long as they are believed to be time-limited, are euphorigenic processes, perhaps because the person—with an altered sense of time and sense of self—is less concerned about what will happen to himself.

Acute psychiatric patients, however, who do not know the source or time course of their temporal and self distortions, usually react to temporal disintegration and depersonalization with terror. Even though there is this difference in emotional reaction, our studies of serial changes in acutely psychotic patients, to be reported later, again showed that changes in temporal
disintegration and depersonalization significantly co-vary. This finding replicates the present study and indicates that the relationship between these processes is not restricted to THC conditions. It is also possible, though not as yet specifically investigated, that these processes would co-vary during intoxication with psychotomimetic agents other than THC.

Since our method of studying correlated changes derives from cybernetic models that posit mutually interacting influences,12 we may interpret our findings as a disorganization of a servomechanism, taken to represent a simplified model of subjective experience. During normal consciousness,4.13.14 the person functions like a sensor which detects matches and mismatches between the expected and the actual. Or, in terms of goal-striving, the person detects differences between what he intended and what actually takes place. By comparing the now to the then, the person predicts, plans, and makes adjustments to reach his goals or, if warranted, modifies his goals.14 Comparing now and then requires keeping track of time and distinguishing past, present, and future. But if perceptions become confused with memories, or with expectations inferred from memories, it will be difficult to detect matches from mismatches. In other words, the sensor (the person) no longer functions as usual, since the temporal disorganization has made it difficult to distinguish what is happening (feedback) from what is likely to happen (feedforward), or from what is intended (goal-directedness). When time becomes disorganized so does the person.

In other papers,1,15 we have shown that impaired immediate memory may account, in part, for temporal disintegration. To make comparisons between now and then, a person must hold in mind and juxtapose diverse events, each embedded in a particular temporal series. THC-induced impairments of the GDSA, our cognitive measure of temporal disintegration, stem largely from mistakes in serially coordinating and keeping track of information in immediate memory.1 Similar interferences with short-term memory have been highlighted as central to schizophrenic thought disorder.16.17 Lapses of immediate memory could, at the subjective level, relate to discontinuities in the flow of personal time. Moreover, if a person forgets what came before or after an experience, he will have difficulty locating that event in time. When an experience appears to have no before or after, it is isolated from time and, hence, may seem timeless.

The sense of timelessness, emerging during THC intoxication, can be likened to the progressive fragmentation of a movie film. Five of our subjects spontaneously reported their experiences in terms of the movie analogy that is paraphrased below.

Normal consciousness is like a movie, in which each frame of a film merges with the next to give the impression of a continuum with smooth transitions of content. When a subject is "going
up" or becoming mildly "high," the frames of the film seem separated and the individual "grooves" on the content (which is often an inner vision or fantasy) of one frame at a time before moving on to the next. He is still somewhat aware of a continuum, but is more focused on just the present. During the "peak" or "superstoned" stage, induced by high doses, the subject fixes on one frame, more or less unaware of other frames; there is no continuum—just one frame in which completely different contents flash in and out. These "flashes" are inner fantasies from past, present, and future, admixed with outside perceptions, all telescoped into one frame, almost like a superimposition of images that flick in and out with no temporal relation to one another. Since there is no continuum of before and after, or—in the words of Henri Bergson's—no "continuous progress of the past which gnaws into the future," the experience seems timeless.

Summary

Using double-blind controls, we gave eight normal men a placebo and 20-, 40-, and 60-mg marihuana extract calibrated for content of THC. On a cognitive task and a subjective inventory we found that the oral doses of marihuana extract induced the subjects to confuse past, present, and future and to lose their goal-directedness. This temporal disintegration was related to increases in depersonalization for all eight subjects. Moreover, for each subject studied separately changes in temporal disintegration correlated positively and substantially with changes in depersonalization; this indicates that these processes were dynamically interrelated.

Although each subject showed unique emotional patterns and some had transient adverse reactions, the overall findings indicated that the fragmentation of temporal experience and the accompanying depersonalization were euphorogenic. The euphoria often took place when subjects felt less concerned about future outcomes relevant to maintaining their usual sense self.

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Temporal Disintegration and Depersonalization During Marihuana Intoxication

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References


