



Time perception, depression and sadness

Sandrine Gil, Sylvie Droit-Volet*

Blaise Pascal University, Clermont-Ferrand, France

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ABSTRACT

This study examined changes in time perception as a function of depressive symptoms, assessed for each participant with the Beck Depression Inventory (BDI). The participants performed a temporal bisection task in which they had to categorize a signal duration of between 400 and 1600 ms as either as short or long. The data showed that the bisection function was shifted toward the right, and that the point of subjective equality was higher in the depressive than in the non-depressive participants. Furthermore, the higher the depression score was, the shorter the signal duration was judged to be. In contrast, the sensitivity to time was similar in these two groups of participants. These results thus indicate that the probe durations were underestimated by the depressive participants. The sadness scores assessed by the Brief Mood Inventory Scale (BMIS) also suggest that the emotional state of sadness in the depressive participants goes some way to explaining their temporal performance. Statistical analyses and modeling of data support the idea according to which these results may be explained by a slowing down of the internal clock in the depressive participants.

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One of the most widespread affective disorders is depression. According to the DSM-IV criteria (American Psychiatry Association, 1994), depression is characterized by symptoms of a depressive mood indicated by the feeling of being sad or empty, as well as by a markedly diminished ability to take pleasure in things. Associated with these symptoms, there is also the feeling that time is passing more slowly than normal (Bech, 1975; Blewett, 1992; Hoffer and Osmond, 1962; Kitamura and Kumar, 1982; Lehmann, 1967; Mezey and Cohen, 1961; Straus, 1947; Wyrick and Wyrick, 1977). A patient suffering from depression often says “Every hour seems a year to me” or “Time, it’s terribly slow” (Mezey and Cohen, 1961, p. 270). However, as stated by Bech (1975, p. 49) when “the depressed patient tells us that he is very sad and unhappy and when he tells us that time passes by very slowly, he is trying to communicate the same or a similar experience”: his sadness, and his dissatisfaction with a period of his life. However this subjective appraisal of the passage of time does not indicate any intrinsic change in time perception, i.e. such individuals experience time in the same way as other people.

In line with Bech (1975) conclusion, some studies have found no evidence that depression affects time perception (Bech, 1975; Hawkins et al., 1988; Kitamura and Kumar, 1984; Mezey and Cohen, 1961; Prabhu et al., 1969). Nevertheless, other studies have sug-

gested that time judgments are modified by depressive affect (Bschor et al., 2004; Grinker et al., 1973; Kuhs et al., 1991; Sévigny et al., 2003; Tysk, 1984). When they asked their participants to count at a rate of one per second or to count quietly up to 10, Tysk (1984) and Kuhs et al. (1991), respectively, showed that their depressive patients counted time more slowly, and consequently underestimated time. In line with these results, Bschor et al. (2004) found that depressive patients underestimated durations by between 7 and 109 s compared with non-depressive patients, both in a temporal production and a verbal estimation task. Using a small number of subjects per group (less than 7), Grinker et al. (1973) obtained a significant correlation between the individual depression scores and time estimates in a discrimination task: the more depressive the subjects were, the shorter the standard durations of 1 and 3 s were estimated to be. Furthermore, according to Sévigny et al. (2003), temporal discrimination should be poorer in depressive than in non-depressive subjects. In their study, the former indeed produced fewer correct responses in a discrimination task than the latter for durations of 1.12 and 1.20 s, while no depression-related difference was observed for shorter durations from 0.08 to 0.55 s (Experiment 1). The depressive individuals also appeared to be more variable in the timing of a motor response for duration values both shorter and longer than 2 s (Experiment 2), although no data was provided relating to the absolute values of the produced durations. Whatever the case, when time judgments are altered by depression, this modification almost always takes the form of an underestimation of time.

Nonetheless, it is difficult to draw conclusions about the effect of depression on time perception on the basis of the methods used

* Corresponding author at: Laboratoire de Psychologie Sociale et Cognitive, CNRS, UMR 6024, Université Blaise Pascal, 34 avenue Carnot, 63037 Clermont-Ferrand Cedex, France.

E-mail address: sylvie.droit-volet@univ-bpclermont.fr (S. Droit-Volet).

so far. With the exception of two studies which used duration values shorter than 2 s, i.e. Grinker et al. (1973) and Sévigny et al. (2003), all the studies reported above tested durations of several seconds without taking the methodological precaution of preventing the subjects from using a counting strategy. Furthermore, they made use of temporal judgment which required the production and timing of a motor response, i.e. temporal production, tapping, counting. There is now ample evidence that psychomotor alterations are fundamental psychopathological features of depression, which can be seen in a general decrease in movement speed, i.e. retardation (Lemke et al., 1999, 2000). Consequently, in these studies, it is difficult to dissociate the role of the motor component from that of the timing component in temporal performance, even though these two components may be related (Wearden, 2003; Wing and Kristofferson, 1973). For instance, on the basis of results which indicated a slowing down of counting in depressive patients, Tysk (1984, p. 461) concluded that “their sense of time is altered so that the internal second standard is slow, resulting in slow counting”. However, without further analysis it is impossible to draw such a conclusion, since the motor component of counting could be the main cause of this deceleration of counting in depressive individuals. Most studies of time and depression are relatively old and a-theoretical. These studies can thus be regarded as exploratory in nature, providing no clear explanation of the mechanisms by which depression might affect time perception. As stated by Sévigny et al. (2003), experimental evidence for the disturbance of time judgments is sparse and somewhat contradictory. The aim of the present study was thus to further investigate the difference between depressive and non-depressive participants in time perception with short durations (<2 s), using a temporal discrimination task that did not require the timing of a motor response, i.e. the temporal bisection task. In addition, in order to test our results, we decided to subject our data to a form of modeling which has been used successfully to explain time perception in animals and humans adults (Allan, 1998; Droit-Volet et al., 2007; Droit-Volet and Wearden, 2001; Penney et al., 2000; Wearden, 1991).

In the temporal bisection task, the subjects were presented with two standard durations, one short and the other long. They were then presented with comparison durations of a duration intermediate between or equivalent to the standards and were simply required to categorize each comparison duration as being more similar to the long (long responses) or to the short (short responses) standard duration. According to the time models based on the scalar timing theory (Gibbon and Church, 1990; Gibbon et al., 1984), the raw material for the representation of duration depends on the functioning of a pacemaker-accumulator clock system. The internal clock system is composed of a pacemaker, an attention-controlled switch, and an accumulator. The pacemaker emits pulses at a certain rate. At the beginning of a stimulus to be timed, the switch closes and the pulses enter into the accumulator. At the end of this stimulus, the switch opens. Thus, the estimated duration depends on the number of pulses accumulated during the to-be-timed stimulus. However, the bisection judgment which consists of responding short or long also depends on memory and decision processes. The duration which has just been presented, t , is stored in working memory and compared with a sample drawn from the distribution of exemplars for the short, s^* , and the long, l^* , standard durations stored in long-term memory. Thus, when $(t - s^*)$ is greater than $(l^* - t)$, the participants respond long, and inversely, when $(l^* - t)$ is greater than $(t - s^*)$ they respond short provided that the difference exceeds a threshold. According to the scalar timing models, the duration is processed accurately and the main sources of noise in time judgments come from the variability in the representation of the standard durations (for review, see, for example, Jones and Wearden, 2004; Droit-Volet and Rattat, 2007). However, recent studies have demonstrated that the variability in the mem-

ory representation of standard durations results from noise in the processing of stimulus durations (Delgado and Droit-Volet, 2007; McCormack et al., 2005).

The mechanism in the processing of time that might be affected by depressive mood has been not yet clearly identified, probably because there is not one but several mechanisms involved. Nevertheless, although they did not specify the exact mechanisms involved, Sévigny et al. (2003) suggested that the ability to keep attention focused during the processing of long durations explains the differences in the temporal judgments made by depressive and non-depressive participants. However, these authors observed poorer temporal performances in the former than in the latter for short durations close to 1 s, i.e. in their Experiment 1 with durations of 1.12 and 1.20 s and Experiment 2 with a duration of 1 s. These durations are considered to require only a low level of attentional resources (Lewis and Miall, 2006). As discussed in more detail below, most researchers believe that the depression-related difference in time perception is also due to the speed of the internal clock which runs more slowly in depressive individuals (Bschor et al., 2004; Grinker et al., 1973; Lehmann, 1967; Lemke et al., 2000; Tysk, 1984). Indeed, if the internal clock runs more slowly than normal in people suffering from depression, fewer pulses are accumulated per unit of time and the duration is judged to be shorter. This slowing down of the internal clock would be associated with the affective aspect of depression – the feeling of sadness – which is one aspect of depressive symptomatology. A number of studies have indeed demonstrated that the mood of sadness is associated with a low arousal level and a slowing down of mental and motor activity (Barr-Zisowitz, 2000; Russel, 1980; Schwartz et al., 1981).

However, the few studies that provide support for the clock-rate hypothesis have investigated the effect of depression on time perception in outpatients and hospitalized patients who were being treated with antidepressant medication. It is thus difficult to dissociate the effect of medication on time judgment from that of the mood *per se*. Consequently, in the present study, we decided to recruit non-hospitalized participants, who were not receiving medication, on the basis of their Body Mass Index (BMI). Indeed, the frequency of depression is greater among the overweight than the normal-weight population (Herva et al., 2006; Roberts et al., 2000; Stunkard et al., 2003). Furthermore, as suggested by Grinker et al. (1973), it is the depressive state and not the fact of being overweight *per se* that affects temporal judgments. We obtained a depression score for each participant by using the short form of the Beck Depression Inventory (BDI) (Beck and Beamesderfer, 1974) and a sadness score on the basis of the Brief Mood Inventory Scale (BMIS) (Mayer and Gaschke, 1988). Each participant was given a temporal bisection task with signal durations between 400 and 1600 ms. Our hypothesis was that the depressive participants would judge the signal duration as shorter than the non-depressive participants due to the fact that their internal clock runs more slowly. We also tested this clock hypothesis by modeling our data.

1. Method

1.1. Participants

The final sample consisted of 92 healthy French adult volunteers, paid 10 euros for their participation (50 females and 44 males, mean age = 25.8, S.D. = 3.9). Since depressive symptoms increase with Body Mass Index (BMI), kg/m², we ran local newspaper advertisements in order to recruit a larger number of depressive patients on the basis of their BMI. There were 34 normal-weight (BMI = 18.5–24.9 kg/m²; mean = 21.4, S.D. = 2.1; 16 males and 18 females), 30 overweight (BMI = 25.0–29.9 kg/m²; mean = 27.0, S.D. = 1.6; 15 males and 15 females), and 28 obese participants

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