# Time Perception In Relation To Depressed Mood And Hopelessness.

Sara Melly BA (Hons), Dip. App. Pscyhol.

A thesis submitted in partial fulfilment of the requirements for the degree of Doctorate in Clinical Psychology (D. Clin. Psychol.)

University of Southampton

Faculty of Social Sciences

Department of Psychology

January 2002

19,986 words

## Thesis Abstract

Possible distortions in time perception have been associated with the experience of depression, hopelessness and suicide. People who are depressed often experience time as passing slowly. They also tend to show a preference for certain 'time perspectives.' The first paper of this thesis reviews the literature pertaining to these phenomena from a number of distinct areas of investigation. Evidence from the self report literature for subjectively altered perception of time in depression and hopelessness is examined. Links are made between this work and research looking into the importance of future directed thinking in depression. Evidence from the experimental timing literature is also reviewed suggesting that actual timing abilities may also be altered in depressed mood. Finally, studies which have specifically attempted to measure peoples' timing abilities are critically assessed and the implications for future research are discussed.

The second paper of this thesis describes a study which investigated the association between low mood and disturbed temporal experience by means of the induction of mild sad mood in adolescents. Results showed a non-significant trend for timing performance to be less accurate in low mood. There was also some indication of a relationship between naturally occurring low mood, hopelessness, and poor timing performance. Time perspective did not show any difference as a result of the mood induction, but did show a pattern of associations with naturally occurring low mood. Time perspective did not correlate with timing performance. These results and the limitations of the study are discussed.

**Acknowledgements**

I would like to thank the participants who took part in this study: the students at Henry Beaufort School, Regents Park Girls School and Peter Symonds College. Thanks also to the teachers who made the arrangements possible, particularly John Howells, Mark Gainey and Geoff Rolls. I also wish to thank Henni Cross for trying bravely to translate such a technical paper from German. I wish to acknowledge the input of my supervisors over such a long time, particularly Lewis Bizo for his guidance on the technical aspects of timing and Weber's Law. Most of all I wish to thank my family for their support during one hurdle too many.

## Contents

Literature Review Paper:

# A Review of the Literature on Time Perception in Relation to Depressed Mood And Hopelessness.

Sara Melly

Prepared as if for submission to "Psychonomic Bulletin and Review".

# A Review of the Literature on Time Perception in Relation to Depressed Mood And Hopelessness.

Sara Melly

University of Southampton

Running header: Time Perception and Depressed Mood

Address for correspondence:

Sara Melly, Doctoral Programme in Clinical Psychology, Psychology Department, University of Southampton, SO17 1BJ. Telephone 02380 595321

## Abstract

This review examines the evidence for time perception being distorted in depression by drawing together empirical findings from a number of areas of literature. The self report literature for subjective perception of time is examined first. This literature indicates that people who feel depressed or hopeless tend to favour certain "time perspectives", that is to think more about the present and less about the future than other people, and they also report that external time appears to pass more slowly for them. Links are made between this work and research looking into the importance of future directed thinking in depression. The experimental timing literature is also reviewed and evidence for a likely association between subjective time experience and objectively measured timing is evaluated. Finally, studies which have specifically attempted to measure peoples' actual timing abilities in relation to depressed mood are discussed and suggestions are made for future research.

## Introduction

Possible distortions in time perception have long been associated with the experience of depression, hopelessness and suicide (e.g., Baumeister, 1990; Dillung & Rabin, 1967; Lewis, 1932; Straus, 1928). The notion that time drags when one is depressed is one that is commonly recognised (e.g., Bech, 1975; Blewett, 1992; Kitamura & Kumar, 1982). The opposite is also acknowledged - that "time flies" when one is enjoying oneself. It has been suggested that this alteration in the experience of time is one of several distortions in the way a person perceives their world, themselves and their future that occur in the experience of depression (Beck & Hollon, 1979). It has also been proposed that when depression becomes hopelessness, a crucial shift takes place in which the integration of time into a past, present and future is broken down (Baumeister, 1990) and the depressed person struggles to imagine having anything but a negative future (Beck, Weissman, Lester & Trexler, 1974).

When someone feels hopeless in this way – without any sense that the future may contain positive experiences for them – then suicide, as a means of escape, becomes a risk (Baumeister, 1990). It is important to understand about the cognitive processes underlying depression and hopelessness. Knowing more about these processes, including the role of time perception, not only improves our knowledge about depression, hopelessness and suicidality, but could possibly improve interventions. For example, alternative means of orienting people to the future could be developed to address the role that absence of future thinking seems to play in hopelessness. If it is established that people who are depressed have differences in the

speed they perceive that time is passing, then therapeutic activities could be tailored to include elements of 'pacing' which might help to re-train someone's internal clock. Measures of altered time perception could also potentially be used as outcome measures to monitor the effectiveness of more general cognitive interventions and it may be possible to use measures of altered time perception in the assessment of depression, hopelessness or suicidality.

There have been several lines of investigation into altered time perception. Broadly speaking these have either focused on people's subjective experience of time (e.g., Kitamura & Kumar, 1982; Lennings, 1992a) or have looked at the objective measurement of people's timing abilities to see whether an actual distortion of timing is evident according to different circumstances (e.g., Brown, 1998; Tysk, 1984).

The literature relating to the experience of time is potentially confusing in that the terminology used is not universally agreed and is sometimes used interchangeably. In this review I have used the term 'time perception' as an overarching descriptive term encompassing all types of time experience. Within this there are numerous other terms that have been used to describe the various facets of time perception which have developed as the literature has grown. In this review I have attempted to mirror this chronological development of the terminology. For example, the early papers that are reviewed refer to 'temporal extension' and 'orientation'. Only later does the term 'time perspective' come into use. In the experimental papers authors tend to favour 'temporal' instead of 'time' and these terms are used interchangeably.

Investigations into subjective time perception (which usually focus on longer time scales from hours to years) have consistently reported that people who are depressed often experience time as passing slowly (Bech, 1975; Kitamura & Kumar,

1982). There have also been studies using non-clinical populations which, although not directly comparable with studies of clinical populations, have contributed to the area by examining the role of sub-clinical and induced low mood. These have indicated an association between low mood and a preference for certain 'time perspectives' (Lennings, 1992a). The notion – that orientation to either the past, present or future is important in depression and hopelessness – has been supported in recent years by a growing literature on the importance of future-directed thinking (e.g., MacLeod, Rose & Williams, 1993).

Research on timing has taken the form of experimental studies with both animals and humans generally using durations of seconds or milliseconds (e.g., Angrelli, Pavese & Manfredini, 1997; Craik & Hay, 1999). There are well established experimental literatures derived from animal (e.g., Bizo & White, 1997; Roberts 1981) and human studies (e.g., Brown, 1998). Within the literature on human timing there are several areas of study that indicate links between one type of time experience and another (Craik & Hay, 1999; Hazletine, Helmuth & Ivry, 1997). However, the literature on whether people vary in their timing abilities according to mood in the same way that they describe differences in their subjective experience of time, is less conclusive (Blewett, 1992; Hawkins, French & Enzle, 1988).

This review examines the findings from both the self report literature (e.g., Bech, 1975; Dillung & Rabin, 1967; Kitamura & Kumar, 1982;1984; Lennings, 1994) and the experimental literature (e.g., Angrelli et al., 1997; Brown, 1998; Craik & Hay, 1999; Kuhs, Hermann, Kammer & Tolle, 1991) in order to examine the relationship between the perception of time and the experience of hopelessness and depression. A decision has been made to include studies using both clinical and non-clinical

participant groups despite some problems associated with this. In drawing together clinical and analogue studies there is an implication that these studies are reflective of different levels of severity of a single dimension (that of low mood); however, it is acknowledged that this may not be the case and that there may be qualitative differences in the experiences of people who are clinically unwell. Therefore, the reader should bear in mind that much of the material reviewed is not directly comparable.

Structure of the review

This review attempts to draw together empirical findings from a number of distinct areas of literature. In the first of two sections following this introduction (Section 2) evidence from the self report literature for subjectively altered perception of time in depression and hopelessness is examined. This section includes a review of studies conducted in the 1960s and 1970s as well as later work on the development of the idea of 'time perspective' . Links are also made between this work and that from an allied field of research looking into the importance of future directed thinking.

The following section (Section 3) concentrates on work stemming more from the experimental timing literature. First, evidence is reviewed for a likely association between subjective time experience and objectively measured timing. Second, studies specifically attempting to measure peoples' timing abilities are critically assessed. Finally, implications for future research are discussed and conclusions are drawn.

Prior to considering these two main domains of literature the theoretical underpinning of this literature is considered.

Theoretical Background

One of the features of this field of literature is that it appears to fall between the different areas of clinical and experimental research and as such is informed by the theory relating to those separate areas – i.e., theories of hopelessness and depression and theories of our innate timing abilities – but is there is a lack of theoretical understanding of the role of time perception specific to mood and mental health. Baumeister's 1990 paper on the escape theory of suicide is a notable exception to this in that he attempted a rationale for why it is that altered time perception features in suicidality. He considered that distorted sense of time is part of a shift he named "cognitive deconstruction" whereby the person becomes involved in an "ongoing struggle to stop time" to "avoid the negative affect that is associated with meaningful thought" (Baumeister, 1990 p. 92). However, by and large authors who have examined subjective time perception, such as those discussed below, have done so with little reference to any theoretical grounding. Where implications for their findings have be drawn out the discussion has remained mainly speculative (e.g. Neuringer & Harris, 1974).

One area of theory which is relevant to this literature is that concerning human timing ability. Triesman (1963) proposed the idea of an 'internal clock' and this idea has been widely accepted as a partial explanation of human timing. It is suggested that there is some physiologically based pulser or oscillator which acts as a pacemaker with which both animals and humans can judge the passage of time. The exact mechanisms of this internal clock have been the subject of much research (e.g., Roberts, 1981, 1983; Weardon & Penton-Voak, 1995) that is still ongoing. Since the development of this idea other models of timing have been proposed which

incorporate the idea of an internal clock, but which also more adequately account for the effects of a number of cognitive variables, such as estimation method, arousal and information processing load. These mixed models of timing have been derived from different research approaches. Among the most important are *scalar timing theory* (Gibbon, Church & Meck, 1984), which was originally developed as a model of animal timing, and the *attentional-gate model* (Block & Zakay, 1996; Zakay & Block, 1996) derived from a human information processing approach. Scalar timing theory holds that the standard deviation of underlying time representations is a constant fraction of the mean, giving rise to a constant coefficient of variation (standard deviation/mean) as the duration time varies (Gibbon, Church & Meck, 1984). This is a form of conformity to Weber's law. The attentional-gate model of timing proposes a cognitive model (again, not tied to specific neural networks or brain structures) comprising a pacemaker, which produces pulses at a rate influenced by arousal, and an accumulator. The proposed operation of the these two components of the timer are constrained by an attentional gate which is regulated by whether or not the person is consciously attending to the passage of time. Whether this is the case will depend on the type of timing task they are engaged in (see later discussion).

For the purposes of this review a generic concept of an internal clock is used but the following discussions are not dependant upon any one timing theory or model. Readers are referred to Zakay & Block (1997) and papers by Weardon (e.g. Weardon & Penton-Voak, 1995) for more detail of this area.

## Subjective Time Perception

To understand the work on time perception in relation to depression and hopelessness it is necessary to examine the context of the relationship between depression and hopelessness and their relation to suicidality.

### The relationship between depression, hopelessness and suicidality

The relationship between depression and hopelessness is one that has gradually become clearer over the last few decades (MacLeod, Williams & Linehan, 1992). Baumeister (1990) points out that obviously not all depressed people attempt suicide and not everyone who attempts suicide is clinically depressed. In fact, hopelessness has come to be understood to mediate the relationship between depression and suicidality. In 1974 Beck and colleagues published the Hopelessness Scale (Beck et al., 1974). One of the investigations into the construct validity of this scale established that suicidal intent was more highly correlated with hopelessness than with depression (Minkoff, Bergman, Beck & Beck, 1973). The proposal that the close relationship between depression and suicidal intent is due to their common relationship with hopelessness, is supported by the finding that, when hopelessness is statistically partialled out, depression ceases to be predictive of suicide (e.g., Bedrosian & Beck, 1979; Petrie & Chamberlain, 1983). The studies reporting this association seem to be methodologically sound and many studies from the United Kingdom and the United States have now confirmed that hopelessness mediates the relationship between depression and suicidal intent (e.g., Salter & Platt, 1990; Wetzel, Margulies, Davis & Karam, 1980). Hopelessness, more than depression, has also been

found to be predictive of repetition of suicidal behaviour (e.g., Beck, Brown & Steer, 1989; Petrie, Chamberlain & Clarke, 1988 cited in MacLeod et al., 1992).

Until recently the concept of hopelessness was measured only in broad general terms and MacLeod et al. (1992) point out that the term hopelessness has been used to describe either the expectancy that positive outcomes will not occur or that negative outcomes will occur. What is clear is that, in some way, the concept of a negative future for oneself is central to the concept of hopelessness. This obviously ties in closely with the work on time perspective, as discussed below, in which one of the major findings is the importance of the ability or inability to project into or see a future.

It should be noted that one of the limitations of this review is that it has been necessary to pool and compare studies which address the concepts of low mood, clinical depression, hopelessness and suicidality as if these were positions on a single dimension. Although it is acknowledged that this is not the case and that measurement of these concepts also differs, given the disparate studies that have been conducted into the experience of time, this approach has been adopted at this early stage of investigation into this area in order to try to draw out whether or not there is a case to answer for time experience differing in any of these states.

## Early research into subjective time experience and depression

During the 1960's and 1970's there were several studies that were specifically designed to investigate the experience of altered time perception associated with depression and with other forms of psychopathology.

Dillung and Rabin (1967) investigated potential differences in time experience between clinical groups of people with depression and schizophrenia and non-psychiatric medical patients as controls. They measured several facets of temporal experience including temporal 'extension' and 'orientation'. Extension refers to the temporal distance into the past or future that people recall events from or project into. This was assessed by asking subjects when 10 common life events were likely to happen to them. They also used a story completion task in which subjects were asked how much time their story ending would take. Orientation was measured by rating subjects' stories as oriented to either the past, present or future. They found differences between their groups, with depressed patients showing the lowest scores on the extension measures indicating that they generally looked less to the future or the past than controls. In terms of orientation to a time frame, they concluded that depressed patients were oriented somewhat to the past, mainly to the present and not to the future.

Other studies found similar results with patients who had attempted suicide (e.g., Brockopp & Lester, 1970; Greaves, 1971). These studies employed different means of judging orientation to time frames. For example, Greaves (1971) used a sentence completion task in. He found that suicidal subjects used more present tense verbs and fewer verbs in the future tense than control subjects.

Neuringer and Harris (1974) conducted a study that included measurement of attitudes about time using a five factor measure. The authors found that people who had attempted suicide showed lower scores on the dimension of 'Future Orientation and Achievement'. However, this study was overinclusive in that the measure used encompassed related phenomena such as impulsivity. Although impulsivity continues

to be of interest as a variable related to the experience of time it is now generally studied separately (Lennings, 1991).

Interestingly, in Neuringer and Harris's study suicidal and other participants did not differ significantly on 'Speed of Time Passage'. The experience of time passing slowly has been reported as part of the changed experience of time in depression. Bech, (1975), compared responses on an early version of Beck's depression scale (BDI; Beck, Ward, Mendelson, Mock & Erbaugh, 1961) and the Hamilton Rating Scale (Hamilton, 1960) with the apparent speed of passage of time. The results confirmed that subjective time experience seems to be slowed in depression. Bech also examined potential differences between endogenous depression and reactive depression, but found no differences other than those accounted for by the severity of the depression.

Investigating speed of time passage and orientation to specific time frames, Wyrick and Wyrick (1977) compared depressed patients with control subjects on five dimensions of temporal experience:- temporal 'orientation'; 'extension'; and 'duration'; 'objective time estimation' and 'subjective descriptions of altered time experience'. Overall their findings accorded with previous findings: depressed patients showed less orientation to the future and reported time passing slowly. There was some inconsistency in that, as well as showing significantly less future extension than controls, depressed patients also showed greater extension into the past. Previous studies have reported that depressed patients are consistently orientated to the present and less to both the future and the past (e.g., Brockopp & Lester, 1970; Dillung & Rabin, 1967; Greaves, 1971).

Summary of early work

By the end of the 1970's there was a plethora of different terminology relating to studies of subjective time perception. However, a body of evidence was accumulating in support of subjective time experience being altered in depression. Specifically, time appears to pass more slowly and the depressed person is more likely to focus on events in the present than to think about the future (e.g., Bech, 1975; Blewett, 1992; Greaves, 1971).

Research since 1980

Building upon earlier work, Kitamura and Kumar (1982) confirmed the finding that time passes slowly for patients who are depressed. Their repeated measures design also showed that patients whose depression improved showed concurrent decreases in distorted time perception.

In attempting to refine the concept of subjective time perception, there emerged a general consensus that the notion of 'time perspective' can be used to incorporate the most important aspects of subjective time experience.

Research on Time Perspective

Time perspective (TP) has been described as "the way a person reflects on the past, is concerned with the present and anticipates the future" (Lennings, 2000, p.167). As "a fundamental dimension in the construction of psychological time" TP plays a role in many different mood and motivational states (Zimbardo & Boyd, 1999, p.1271).

In a series of papers published through the 1990's Christopher Lennings examined the association between TP, depression, hopelessness and suicide ideation,

as well as other variables, in adolescents (Lennings, 1991; 1992a; 1992b; 1993a; 1993b; 1994; 1995; 1999; Lennings & Burns, 1998; Lennings, Burns & Cooney, 1998). Lennings regards TP as multidimensional comprising several, previously separate, aspects of subjective time experience. These are:

- temporal extension - the distance into the past or future that people recall events from or project into.
- temporal orientation - a preference for the past or future.
- temporal attitude - feeling positive, neutral or negative about time or about a particular time frame.

Examining the relationship between TP, hopelessness and impulsivity in adolescents Lennings (1992a) considered that TP could be regarded as a possible indicator of suicide-risk. However, Lennings found that hopelessness correlated with attitudinal measures of TP, but the relationships between the other TP measures did not form a coherent pattern. Impulsivity also did not show any associations other than with a negative view of the past.

The Time Perspective Questionnaire (TPQ; Lennings and Burns, 1990), which required participants to list events from their personal past and future and events from society's past and future, did not yield the consistent results that Lennings had hoped for (Lennings, 1992a). The construct validity of the measure is questionable and it yielded high variability across studies (Lennings, 1992a; 1992b; 1993a; 1994).

Lennings' later adapted and modified the TPQ and reported some success in exploring the relationship between TP, depression and suicide. Lennings (1994) found that seeing the future as either remote and beyond control or as stable and certain, was

the most closely correlated aspect of TP to suicide ideation and hopelessness. He suggested that distortions of TP may contribute to suicidal ideation in several ways:

- Excessive focusing on the present may be de-motivational. – TP is considered motivational in that goals located in the future provide incentives for action (Jones, 1988; Nuttin & Lens, 1985).
- The development of negative attitudes to the future could engender despair that, together with a sense of a truncated future, could lead to thoughts of 'escape' through suicide (Baumeister, 1990).
- Concentration on the past, if imbued with negative affect, may set up a set of experiences reinforcing pessimistic feelings about the future (Yufit & Benzies, 1979).

However, claims made for the role of TP are hampered by the questionable construct validity of the measures (Lennings,1992a). The methodology of TP studies prior to the mid 1990s has been criticised in terms of its replicability and the findings for being non-cumulative (Schroots , 1996; Zimbardo & Boyd ,1999). Therefore, considerable caution should be exercised regarding the conclusions drawn.

The Zimbardo Time Perspective Inventory

In order to address the problems associated with TP measurement Zimbardo and Boyd (1999) developed the *Zimbardo Time Perspective Inventory* (ZTPI). Their conceptualisation of TP places an emphasis on what had previously been called temporal orientation. Discarding the distinction between personal and social constructions of time (Lennings, 1992a; 1994) Zimbardo and Boyd (1999) concentrate on the tendency to draw upon memories or thoughts about particular time frames; the

past, present or the future. They also incorporated an attitudinal component into the factor structure.

The ZTPI divides time perspective into five factors. These are:

1. Past Negative - reflecting a generally negative, aversive view of the past.
2. Present Hedonistic - reflecting a hedonistic, risk-taking, 'devil may care' attitude toward time and life.
3. Future – reflecting a general orientation to the future.
4. Past Positive – reflecting a warm, sentimental attitude toward the past.
5. Present Fatalistic – reflecting a fatalistic, helpless attitude toward the future and life.

The ZTPI appears to have been better validated than previous measures on a number of different samples (Keough et al., 1999; Zimbardo & Boyd, 1999; Zimbardo et al., 1997). Indeed Lennings, in a personal correspondence, has advocated the use of the ZTPI.

Independence of different Time Perspectives

A specific criticism of earlier measures of TP was the assumption that scoring low on orientation to one particular time frame (e.g., Future) is equivalent to scoring highly on another (e.g., Past or Present) (Zimbardo & Boyd, 1999). Zimbardo and colleagues demonstrated the relative independence of these dimensions. Two large scale studies found that Present TP was strongly correlated with certain risk taking behaviours, whilst there was only a weak negative association between Future TP and these behaviours (Keough, Zimbardo & Boyd, 1999; Zimbardo, Keough and Boyd, 1997).

These studies showing a link between a Present TP and risky behaviours not only serve to demonstrate the relative independence of the Present and Future dimensions of time perspective, but are consistent with the present focused orientation and the role of impulsivity in suicide attempts.

The importance of seeing a future

In relation to the negative mood states of depression and hopelessness each of the dimensions of TP may play a different role and Future TP may be particularly important. Zimbardo and colleagues looked at the ZTPI and depression scores on the Beck Depression Inventory (BDI; Beck et al., 1961). They found a strong positive correlation between depression and the Past Negative dimension. This is consistent with the association between suicidal ideation and negative life events, such as interpersonal loss (see Williams & Pollock, 1993, for review). However, contrary to expectation, there was only a relatively weak negative correlation - between BDI scores and the ZTPI Future dimension. These findings provide further evidence for the separability of thoughts about the past and thoughts about the future. However, the weakness of the association between Future TP and depression is surprising given that previous studies of future orientation have shown a negative association with depression (Brockopp & Lester, 1970; Dillung & Rabin, 1967; Greaves, 1971; Neuringer & Harris, 1974; Wyrick & Wyrick, 1977).

A possible explanation of Zimbardo and Boyd's finding might be that hopelessness, rather than depressed mood, is related to Future TP. Theoretically one might predict a strong negative correlation between hopelessness and Future TP. To date only one study has investigated this: Brier-Williford and Bramlett (1995) found a slightly stronger negative correlation between both the BDI and BHS and Future TP.

However, this study used an earlier version of the ZTPI (the Stanford Time Perspective Inventory, Zimbardo, 1992).

Future-directed thought

Another area of research indicating differences between depressed mood and hopelessness in relation to thinking about the past and the future is that by MacLeod and colleagues. These authors focused on the role of future-directed thinking in depression, investigating the contributions made by positive and negative cognitions about the future. This is part of a wider recognition of the distinct contributions made by positive and negative aspects of experience. As thoughts about the past and future may be distinct but related, there is a parallel acknowledgement that positive and negative cognitions may be mediated by separate psychological systems, rather than being opposite ends of a single dimension. There is accumulating evidence for this case in different areas of experience including affect, motivation and behaviour as well as cognition (MacLeod & Moore, 2000; MacLeod & Salaminiou, 2001).

MacLeod et al., (1993) and MacLeod, Pankhania, Lee and Mitchell (1997) studied future-directed thinking in both depressed and suicidal patients. Using a measure adapted from a standard verbal fluency paradigm, participants generated as many positive future events (things they were looking forward to) and negative future events (things that they were not looking forward to) as they could within a given time limit. This was done for a range of time periods, from the next 24 hours to the next 10 years. Findings indicated that parasuicidal individuals did not anticipate a disproportionately high number of negative experiences in the future, but that they were less able than non-depressed people to generate positive thinking about the future (MacLeod et al., 1993; MacLeod et al., 1997). Comparing depressed and non-

depressed parasuicidal the authors found that decreased expectation of positive future events was specifically related to hopelessness rather than depression. This distinction is consistent with the finding that non-clinical mildly depressed individuals, unlike severely depressed or suicidal individuals, did not show decreased positive future thinking compared to controls (MacLeod & Cropley, 1995).

The association of reduced positive future thinking with suicidal behaviour was replicated by MacLeod and Salaminiou (2001), who also explored the means by which reduced positive future thinking may occur. By comparing people's reduced ability to generate anticipated future experiences with their expectations of how much pleasure they would derive from such experiences MacLeod and Salaminiou concluded that the inaccessibility of positive anticipated events did not result from an incapacity to experience or anticipate pleasure (MacLeod & Salaminiou, 2001).

Links with the role of memory in depression and hopelessness

MacLeod has also worked alongside Williams on the related field of the role of autobiographical memories in depression. This research is considerable and only that relating to time perception and the role of future thinking is discussed here. In studies by Evans, Williams, O'Loughlin and Howells, (1992) and Williams, Ellis, Tyers, Healy, Rose and MacLeod (1996) people who had attempted suicide were found to show deficits in the specificity of the memories that they were able to recall. This inability to recall specific information was also found to be related to an inability to solve current problems (Evans et al., 1992). Moreover, Williams et al. (1996) also examined specificity of future events imagery and found that there was a correlation between participants' inability to recall specific events from the past and their ability to imagine specific events in the future. This indicates a role for the

accessibility of autobiographical memories in the ability to generate future images (Williams et al., 1996).

In this way a picture is being built up in which people - in whom depression turns to hopelessness - seem to generate less specific autobiographical memories. Their inability to recall events in a specific fashion is also linked with a similar difficulty in generating mental representations of events for their future. Rather than an inability to experience pleasure or an imbalance of positive and negative thoughts about the future, there is an absent ability to generate the expectation of a future, particularly a pleasurable one. This, in turn, results in less planning and engagement in activities which would result in such future events occurring. (MacLeod et al., 1993; Williams et al., 1996).

This body of research on future-directed thought confirms the suggestion derived from time perspective work that a deficit in future thinking (Future TP) is of central importance in depression and hopelessness. The inverse of this situation - that being oriented to the future is, in some way, protective - also has some evidence in its support. Theories of time perspective have long assumed that Future time perspective is motivational in that goals located in the future provide incentives for action (Cottle & Klineberg, 1974; Jones, 1988; Lens, 1986; Nuttin & Lens, 1985). Moreover, Future TP has been found to be associated with positive health practices amongst adolescents (Mahon, Yarcheski & Yarcheski, 2000) and successful prison programme attendance in women prisoners (Chubick, Rider, Owen & Witherspoon, 1999). Recently the research on decision-making has established an important role for "anticipated regret" in preventing risk-taking behaviour (Parker, Stradling & Manstead, 1996; Richard, van der Pligt & deVries, 1996). Unless one is able to imagine a future in which one

might regret actions taken in the present, this check upon one's present behaviour does not exist. It is possible that in a state of hopelessness, without any sense of a future, people may be more likely to act impulsively because they lack the sense of anticipated regret that might otherwise act as an inhibitor.

Summary of subjective time perception

Overall the research into subjective time experience indicates that it is a common aspect of people's experience of depression and of hopelessness to perceive that time has altered. Specifically, time appears to pass more slowly and the depressed person is more likely to focus on events in the present than to think about the future. Whereas it is probable that past events play a dominant role in the origin of depressive thinking (MacLeod et al., 1992) it is generally agreed that an absence of the ability to think about positive future events plays a crucial role in feeling hopeless.

One of the questions remaining after this conclusion is whether or not there is some way in which people's objectively measured timing also slows to achieve or contribute to their subjectively altered experience of time. In their study of reduced future thinking in suicidal individuals MacLeod et al., (1993) found no evidence that this deficit relates only to longer time frames (the next ten years) rather than also to shorter time frames (the next 24 hours). This finding would seem to imply that it is logical that even shorter time scales are experienced differently. In order to see whether this consistency of effect applies to even shorter timescales, it is necessary to examine the experimental literature on timing.

## The Experimental Literature on Measurement of Timing and its Relation to Subjective Time Perception

There is a substantial literature based on experimental investigations (in both humans and animals) relating to timing and the perception of time. This work extends well beyond the remit of this review to include different theories of timing (e.g., scalar timing theory by Gibbon, 1977; Gibbon, Church & Meck, 1984; and the behavioural theory of timing by Killeen & Fetterman, 1988) and debates over the models that best account for the proposed mechanisms of timing, for example, the attentional-gate model by Block and Zakay (1996). Two strands of work from within this substantial literature are reviewed here. The first concerns a number of sources of evidence which would indicate that a link should be expected between experimentally measured timing and more general time perception. The second concerns studies which have specifically tried to measure timing in depression and hopelessness.

Source one: The study of time perception in old age

The first source of evidence that indicates the likelihood of subjective time experience and objectively measured timing co-varying in depressed or hopeless mood is the finding that judgements of duration, objectively measured, alter with age. The altered subjective experience of time according to age is nicely illustrated by the verse below:

> "For when I was a babe and wept and slept, Time crept
> When I was a boy and laughed and talked, Time walked
> Then when the years saw me a man, Time ran
> But as older I grew, Time Flew." (Inscription on Chester Cathedral)

What is interesting is that this common subjective experience actually has an expression in timing tasks with durations of just seconds (Craik & Hay, 1999). Older adults, when asked to retrospectively estimate how much time had elapsed while conducting a task, consistently underestimated the time by a larger amount than younger adults. When asked to stop the same task after a given duration, they consistently overestimated the length of time available to them in comparison with younger adults. This finding is consistent with the suggestion that the internal clock slows with age resulting in external clock time appearing to pass faster. Given that people report that time seems to go slowly in depression the opposite finding might be expected.

Source two: A common timing mechanism for production and perception tasks

The second area of research which would indicate a consistency between different aspects of time perception is that concerning the evidence for a common timing mechanism underpinning timing performance in both perception and production tasks. Hazeltine, Helmuth and Ivry (1997) have argued that both types of task are subserved by the same system. The evidence for this proposition comes from the observation that both time perception and production tasks have a tendency to be influenced by external stimuli (Hazeltine et al., 1997). An example of this is the finding that both activities can become automatically entrained to external stimuli such as evenly spaced clicks (Hazeltine et al., 1997; Treisman, Faulkner & Naish, 1992). Ivry and Hazeltine (1995) also found that subjects varied in a similar way whether it was a time perception or a time production task that they undertook.

The third area of research which would indicate that objectively measured timing should vary along with subjective time perception is that concerning the effects of arousal on timing performance.

Source three: The effects of attention and arousal on timing

The effects of attention and arousal on timing performance are well researched. The idea that the amount of attention devoted to a timing task can increase the subjectively experienced duration of the task is also part of everyday experience. Hence the saying: "*The watched pot never boils*". Attention is thought to play a crucial part in the processing of temporal information, to the point where several attentional models of timing have been proposed (e.g., Block & Zakay, 1996). In general the attentional resources allocated to the stimulus are subtracted from the attention that people devote to the processing of time.

Examples of studies which demonstrate that the amount of attention given to timing affects that timing include:

- Comparisons of "empty" intervals versus intervals "filled" by some task in which the empty intervals are experienced as longer than filled intervals. For example, Zakay (1992) reported a study in which children who had been distracted by jumping toy frog reproduced a duration (by switching on a light) as shorter than those who did not see the toy frog.
- Manipulations of how easy or difficult the non-temporal task is. This indirectly manipulates the attention given to timing. Complexity of the task can shorten the impression of the duration of the interval (e.g., Zakay, Nitzan & Glicksohn, 1983).

- Direct manipulations of the amount of attention given to the timing component of a task by telling participants how much attention to devote to it (e.g., Macar, Grondin & Casini, 1994; Zakay, 1989).

A related area is that of arousal: research has shown that manipulating people's arousal levels alters their perception of the passage of time. This has been done in various ways, one of which is by manipulating people's body temperature. Wearden and Penton-Voak (1995) reviewed studies that had looked at manipulations of body temperature and the effect on timing conducted between 1927 and 1993. In almost all cases, rates of perceived time increased, that is, subjective time passed faster with increased body temperature. The opposite was also true: that when body temperature was decreased the rate of perceived time also decreased. Wearden and Penton-Voak concluded that these results provide support for the hypothesis that humans possess an internal clock that is sensitive to temperature. On the assumption that higher body temperature leads to increased arousal they propose that there is likely to be "some kind of pulser or oscillator mechanism that is sensitive to arousal" (Wearden & Penton-Voak, 1995, p.137).

It has been pointed out by Angrelli, Cherubini, Pavese and Manfredi (1997) that arousal effects may be confounded by concurrent valence effects. In a study that looked specifically at the influence of affective factors on time perception Angrelli et al., (1997) attempted to separate out the effects of arousal and valence by using photographic slides rated for both dimensions. They found a significant interaction of arousal and valence in which people underestimated the duration of presentation of positive slides in the high arousal condition by a greater amount than negatively rated slides. In the low arousal condition the positive slides were underestimated less than

the negative slides. These results were interpreted as evidence of an effect on time estimation of the manipulation of emotional valence and level of arousal. However, the immediate relevance to depression and low mood is lessened by the fact that the system used by Angrelli et al. did not discriminate between different types of positively or negatively valenced emotional reactions (e.g., fear, revulsion, sadness). This means that the direct relevance of this study is less than it might otherwise be in terms of its relation to depression and hopelessness. Nevertheless, this study provides indirect support for the notion that time estimation is likely to be affected in negative mood states. The next section looks specifically at studies relating to individual differences and depressed or hopeless mood.

Studies of timing relating to depression and hopelessness

Several attempts have been made to look at the effect of depression and hopelessness on time estimation, but it is worth setting this work in the context of other research into individual differences in timing and time estimation.

Individual differences in timing and time estimation

Unlike work on the effects of arousal and attention on timing, the notion of whether individuals experience time differently has been largely overlooked (Brown, 1998). The literature that does exist has tended to be largely unfocused because it stems from a number of different directions (Brown, 1998).

In terms of the consistency that people show across different circumstances research has suggested a general stability within individuals. For example, Brown (1998), conducted timing tasks with participants on two occasions a few days apart. Initially he used a computer based timing task to distinguish between high-sensitivity

and low-sensitivity participants. Performance of these two groups was then compared on the other timing tasks, namely, a temporal reproduction task with interference effect and an isochronous-tapping task. Brown found that the results formed a consistent pattern whereby subjects classified as high-sensitivity showed more accurate timing performance across the different tasks and also across different durations. Subjects in the low-sensitivity group always showed more error and variability in their judgements. It was not suggested that subjects with high and low temporal sensitivity differed in any functional way in their timing performance, but rather that they differed in the degree of their accuracy of timing performance. From this pattern of results Brown concluded that timing performance within individuals is relatively consistent across different tasks, time-judgement methods and stimulus durations (Brown, 1998).

Methodology of time estimation studies

In addition to the general work on timing there have been a number of studies over the past four decades that specifically look at time estimation and depression or suicidality. Before discussing some of these studies, it is important to understand why the results of these studies have been described as "confusing and contradictory" (Tysk, 1985, p.179). One of the main reasons appears to be that, by and large, these studies have not been conducted by researchers into timing, but have been done by clinical researchers because of the obvious relevance to clinical work. This has resulted in difficulties because the implications of different methodologies in measuring temporal experience have not always been appreciated.

In considering the findings from these experimental studies of time estimation it is important to bear in mind that the expected direction of change is dependant on

the methodology employed. Figure 1 shows a diagrammatic representation of the potential difference when someone's internal pacemaker is either speeded up or slowed down.

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Insert Figure 1 about here

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If, for example, someone is required to verbally estimate the length of a real time duration (B in Figure 1 above) that they have just experienced (e.g., "How long were you doing that test?") and their internal clock is speeded up (A), then this retrospective judgement will result in a lengthened estimate. On the other hand, if they are required to produce the same duration prospectively (such as being asked to hold down a button for 20 seconds), then the same hypothetical speeding up will result in the production of a shortened estimate in comparison with real time. Conversely, the slowing down of a clock (C) in comparison with real time (B) will lengthen production responses, but shorten retrospective verbal estimates (Wearden & Penton-Voak, 1995, Craik & Hay, 1999). However, although the examples used here compare verbal estimations with a non-verbal production task, both verbal and non-verbal methods can be used either prospectively or retrospectively. Other authors (Killeen, Fetterman & Bizo, 1997) have also noted that even within one category of timing task, such as retrospective estimation, whether or not the person *knows* that they will be asked for an estimate of the duration may affect their conscious timing of whatever event fills the duration. The dependency of the direction of results upon the methods used, in combination with a lack of clarity about the terminology used to describe the methods employed and their effects on timing performance, has led to the

confusion referred to by Tysk (1985). Rammsayer and Rammstedt (2000) point out that even the terms "overestimation" and "underestimation" have been subject to this confusion.

One of the studies that demonstrates this confusion is actually one conducted by Tysk (1984). In this study the methods described for measuring time estimation abilities include retrospective verbal estimations and production of a number of durations. However, no distinction is then made between them by the author, either in the predictions concerning these tasks or the interpretation of the results.

Another consideration to be borne in mind when examining this literature is that it is not possible to compare the results of different studies because many of the tasks that have been used affect the perception of time differentially. For example, some studies have used empty intervals (e.g., Neuringer & Harris, 1974) while others have used intervals filled by cognitively demanding activities (e.g., Bech,1975, who used driving as the non-temporal activity being timed).

In the light of these considerations the literature becomes clearer, but still falls short of forming a coherent body of work. There still appear to be contradictory findings which are seemingly difficult to reconcile. The next section of this review discusses a number of experimental studies the results from which suggest that people's timing performance is not actually impaired or distorted in any way in depression and hopelessness.

Studies suggesting that timing is intact in depression and hopelessness

One of the earliest investigations to measure people's timing performance using an objective measure rather than self-report found that subjective experience of slowed time was *not* reflected by objective measures. Mezey and Cohen (1961)

conducted a study in which they measured people's ability to imitate a given rhythm that had been set by watching a metronome. This was set at approximately twenty beats per minute and participants were asked to continue to produce the regular beat by tapping for approximately 30 seconds, the time taken to produce 10 taps. They found that depressed patients did not display any deficit in their ability to continue to tap out the beat.

This finding, by Mezey and Cohen (1961), is frequently cited in the literature as providing evidence that objectively measured timing is not affected by depression. This is despite the fact that the study has a number of weaknesses, including not using a control group. In an attempt to improve upon the design of the study by Mezey and Cohen, Kitamura and Kumar (1984) used a similar methodology, but also employed explicit diagnostic criteria for depression (which, the earlier study had not) and used matched non-clinical controls. They looked at reproduction of a rhythm of approximately 40 beats per minute which participants produced by tapping a table having had the beat set by watching a metronome. Kitamura and Kumar found differences in subjective experience of time but not in objective measurements of timing abilities. That is, no difference was found between the timing abilities of depressed patients and control participants. However, the authors themselves acknowledged that, they may not have picked up any "subtle abnormality" if any exists (Kitamura & Kumar, 1984, p. 25/26) because their measure was the time taken for 10 beats to be tapped out and they had increased the frequency of beats from that used by Mezey and Cohen (1961) due to 20 beats per minute being "too boring", this left an examination time of only approximately 10 seconds, which may have been too small to pick up any disturbances given the type of task being used.

Moreover, another substantial criticism of these two studies (Mezey & Cohen, 1961; Kitamura & Kumar, 1984), is that, within the timing literature, the technique of listening to a beat followed by being asked to replicate it has been used to "entrain" timing responses (Penton-Voak, Edwards, Percival & Wearden, 1996; Treisman et al., 1990). If timing by this method is susceptible to entrainment then it cannot also be used to reliably detect individual differences because it would not be possible to separate out the effects of that person's potential to be entrained from any naturally existing timing biases towards either speeding up or slowing down.

However, these two studies have not been alone in providing supportive evidence for timing remaining intact in depression. Bech (1975), reached the same conclusion after a study comparing a number of groups of depressed patients with non-depressed control participants on two measures of retrospective verbal time estimation. All participants were involved in a driving simulation task after which they were asked two sets of questions on their estimation of the passage of time. Bech did not find significant differences in the estimations of the amount of time that had passed between the different groups. This was despite the finding, reported in a previous section of this review, that subjective experience of the slowing of time passage correlated positively with severity of depression scores.

Bech's study is quite unusual in the fact that he used a driving simulation task as the non-temporal task. On the grounds, previously mentioned, that attentional load is known to affect timing, the relative complexity of this task is likely to have affected timing judgements. Therefore, it is difficult to compare the results of Bech's study with other studies in which either the non-temporal task is less complex (e.g., sorting

decks of cards in Hawkins, French, Crawford & Enzle, 1988, see below) or the interval is empty (e.g., Neuringer & Harris, 1974; Wyrick & Wyrick, 1977).

In spite of the weaknesses of some of these studies these findings have lead some authors to conclude that people's experience of time can be divided into two components: one of which is affected during depression and hopelessness ("subjective experience") and one of which is not ("objective time perception")(Hawkins et al., 1988). Hawkins and colleagues reviewed a number of studies, including some which utilised various mood induction procedures to induce temporarily depressed mood, and concluded that there was evidence to say that subjectively time experience is altered in depression, but that studies which used "objective chronometric units" have mainly failed to show any change attributable to depressed affect. Hawkins et al. conducted their own study in which they used the Velten mood induction procedure (Velten, 1967) to induce elated, neutral and depressed mood. Participants, comprising undergraduate students, were then asked to estimate, retrospectively, the amount of time they had spent occupied with a version of a card sorting task. They found no differences between the estimates made by participants in the three groups in whom different mood states had been induced, but they did find a difference in how quickly or slowly participants felt that time passed while doing the task. However, it is possible that Hawkins et al. did not show an effect on time estimation performance because of the weakness of the mood induction procedure. Although the Velten procedure is well known, it has been criticised for being less effective than other means of inducing temporary mood states (Pignatiello, Camp & Rasar, 1986; Westerman, Spies, Stahl, & Hesse; 1996). Hawkins et al. did acknowledge that others (Dillung & Rabin, 1967) had found a difference in the time estimation of depressed or

suicidal participants in comparison with control participants. This study and others are discussed below.

Studies showing altered time estimation in depression and hopelessness

In contrast to the view that timing per se is not affected in people who are depressed or suicidal there have been a number of studies that have detected some form of disturbance in timing performance. Dillung and Rabin (1967) compared the retrospective time estimation responses of depressed patients with those of non-psychiatric hospital patients and patients with a diagnosis of schizophrenia. They found that, for the longer of two intervals (of approximately 14 and 31 minutes) depressed subjects significantly overestimated the amount of time that had passed. They interpreted this finding as supportive of the hypothesis that experience of time is affected by "psychopathological disturbances" and also that longer intervals were subject to a greater effect than shorter intervals.

Similar results have been shown by Neuringer and Harris (1974) who compared the retrospective verbal estimation of empty time intervals (durations of between 30 and 300 seconds) by suicidal and hospital control subjects. They found that suicidal patients produced significantly longer estimates of elapsed time than the other patients for the shorter intervals, but their estimations for the longer intervals (also overestimated) were not significantly different from controls. Wyrick and Wyrick (1977) used stimulus durations of 5, 10, 20, 80, 160 & 240 seconds like those used by Neuringer and Harris (1974) and 15 & 30 minutes like Dillung and Rabin (1967). Their results were consistent with the hypothesis of altered timing in the same direction as both of these studies in that depressed subjects were found to have overestimated the time passed, but, like Dillung and Rabin they found this for the

longer durations, but not the shorter durations. All three studies used retrospective verbal estimations although they did differ in that Dillung and Rabin's intervals were filled and the other two studies used empty intervals.

The previously mentioned study by Tysk (1984), also provides some evidence for timing being distorted in depressed patients, although some of the results appear to contradict the direction of findings from other studies and the interpretation of these results is somewhat muddled. Tysk used a number of different methods to measure time estimation including metronome adjustment as used by Mezey and Cohen (1961) and Kitamura and Kumar (1984). A potential weakness of this method has already been referred to. Tysk also used two sets of retrospective verbal estimations for short durations (of 7.5 seconds to 27.5 seconds) and longer durations (between 5 & 10 minutes) and a prospective timing production task for durations of 10 to 30 seconds. Tysk found that depressed patients underestimated the durations across each of the tasks except the longer verbal estimation. In comparison with other studies the finding that depressed participants underestimated a retrospectively estimated duration is surprising and would not fit with the hypothesised speeding up of an internal clock. Tysk's own predictions for the direction of altered time perception did not distinguish between the different methods used and specifically did not make any distinction between prospective or retrospective estimations. However, some of Tysk's findings do concur with the other studies already reported and the hypothesis of a faster paced internal clock. These include the fact that the largest degree of underestimation was in the production task and that, although not significantly more that the control group, Tysk reports that depressed patients had a tendency to overestimate the longer retrospectively estimated durations. Therefore, although at first sight this study

appears inconsistent with several others, it is actually only a small proportion of the findings that are discrepant.

Another, more recent, time estimation study which provides evidence in support of timing being disturbed in depression is that by Kuhs et al., (1991). These authors did distinguish between prospective and retrospective methods and realised the implications for interpretation of the results found. They used a novel prospective method in which they covered the face of a stopwatch but asked participants to press start and stop to signify their estimation of the passage of specific durations (e.g., 10 seconds). Kuhs et al. found that depressed patients consistently underestimated intervals of between 10 and 30 seconds. In their estimations of 30 seconds the average underestimation by depressed participants was 5.79 seconds, whereas control participants generally overestimated the same duration by nearly 10 seconds. These results are consistent with the hypothesis of the speeding up of an internal clock in depression. In their discussion of their results these German authors also referred to their findings being consistent with those of a number of other German papers which are not available in English (e.g., Bojanovsky, 1969; Payk, 1979; Straus, 1928).

Indeed, work on timing and depression has continued in Germany and a recent study by Mundt, Van Hees and Stumpf (1998) also contributes to the body of work showing differences in the timing abilities of people when depressed. Mundt et al., (1998) tested forty depressed patients comprising two diagnostic groups: endogenous depressed individuals and neurotic depressed individuals, and fifteen controls. They used production and reproduction timing tasks with empty intervals or intervals filled only with relaxing music. They reported significant differences between the groups and attributed this to time being 'elongated' for the depressed patients. They also

followed the progression of their participants through their therapy and clinical improvement and found that timing also recovered. Moreover, these authors make suggestions about the clinical implications and ways in which therapeutic interventions could be targeted at such improvement. However, unfortunately further consideration of their ideas is hindered by the fact that a full translation of this paper is not available.

Summary of experimental measurement of time

To date experimental work on time estimation in depression has suffered from a confusion of different methods. These various studies, although difficult to compare, show somewhat mixed results. Four studies have been reported in which no distortion of timing was found in depressed or suicidal subjects, but these studies have various weaknesses (Bech, 1975; Hawkins et al., 1988; Kitamura & Kumar, 1984; Mezey & Cohen, 1961). At least six studies have found a difference between depressed or suicidal participants' timing and control participants (Dillung & Rabin,1967; Kuhs et al., 1991; Mundt et al., 1998; Neuringer & Harris, 1974; Tysk, 1984; Wyrick & Wyrick, 1977). On balance, there does appear to be some indication that peoples' timing abilities, as well as their subjective perception of the passage of time, are affected during the experience of depression and hopelessness. However, given that this conclusion has so far been reached on the basis of studies which have varied widely in their methodology and which, by and large, have not been replicated or extended, there is still the need for further evidence that this conclusion is robust.

**Directions for Future Research**

There are several questions that further research could usefully address. In addition to the need for consolidating the evidence showing that time experience is altered in depressed and hopeless mood, more information is needed about this experience. As we have seen in the course of this review, the experimental timing literature has yielded some evidence that the experience of time appearing to pass more slowly may be underpinned by a 'real' difference in people's timing abilities (Dillung & Rabin,1967; Kuhs et al., 1991; Mundt et al., 1998; Neuringer & Harris, 1974; Wyrick & Wyrick, 1977; Tysk, 1984), yet it remains to be known whether this perception of slowed time is related at all to the bias towards favouring a present or past time perspective seemingly at the expense of being able to think about the future. Future research might address the question of whether these two types of temporal experience are related and if so how?

Given that the concept of Time Perspective has undergone redefinition with the advent of the Zimbardo Time Perspective Inventory, replication of research which used other TP measures would be worthwhile in order to establish whether the associations between the dimensions of TP and mood have been maintained.

Any research that did look into both types of experience could address the weaknesses of previous work by attending to the implications of the experimental methods employed. Much of the research conducted into timing uses durations as short as milliseconds. It remains to be tested whether differences at this level of timing would be evident as a result of depressed or hopeless mood.

One important aspect for discussion and potential area for research is clarification of what kind of disturbed timing it is that is being seen. Using the right

experimental methods it should be possible to measure what kind of distortion it is that is present in these mood states. Is it just, as has been proposed by some (e.g. Blewett, 1992) that there is simply more variation in the timing of depressed individuals or is it consistent with the proposal that a hypothesised internal pacemaker/clock is going faster?

Something that as has not really been adequately addressed by the scope of this review is the function that any alteration in the speed of an internal clock may serve in depressed mood or hopelessness. Why should it be the case that the internal clock speeds up in depression? In contrast to the situation regarding the hypothetical slowing down of an internal pacemaker in old age, which fits easily with theories of ageing, the potential speeding up of such a pacemaker in depression seems counter intuitive and does not fit easily with other aspects of depression such as retardation. Yet this seems to be the direction that the evidence to date would suggest. Continuing the analogy with old age research it should be borne in mind that, although people recognise the sensation of time appearing to speed up in old age, older people are not aware of their own internal clock being slower. Although this review does not have the scope to explore discussion of the potential function of a speeded up internal clock in depression, one possible explanation is that, whereas physical withdrawal and slowing down is adaptive in that it prompts the person to keep themselves safe from possible repetition of whatever negative life experiences may have triggered their depression, mental processing needs to speed up at such times in order to try to solve the 'problem' underlying the depressed mood. Melges (1982) proposed the idea that an altered rate of mental events may be the link between depressed mood and timing distortions. Theoretical understanding of this area remains lacking.

Future studies could also address why it is that some investigators have not found the same results as others. For example, Hawkins et al. (1988) did not see a difference in people's estimates of time when they investigated this using a mood induction procedure. Was this because the mood induction procedure used was not effective or for some other reason?

Another study that used a mood induction procedure was that conducted by Angrelli et al. (1997). However, this work was of limited relevance to specific mood states because the procedure that was used only differentiated valence (negative or positive) rather than specific moods such as sadness or worry. Following on from this similar investigations could be conducted looking at the effect on time estimation of inducing specific moods.

Once the parameters of disturbed time perception in depression are established, the phenomenon could be clinically useful. Studies have already indicated that when depressed mood is alleviated timing returns to normal (Kitamura & Kumar 1984; Mundt et al., 1998). It is possible that treatment could target time perception to facilitate recovery. For example, Lennings (1995) suggests the use of 'Time Lines' as a clinical tool to try to shift people's focus to their future in order to prompt a more balanced time perspective. Other means of promoting future-directed thinking could also be devised to address the difficulties that people have in imagining a future for themselves. Similarly, to address the issue of distorted timing abilities activities could contain pacing components, such as using music, to try to re-train depressed people's time judgement.

A better understanding of the role of future directed thinking and time perception in depression may also reveal the 'active components' of well established

therapeutic techniques. Activity scheduling may operate in just this way, orienting people to thinking about their activities in the next few days, hence contemplating their future, albeit the near future. MacLeod, Tata, Evans, Schmidt et al. (1998) found that suicidal individuals showed a relative increase in positive future thinking after receiving a manualised cognitive behaviour therapy intervention in comparison with those receiving treatment as usual. This result suggests that there may be something within a cognitive approach that remedies the lack of future directed thinking in suicidal people, although the findings from this study were not altogether clear as the authors also unexpectedly found a relative increase in the future directed thinking of the control group.

**Conclusions**

Time perception has been studied through the use of self-report measures of the subjective experience of time and by the use of more objective measures of timing abilities. Evidence from these two broad spheres of study has suggested that people who are depressed or who feel hopeless tend to favour a present or past time perspective seemingly at the expense of being able to think about the future and they report that external time passes slowly for them. The experience of time being slowed seems to have some basis in actual differences in the ability to judge the passage of time, but it is still not clear how the experience of time slowing relates to people's inability to imagine a positive future for themselves.

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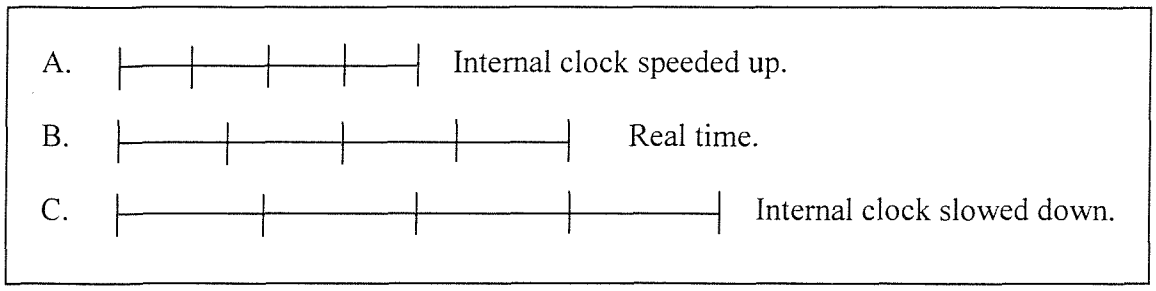


Figure 1. Diagrammatic representation of the pacing of a hypothesised 'internal clock'.

Empirical Paper:

# The Effect of Low Mood on the Perception of Time in Adolescents

Sara Melly

Prepared as if for submission to "Psychonomic Bulletin and Review".

# The Effect of Low Mood on the Perception of Time in Adolescents

Sara Melly

University of Southampton

Running header: Time Perception and Depressed Mood

Address for correspondence:

Sara Melly, Doctoral Programme in Clinical Psychology, Psychology Department,

University of Southampton, SO17 1BJ. Telephone 02380 595321

# The Effect of Low Mood on the Perception of Time in Adolescents.


## Abstract

The present study investigated the association between depressed mood and disturbed temporal experience. Fifty adolescents aged between 14 and 17 years participated. They completed measures of depressed mood, hopelessness and impulsivity. They were randomly allocated to either a mood induction condition or control condition with high scorers on the depression measure screened out of the mood induction condition lest any depression be exacerbated. All participants completed two computer based timing tasks and the Zimbardo Time Perspective Inventory. Data were analysed using t-tests and correlational analyses. The only significant difference found between the mood induced condition and controls was on the standard deviations of the Time Reproduction Task. There were also indications of a relationship between naturally occurring low mood, hopelessness, and poor timing performance. Correlations were found between mood and various dimensions of time perspective, but time perspective per se was not found to correlate with timing performance. These results and their limitations are discussed.

## Introduction

The notion that time perception is disturbed in some way when people feel depressed or suicidal has long been of interest to researchers (e.g., Dillung & Rabin, 1967; Lewis, 1932; Staus, 1947; Wyrick & Wyrick, 1977). Research into this area has spanned studies relating to low mood, depressed mood, hopelessness and suicidality. Despite the differences between these categories of experience, the findings from these areas appear to indicate a common thread of altered experience of time. Two key features of this altered experience have been noted. These are: (a) that people who feel depressed or hopeless have a tendency to favour certain "time perspectives", that is to think more about particular time frames and have different attitudes towards them (e.g., Lennings, 1994), and (b) that people who are depressed or who feel hopeless report that external time appears to pass more slowly (e.g., Bech, 1975; Kitamura & Kumar, 1982).

Evidence that people who are depressed or who feel hopeless tend to focus more on the present and less on the future than other people has come from a number of empirical studies (Brockopp & Lester, 1970; Dillung & Rabin, 1967; Greaves, 1971; Lennings, 1992; 1994; Neuringer & Harris, 1974; Wyrick & Wyrick, 1977). These studies include some that have examined time perception in clinical samples and some that have used non-clinical samples. Although there are limitations to the conclusions that can be drawn from comparing these different types of study, both seem to suggest similar tendencies. For example, Dillung and Rabin (1967) looked at orientation to particular time frames and how far into them people either remembered back or projected forward. They compared depressed patients with control participants and found that depressed patients were oriented somewhat to the past,

mainly to the present and hardly at all to the future. Dillung and Rabin found that depressed subjects also had lower scores on the measure of extension into the past or future than control subjects indicating that they generally looked less far ahead to the future and less far into the past than controls. Greaves (1971) reached similar conclusions in relation to suicidal subjects. Greaves analysed the verb tenses used by suicidal and non-suicidal subjects on a sentence completion task and found that suicidal subjects used more present tense verbs and fewer verbs in the future tense than control subjects.

Investigations into "time perspective" (TP) have similarly contributed to the conclusion that, in depression and hopelessness, people tend to concentrate on the past and present rather than the future. TP has been defined as "the way a person reflects on the past, is concerned with the present and anticipates the future" (Lennings, 2000, p.167). The concept of TP has been used to capture and define the various aspects of subjective time experience that have been investigated. It is important to note that there has been a confusion of alternative terms used to describe these various aspects of time experience. In this paper 'time perception' is used an overarching term encompassing the experiences captured in both the experimental and non-experimental literatures including TP.

Lennings conducted a number of studies looking at the association of TP to depression and suicidality (e.g., Lennings, 1992; 1994) and concluded that attitudes towards time, in the sense of seeing the future as either remote and beyond control or as stable and certain, are the most closely correlated aspects of TP to suicide ideation and hopelessness. However, there have been problems with the methodology of TP research centring on the tools used to measure TP (Lennings, 1992; Schroots, 1996; Zimbardo & Boyd, 1999). In an attempt to overcome these problems a new measure

has been devised by Zimbardo and Boyd (1999). This measure, the Zimbardo Time Perspective Inventory (ZTPI), divides time perspective into five factors. These are: *Past Negative*, which reflects a generally negative, aversive view of the past; *Present Hedonistic*, reflecting a hedonistic, risk-taking attitude toward time and life; *Future*, reflecting a general orientation to the future; *Past Positive*, reflecting a warm, sentimental attitude toward the past; and *Present Fatalistic*, which reflects a fatalistic, helpless attitude toward the future and life.

On the basis of work such as that by Lennings, it could be predicted that each TP dimension would show a different relationship to depressed and hopeless mood and that Future TP may be particularly important. There have been two studies to date which have compared depression measures and TP as re-defined within the ZTPI: Brier-Williford and Bramlett (1995) and Zimbardo and Boyd (1999). Brier-Williford and Bramlett (1995) used an earlier version of the inventory, then referred to as the Stanford Time Perspective Inventory (Zimbardo, 1992). Somewhat surprisingly, both studies reported only a weak to moderate negative correlation between Future TP and depression. This may be because Future TP within the ZTPI does not differentiate between negative and positive cognitions about the future which some investigators believe is an important distinction to make (MacLeod & Moore, 2000).

MacLeod and colleagues have investigated the distinct contribution that is made by positive and negative cognitions about the future in depression and in suicidal ideation. Results from this source of investigations have also provided further evidence for the important role of future thinking in depression and hopelessness. MacLeod, Rose and Williams (1993) and MacLeod, Pankhania, Lee and Mitchell (1997) found that suicidal patients were significantly less able than non-depressed people to generate positive thinking about the future.

In addition to the inability to focus on the future, studies of time experience in depression have also found that people report that time seems to drag for them when they are depressed and feeling hopeless (Bech, 1975; Blewett, 1992; Hawkins, French, Crawford & Enzle, 1988; Kitamura & Kumar, 1982). Three of these studies (Bech, 1975; Blewett, 1992; Kitamura & Kumar, 1982) have also found that this subjective experience of time dragging is more pronounced when the level of depression is more severe. Moreover, there have been some indications, with repeated measures designs, that when the depression is alleviated that the apparent speed of the passage of time also returns to normal (Kitamura & Kumar, 1982).

However, despite recognition of these two aspects of altered time experience in depression, very little is actually known about them. It is not known whether TP, particularly as it is now defined, is related to other aspects of time experience, such as the apparent slowing of time. Nor is it known whether the subjective self-report of slowed time experience is actually based in a 'real' difference in people's timing abilities that can be measured experimentally.

There are several reasons to suggest that the differences in time perspective associated with depression and hopelessness should also be reflected in people's actual timing abilities. Studies from the general timing literature have shown relative stability in timing responses across different situations and durations (Brown, 1998; Ivry & Hazeltine, 1995). It has also been found that judgements of duration, objectively measured, alter with age in line with subjective experience of time speeding up in old age (Craik & Hay, 1999).

Although it could be argued that the timing of long periods of time is different from very short periods of time in terms of the memory processes involved, there is

little evidence of any qualitative difference. MacLeod et al., (1993), in their study of reduced future thinking in suicidal individuals, found no evidence that this reduction applies only to longer time frames (the next ten years) rather than also to shorter time frames (the next 24 hours).

Studies which have tried to examine and compare both subjective experience of time and objectively measured timing performance have found confusing and sometimes contradictory results. There have been problems interpreting the findings of research to date because of confusion over the direction of predicted differences according to the methodology used to look at time estimation performance. The direction of any differences that have been found have varied according to whether the methods used have involved retrospective or prospective estimations (Killeen, Fetterman & Bizo, 1997; Zakay & Block, 1997). Whether or not the durations to be measured have been filled with an activity has also influenced the time judgements made (Zakay & Block, 1997).

One study that attempted to examine the relationship of time perspective to time estimation was that by Lennings and Burns (1998). They found no systematic association between TP and time estimation, but they not only recognised that their measures of TP may be problematic, they also failed to discriminate between their time estimations tasks; one of which was prospective and one of which was retrospective. Therefore, this study alone contributes little to clarifying the relationship between these two aspects of time experience.

Some researchers have concluded that their findings indicate that, in spite of changes in subjective self–report of time experience, timing is intact (e.g., Bech, 1975; Hawkins et al., 1988; Kitamura & Kumar, 1984; Mezey & Cohen, 1961). For

example, Bech (1975) compared groups of depressed patients with non-depressed participants in their responses on the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock & Erbaugh, 1961); a three point scale of speed of time passage (where rapidly = 1; medium = 2; and slowly = 3) and two estimates of the length of time that they had been occupied in a non-temporal task (driving). Bech found that subjective time experience was slowed in the depressed participants and that this dragging of time was associated with severity of depression, but this study found no significant differences between the different groups in the estimations of the amount of time that had passed.

Similarly, Hawkins et al. (1988) found no difference in people's estimates of time passed spent sorting card decks according to artificially induced depressed mood. This could be due to several possible causes. It could be that objectively measured timing is not affected by depressed mood (as Hawkins et al. concluded) or that disturbed timing is more likely to be seen in people who are severely depressed rather than in temporarily induced low mood. Another possibility is that their result could be due to lack of effectiveness of the mood induction. The Velten mood induction was used by Hawkins et al. and, despite being widely used, this method has been criticised for being less effective than other means of inducing temporary mood states (e.g., Westermann, Spies, Stahl and Hesse, 1996).

Other investigators have concluded that timing is altered in some way in depressed or hopeless mood (Dillung & Rabin, 1967; Kuhs, Hermann, Kammer and Tolle, 1991; Mundt, Richter, Van Hees & Stumpf, 1998; Neuringer & Harris, 1974; Tysk, 1984; Wyrick & Wyrick, 1977). Neuringer and Harris (1974) compared the retrospective verbal estimation of empty time intervals by suicidal and hospital control subjects. They found that suicidal patients produced significantly longer

estimates of elapsed time than the other patients for the shorter intervals, but their estimations for the longer intervals (also overestimated) were not significantly different from controls.

A more recent study by Kuhs et al. (1991) also found differences between depressed and non-depressed individuals using a prospective method of time estimation. They covered the face of a stopwatch but asked participants to press start and stop to signify their estimation of the passage of specific durations (e.g., 10 seconds). Using this method and one in which participants estimated the passage of time by counting aloud, Kuhs et al. found that depressed patients consistently underestimated intervals of between 10 and 30 seconds. In their estimations of 30 seconds the average underestimation by depressed participants was 5.79 seconds, whereas control participants generally overestimated the same duration by nearly 10 seconds.

Therefore, there does seem to be some evidence for disturbances of timing occurring in depressed mood, but the parameters for this disturbance are not yet known. The study reported here attempts to pull together some of the strands of investigation that have been mentioned. In order to examine the relationship between timing performance and TP, both objective measurements of time estimation and subjective report of time perspective are examined.

Timing will be assessed using a methodology, developed within general timing research, whereby responses at the level of milliseconds are recorded by computer. This method will have the advantage that it reduces the problem of what to fill the duration with – thus overcoming a problem found in earlier studies in which either tasks were cognitively demanding and complex (e.g., Bech, 1975) or, where

empty intervals were used, could be construed as boring (e.g., Mezey & Cohen, 1961).

Naturally occurring low mood will be measured using questionnaires. Temporary sad mood will be induced using a procedure developed by Mayer, Allen and Beauregard (1995). This method has advantages over the manipulation used by Hawkins et al. (1988), in that it uses a combination of two procedures; guided imagery vignettes to occupy foreground attention and mood rated music to occupy background attention. By measuring both naturally occurring low mood and temporarily induced low mood it will be possible to infer whether any effects found are due to a temporary state or due to a more enduring trait.

Given that the concept of Time Perspective has undergone some redefinition with the advent of a new tool for its measurement – the Zimbardo Time Perspective Inventory – this measure will be used to examine TP in relation to mood and to performance on the timing tasks.

Lastly, and peripheral to the main hypotheses, given that impulsivity has been regarded as an important factor in suicide attempts (e.g., Baumeister, 1990) and has also been thought of in terms of over-sensitivity to time and an aversion to delay (in the context of Attention Deficit Hyperactivity Disorder in children: ADHD; e.g. Sonuga-Barke, Saxton & Hall) the study will examine the relationship between impulsivity and time experience. TP and timing performance will be compared with impulsivity using a self-report impulsivity measure which separates functional and dysfunctional impulsive behaviours.

The aim of this study is to examine whether both timing performance (measured on two types of timing task) and time perspective (as measured by the

Zimbardo Time Perspective Inventory) will be affected by the induction of a mild sad mood using a validated mood induction procedure in a normal adolescent population.

Hypotheses

The hypotheses are:-

that differences will be found between the timing performance on a Time Discrimination task and a Time Reproduction task of a group of young people in whom a negative mood has been induced and a control group drawn from the same (non-clinical) population;

that differences will be found between responses on the Zimbardo Time Perspective Inventory of a group of young people in whom a negative mood has been induced and a control group drawn from the same population;

that there will be an association between timing performance and scores on the Zimbardo Time Perspective Inventory;

that there will be an association between scores on the Beck Depression Inventory-II, the Beck Hopelessness Scale; the Dickman Impulsivity Scale and timing performance;

there will be an association between scores on the Beck Depression Inventory-II, the Beck Hopelessness Scale; the Dickman Impulsivity Scale and responses on the Zimbardo Time Perspective Inventory.

## Method

### Design

A mixed design was used: between groups comparisons were made between the experimental group (n = 24) who received a sad mood induction and the control group who did not (n = 26). In addition to the primary analysis between the two groups within groups comparisons were also made between participants' performance on the timing tasks and their questionnaire responses.

### Participants

Fifty adolescents aged between 14 and 17 years took part in the study, 34 female and 16 male. They were recruited from three local secondary schools, one of which was a girls' school. This was arranged through the head teacher and class teachers and parental consent was obtained by letter. The young people themselves also gave their consent. A copy of the parental consent letter can be found at Appendix II.

Young people were to be excluded from participation if they had disabilities that would impair performance on the timing tasks. It was not necessary to exclude any potential participants. All participants were also screened for any history of depressive illness or suicidal behaviour before inclusion into the mood induction group.

### Apparatus & Materials

#### *Questionnaire Measures*

Participants were seated in a quiet room and asked to self-administer the questionnaires (with the investigator on hand to assist if there were any problems or queries).

The Beck Depression Inventory – Second Edition (BDI – II; Beck, Steer & Brown, 1996). This is a well established 21 item measure designed to assess severity of depression in adults and adolescents aged 13 years and older. The BDI-II was developed to assess symptoms of depressed mood corresponding to the Diagnostic and Statistical Manual of Mental Disorders – Fourth Edition (DSM-IV; American Psychiatric Association, 1994) criteria for the diagnosis of depression. It is based on the original BDI (Beck, Ward, Mendelson, Mock and Erbaugh, 1961), which has become one of the most widely accepted assessments of depression.

A score of between 0 and 10 denotes minimal depression; 11-18 = mild depression; 19-29 = moderate depression; 30+ = severe depression. A score of 19 or above, indicating moderate levels of depressed mood, was used as a cut off point for exclusion from the experimental group.

The Beck Hopelessness Scale (BHS; Beck, Weissman, Lester & Trexler, 1974). This is a 20 item scale for measuring pessimism in adolescents and adults. The BHS was originally devised by Beck and colleagues to measure pessimism in psychiatric patients considered to be at risk of suicide, but the measure has been used subsequently with adolescents and adult normal populations. The manual reports an average reliability coefficient of .92 and test-retest reliability of .69 over a week. The scale has been shown to have good validity and is widely used. Scores of between 0 and 3 denote minimal hopelessness/pessimism; 4 - 8 = mild; 9 -14 = moderate; 14+ = severe hopelessness.

Dickman Impulsivity Scale for Children (Brunas-Wagstaff, Tilley, Verity, Ford & Thompson, 1997). This scale was developed from Dickman's Impulsivity Inventory (Dickman, 1990) which was devised to measure functional and dysfunctional impulsivity in adults. Functional impulsivity, is defined as a tendency to favour a rapid approach to social and cognitive problem-solving situations together with a tendency to benefit from this approach. Dysfunctional impulsivity is associated with a tendency not to consider all available options when making decisions accompanied by generally negative consequences. Brunas-Wagstaff et al., found that these two traits also applied in children and they developed the adapted scale for the measurement of functional and dysfunctional impulsivity in children. The scale comprises ten functional impulsivity items and ten for dysfunctional impulsivity. The scale showed good validity in that the Functional and Dysfunctional scales were found to be distinct from one another. Brunas-Wagstaff et al. (1997) reported significant reliability coefficients for both scales with a number of different aged children (ages 8 –16). Concurrent and discriminant validity was also established by comparison of the two subscales with Eysenck's Impulsiveness Scale for Children comprising the scales of Impulsiveness and Venturesomeness (Eysenck, Easting & Pearson, 1984).

The Zimbardo Time Perspective Inventory (ZTPI - Zimbardo & Boyd, 1999).

This inventory measures the tendency to favour memories or thoughts about one particular time frame; either the past, present or the future. A copy of this measure can be found in Appendix III.

The ZTPI divides time perspective into five factors. These are: *Past Negative*; *Present Hedonistic; Future; Past Positive;* and *Present Fatalistic.*

The ZTPI has been shown to have good psychometric properties across different populations (Zimbardo & Boyd, 1999). It was developed using exploratory factor analysis followed by a confirmatory factor analysis. Test-retest reliability was between .70 to .80 for the five different factors. Convergent and divergent validity was shown by comparison with a number of other well established measures including, the BDI (Beck, et al., 1961) and the Spielberger Stait-Trait Anxiety Inventory (Spielberger, Gorsuch & Lushene, 1970).

***Mood Induction***

The procedure followed was based on that identified by Mayer et al. (1995). This requires participants to listen to selected mood rated music and the use of guided imagery vignettes. The music for the sad mood condition was Chopin's (1839) Opus 28,# 6 from Preludes. The music used for the happy mood induction was Bach's (1721) Brandenburg Concerto #2.

For ease of administration, to improve consistency in delivery and to overcome any reading difficulties among subjects, the vignettes were read over the selected piece of music and a recording of the two combined was made. This was played during a Powerpoint slideshow presentation of the written vignettes as a complete audiovisual presentation. There were eight vignettes spaced 30 seconds apart. Some minor alterations to the vignettes used by Mayer et al., (1995) were necessary to allow for the age range of the participants. For example, rather than being asked to imagine: "You just got a new job, and it's even better than you expected" the statement used was: "You just got a Saturday job, and it's even better than you expected." A copy of

the vignette slides for both the sad and happy inductions can be found at Appendix IV.

***The Timing Tasks***

The timing tasks were controlled and responses recorded via a programme written in C++ Builder administered on Toshiba laptop computer with an 11inch screen. The computer programme was used to display instructions for the time estimation tasks and to display the stimuli to be timed. The stimuli comprised presentations of a black circle of 6 cm diameter. Participants' responses were recorded via a response box with three buttons (black to signify readiness, red and green for responses – see Appendix V for diagram of apparatus).

There were two time estimation tasks administered: a Time Discrimination task and a Time Reproduction task. The order of presentation of the two tasks was counterbalanced.

The Time Discrimination Task. This timing task was a retrospective pair comparison of visually presented stimuli (Killeen, Fetterman & Bizo, 1997) which involved the presentation of two identical circles on the computer screen one after the other for different durations. Participants had to indicate whether the second circle appeared for a shorter or longer duration than the first circle. The target stimulus duration was 450 milliseconds. The test stimuli were of 150, 225, 300, 375, 525, 600, 675 & 750 milliseconds durations. The inter-stimulus interval was 500 ms. The order of presentations of the target and the test stimuli was counterbalanced.

Standardised instructions were given verbally and via the computer screen. The participants were instructed to press the black button on the response box when ready, then a forced choice paradigm was used in which participants were told to indicate via either the red or green button whether the second of the two circles they had seen was shorter or longer than the first. (See Appendix VI for the instructions to participants.) There were four training stimuli (for which feedback was given) followed by 5 x 8 blocks of trials during which there was no feedback as to whether responses were correct or incorrect.

The Time Reproduction Task. The Time Reproduction task involved subjects reproducing the estimated length of the target stimulus presentation by holding down the red button on the response box. The black button was used to register readiness for receipt of the next trial, but the green button was not used for this part of the experiment. As in the Time Discrimination task, standardised instructions were given verbally and via the computer screen and four practice trials preceded the randomly presented 10 presentations of each of 6 target durations which formed the experimental trials . In the practise trials the participants were shown if they were correct or incorrect in their duration reproductions. Correct responses were those within a thirty per cent error range. In the experimental trials no feedback was given. The target durations used were:750, 900, 1050, 1200, 1350 & 1500 milliseconds.

Procedure

Ethical approval was obtained from the University of Southampton. A copy of this can be found at Appendix I. Participants from a local secondary school were

approached by letter addressed to their parents (please see Appendix II) and asked to take part voluntarily in the research. Once parental consent for their participation had been obtained the young people were visited during the school day by arrangement with the Head teacher and the individual class teachers. Verbal information about the study was provided to the young people and then each was seen in a quiet room in the school. Using standardised verbal instructions (see Appendix VII), the young people were asked to confirm their consent to participate, their age, whether or not they were colour-blind and whether they were taking any medications for mood related disorders. If there were any contra-indications to participation at any stage this was explained to the young person and they were returned to their classroom.

All participants completed the BDI-II, BHS and Dickman Impulsivity Scale (adapted for children) in that order. They also completed a rating of present mood. Participants were randomly allocated to either the mood induction or control condition with the exception of any young people who scored over 19 on the BDI-II. Five participants were excluded from the main analysis because their BDI-II score indicated clinical levels of depression. The participants allocated to the experimental group then received the sad mood induction followed by a second mood rating as a mood manipulation check.

The procedure for the mood induction comprised first asking the participant to make a rating of their present mood on a 21 point scale from sad [-10] to happy [+10]. They were instructed to read and listen to the statements that they were about to hear and imagine that the statement applied to them. Participants then put on headphones and were seated at the computer. They watched and listened to the Powerpoint

presentation comprising:- the recorded music; the vignettes audibly presented over the music; and visual presentation of the vignettes on the screen. When this was completed, the participants were asked to rate their mood again on the same −10 to +10 scale.

All participants then completed the two computer-based timing tasks and the ZTPI after which they rated their mood again.

To ensure that participants who had received the sad mood induction finished their participation in the study in a mood no worse than when they started, the experimental group underwent a final happy mood induction at the end of the experiment. The procedure followed was the same as above using a second Microsoft Powerpoint presentation with happy music. The vignettes presented were the happy vignettes adapted from Mayer et al. (1995). The happy mood induction was followed by final mood manipulation check.

After participation all participants were debriefed in accordance with the procedure agreed by the Ethics Committee.

Data Analysis

For both the Time Discrimination task and the Time Reproduction task it was necessary to reduce the data obtained in order to be able to compare this with the questionnaire data and to be able to compare results from the two tasks.

For the Time Discrimination task this involved non-linear curve fitting of a two parameter logistic to generate estimates of the means and standard deviations of the psychometric functions. A table of the means, standard deviations and variance accounted for is given in the appendices (Appendix VIII). The mean R Square across all subjects was .84. Thus showing that overall the logistic provided a good fit to the data.

In addition to the means and standard deviations of responses on both timing tasks Weber Fractions were calculated (each by dividing the standard deviation by the mean). This measure provides a coefficient of variation according to Weber's law, which summarises the variability of responses (Getty, 1975). The larger the Weber Fraction the more variable the timing performance.

For the Reproduction task it was necessary to find another way of summarising the data in a way that reflected not only the arithmetic mean (which is a point measure that does not reflect differences in the trajectory of a function). Therefore the proportion differences between the reproduced times and the target times were calculated. These were then averaged across target times for each participant to give one measure that captured overestimation or underestimation of the target duration. To calculate a Weber Fraction for the Reproduction task the absolute standard deviation was divided by absolute mean estimates for each duration. These were then averaged across each duration for each participant.

A number of t-tests were used in the analysis, however, care was taken to ensure that the number of similar comparisons used on the same sample did not exceed that which would incur the risk of a Type 1 error being made.

**Results and Discussion**

Upon screening for history of depressive illness one participant reported that she had been prescribed antidepressant medication a fortnight prior to her participation. Her scores on the depression measure were high (47) and her data was removed from the primary analyses although she did take part in the study without the mood induction component. Four other participants scored relatively highly on the BDI (over 19) and they were also removed from potentially being allocated to the mood induction condition and placed in the control group.

Table 1 shows the mean, standard deviations and range of the two groups on age, questionnaire responses and timing performance. The table also shows this information separately for the participants who scored highly (20+) on the BDI-II.

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Insert Table 1 about here

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As can be seen from Table 1 the inclusion of these five subjects (all of whom were female) in the control group would have had the effect of creating a difference between the two groups in terms of mean depression scores. Therefore, in order to

determine whether the mood manipulation was effective it was necessary to remove these high scorers for the purposes of the primary analysis.

Gender and Age Effects

In exploring the data further it was established that the female participants, over and above the high BDI scorers - who were removed from the analysis, generally scored more highly on the depression measure than the males (significant at $t = -2.64$ (42), $p > 0.05$). Males' mean score was 5.25 ($SD = 3.32$), females' was 8.71 ($SD = 4.59$). However, there were no significant differences between males and females responses on the BHS hopelessness measure.

There were also gender differences for the impulsivity measure. Males scored more highly on the functional impulsivity measure than females ($t = 2.53$ (42), $p < 0.05$) although the sexes did not differ in their dysfunctional impulsivity scores.

There were no significant differences between the sexes on the timing performances or on the ZTPI factors with the exception of a difference between the genders on the measure of Past Positive. The males scored a mean of 27.44 ($SD = 2.25$) and females 29.46 ($SD = 3.49$). This difference was significant ($t = -2.08$ (42), $p < 0.05$).

Although these differences were noted, because the genders were evenly distributed between the experimental and control conditions, they were not held to be confounding and, therefore, no further action was taken regarding gender.

Age was also noted to be negatively correlated with functional impulsivity ($r$ =-.304, $p < 0.05$). This relationship between functional impulsivity and age was also reported by Brunas-Wagstaff et al. (1997) who adapted the scale for children, who commented that Functional impulsivity "may only emerge as a consistent trait as children get older" (Brunas-Wagstaff et al., 1997, p.22).

Between Groups Comparisons

The primary analysis was the between groups comparison of induced sad mood compared with no mood induction. This required comparison of the two groups to check the effectiveness of the mood manipulation.

***Mood Manipulation check***

With the high depression scorers removed (N remaining for experimental group = 24; control group = 21) there was no difference between the two groups' ratings of mood at the start of the experiment (experimental group mean = 5.33, range = 12 [-2 to 10], $SD$ = 2.83; control group mean = 6.04, range = 14 [-5 to 9], SD = 2.91; $t$ = -.82 (43), $p > 0.05$). A repeated measures analysis of variance (Anova) was conducted for the four points in time (before and after the sad mood induction and before and after the happy mood induction). This failed to show any significant main effect, that is, difference between the mood induced and control groups ($F$ = 0.49 (1), $p$ = 0.49). However, there was a significant interaction between the group and the time ($F$ = 36.26 (3), $p < 0.01$). This revealed that, while the control group's mood ratings remained stable, the mood induced group first showed a reduction in mood ratings (i.e. their mood was lowered) then (at time three after the timing tasks and the ZTPI) showed a return to baseline mood, then (after the happy mood induction) showed increased positive

mood. This confirms that the mood induction was effective, but that there was a decay in this effect over the time taken to complete the timing tasks and ZTPI. Moreover, the use of a happy mood induction following the sad mood induction resulted in the experimental group finishing the experiment with higher positive mood ratings than the control group.

No significant order effects were found for any of the conditions therefore the data from the four conditions was combined into the two groups; experimental and control.

***Experimental Timing Tasks***

It was predicted that differences would be found between the timing performance of the experimental and control groups. Specifically, it was expected that those who had received the sad mood induction might show less accurate timing performance than those who had not.

The Time Discrimination Task. Figure 1 shows the functions produced by the experimental and control groups.

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Insert Figure 1 about here

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Upon visual inspection the function produced across control participants appears to be slightly steeper than that produced across experimental participants. Given that the flatter the function the less discriminating the responses, this indicates slightly poorer timing on the part of those in whom low mood was induced. This was explored

further with comparison of the mean scores, standard deviations and Weber Fractions for the two groups.

Figure 2 shows bar chart comparisons of the mean scores, standard deviations and Weber Fractions for the Time Discrimination task.

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Insert Figure 2 about here

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T-tests were performed on the three comparisons shown in Figure 2. There is a shift in the mean estimate in line with the predicted direction, but this is not significant. Indeed, counter to the experimental hypothesis, none of these measures showed a significant difference between the mood induction and control groups indicating that performance on the Time Discrimination task did not alter as a result of the induction of negative mood.

The Time Reproduction Task. Figure 3 shows the plots of the functions of the mean differences for the Time Reproduction task for the Experimental and Control groups.

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Insert Figure 3 about here

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As can be seen from the graph, the trajectory of the two functions appears to differ with the mood induction condition producing a slightly flatter function than the

control condition indicating slightly poorer timing by participants in the experimental group. Again, as with the responses on the Discrimination task, the mean differences, standard deviation of the differences and the Weber Fractions for the Reproduction task were compared. Figure 4 shows the bar charts of these measures.

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Insert Figure 4 about here

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Figure 4 shows that there was a trend in the predicted direction for all three measures of the Reproduction task. T-tests showed that the differences between the two groups were not significant for the mean difference scores and the Weber Fractions, but there was a significant difference between the groups' mean standard deviations as shown in the middle panel of Figure 4 ($t = 2.05$ (42), $p < 0.05$). This indicates that, as predicted, there was some alteration in the Time Reproduction task performance as a result of the induction of negative mood, although this was seen in only one of the three types of measurement of performance on this task.

The predicted differences between the groups in terms of disturbances of timing performance as a result of the induction of a mild sad mood (Hypothesis 1) were not found in most instances. The fact that a difference between the groups was only shown on one of the two timing tasks may be accounted for by the fact that the Time Discrimination task was a retrospective pair comparison in which the order of presentation was counterbalanced which may inadvertently have cancelled out any directional bias that was present. It has also been argued that prospective time estimation is a more accurate measure than retrospective (remembered duration)

(Block, 1990) and as such the Reproduction task may have been generally more sensitive. Despite this, the non-significant trend in the predicted direction and the difference in the error distribution between the groups on the Time Reproduction task indicates that timing judgement performance relating to durations of milliseconds does show slight disruption as a result of the induction of a mild sad mood.

***Between Group Comparisons of Responses on the Zimbardo Time Perspective Inventory***

The ZTPI was administered after the sad mood induction and the timing tasks in order to see if responses on this time perspective measure would be affected by the mood induction. Participants' responses from the two groups differed significantly for only one of the five factors of the inventory: that of Past Negative ($t = 2.19$, df = 42, $p < 0.05$). However, this difference was in the opposite direction (the mean for the control group was significantly higher than that of the mood induction group) than was expected on the presumption that inducing a sad mood may prompt memories of past negative events and could, if anything, be expected to increase scores on the Past Negative dimension of TP. This difference between the experimental and control groups could indicate an unexpected effect of the mood manipulation (to decrease Past Negative scores) or it could be that the decay in the induced negative mood resulted in the experimental manipulation being ineffective in relation to the ZTPI. The latter interpretation would also explain why no other ZTPI factor showed a difference between the groups despite the prediction that differences might be expected. For example, on the basis of previous literature concerning the importance of a Future TP (e.g., Lennings, 1994), it might be expected that participants' scores on

the Future TP dimension would differ according to whether they had received the sad mood induction. This result was not found.

Correlational Analyses

In addition to the primary analyses, the potential relatedness of the questionnaire responses to timing performance was examined using Pearson's product moment correlations and visual inspection of scatterplots. At this stage the data from the two groups was combined. The potential problem with taking this course of action is that any differences between the two groups as a result of the mood induction are ignored and are potentially confounding. However, it was felt that the relatively small number of participants did not allow for separate analyses of the two sets of data. The data from the participants who had scored highly on the depression measure were also added back in for the correlational analyses. This was done on the basis that this was necessary to include all participants to examine any relationships between timing, time perspective and naturally occurring low mood. A correlation matrix of all measures is given at Appendix IX.

***Relatedness of Performance on the Two Timing Tasks***

Prior to examining timing performance and responses on the questionnaires, correlations between the measures of the two timing tasks were examined. Although there was no relationship between the mean scores on the Time Discrimination task and the Time Reproduction task, there were significant correlations between the Standard Deviations ($r = .45, p < 0.001$) and the Weber Fractions ($r = .53, p < 0.001$) on both tasks. This result shows that individuals who performed accurately in one task also performed accurately in the other. This finding provides some confirmation that

performance on the two tasks is related in that people show a related degree of variation in their performances on the two tasks. This is consistent with previous research demonstrating that people's timing performance is relatively consistent across different tasks and judgement methods (Brown, 1998).

***Relationship between timing performance and ZTPI responses***

In relation to the third experimental hypothesis the Pearson's product moment correlations show that, somewhat surprisingly, there was no relationship between participants' scores on the ZTPI and their performance on either of the timing tasks. This result was surprising in the light of the findings in previous research literature (Dillung & Rabin, 1967; Neuringer & Harris, 1974; Wyrick & Wyrick, 1977). On the basis of this literature it had been predicted that there would be some relationship between time perspective (as measured by the ZTPI) and timing performance, yet this was not found. However, this result is consistent with that previously reported by Lennings and Burns (1998) who also reported a lack of association between TP and time estimation using earlier measures of TP. The absence of any relationship between timing performance and time perspective calls into question whether time perspective is really an expression of time experience or whether the attitudes and behaviours being measured by the ZTPI would be better categorised in some other way.

***Relationship between timing performance and mood***

Performance on the timing tasks was examined in relation to the mood questionnaires. There was no relation between the Time Discrimination task and these measures, but the depression measure (BDI) was significantly related to the Time Reproduction task standard deviation of the differences ($r = .33, p < 0.05$) and the Reproduction Weber

Fraction ($r = .45, p < 0.05$). Similarly the Beck Hopelessness Scale also significantly correlated with the reproduction task standard deviation of the differences ($r = .32, p < 0.05$) and Weber Fraction ($r = .41, p < 0.05$). Moreover, as can be seen in Figure 5, examination of BDI scores plotted against Reproduction task timing performance revealed that there seemed to be some suggestion of a linear relationship between these two sets of scores.

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Insert Figure 5 about here

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Figure 5, shows the Reproduction task Weber Fractions plotted against participants' BDI-II scores. It appears from Figure 5 that there is the suggestion of a linear relationship between this measure of timing performance and depression, as measured by the BDI-II. This relationship is not evident from the data of the participants from both groups whose BDI-II scores fell within the range of 0 to 19, but it is suggested from the data from those who were removed from the initial analysis who scored 20+ on the BDI-II. Although this result must be interpreted with caution given the very small number of participants whose performance indicates the relationship, this finding would be consistent with the idea that timing performance, measured using durations of milliseconds, varies in depressed mood in the way that has previously been found with durations of seconds and minutes (e.g., Dillung & Rabin, 1967; Kuhs et al., 1991; Mundt et al., 1998; Neuringer & Harris, 1974; Wyrick & Wyrick, 1977; Tysk, 1984).

***Relationship between timing performance and impulsivity.***

There was no significant relationship between the timing task performance measures and the scores on the impulsivity measure. This result appears to contradict indications from research on children with ADHD which had suggested that impulsivity is related to time estimation (e.g., Sonuga-Barke et al., 1998). However, it is consistent with the attempt by Lennings and Burns (1998) to compare time estimation, TP and impulsivity, which also found no relationship between impulsivity and time estimation.

***Relationship between ZTPI responses and mood measures***

There were significant relationships found between the mood measures and responses on the ZTPI. Depression, as measured by the BDI, correlated with the Past Negative dimension of the ZTPI ($r = .69, p < 0.001$). This result was similar to the correlation reported by Zimbardo and Boyd (1999) and is what would be expected on the basis of the general relationship between negative life events, negative thought bias and depression (e.g., Beck & Hollon, 1979; MacLeod, Williams & Linehan, 1992).

Depression was positively correlated with Present Fatalistic TP ($r = .44, p < 0.05$). This association was similar to that found by Zimbardo and Boyd (1999). Brier-Williford & Bramlett (1995) did not report this association between depression and the Present Fatalistic dimension of TP, however, their use of an early version of the TP measure may account for this difference in results.

Depression was, as expected on the basis of the previous work (e.g., Lennings, 1992; 1994), negatively correlated with the Future time perspective dimension ($r = -.41, p <$

0.05). The correlation between Future TP and depression is slightly higher than that obtained by Zimbardo and Boyd (1999) and Brier-Williford and Bramlett (1995) who reported correlations of $r$ = -.24 and r = -.31 respectively. Both of these studies used an earlier version of Beck's depression measure (Beck et al., 1961). This may account for the difference between the previous findings and the result reported here.

Hopelessness, measured by the BHS, showed a similar pattern of relatedness to the time perspective measure as depression. Scores on the BHS were positively correlated with scores on the Past Negative dimension of the ZTPI ($r$ = .63, $p <$ 0.001) and the Present Fatalistic dimension ($r$ = .44, $p <$ 0.05). They were also negatively correlated with scores on the Future time perspective dimension ($r$ = -.39, $p <$ 0.05). The correlation between BHS scores and Future TP was similar to that obtained in the study reported by Brier-Williford and Bramlett (1995).

***Relationship between the mood and impulsivity measures.***

The BDI correlated highly with the BHS ($r$ = .81, $p <$ 0.001). This is what would be expected on the basis of the theoretical proximity of depression and hopelessness. There was also a relationship between depression and both functional impulsivity ($r$ = -.46, $p <$ 0.05) and dysfunctional impulsivity ($r$ = .39, $p <$ 0.05). Similarly, the BHS correlated moderately with both impulsivity scales: negatively with functional impulsivity ($r$ = -.35, $p <$ 0.05) and positively with dysfunctional impulsivity ($r$ = .39, $p <$ 0.05).

***Relationship between ZTPI responses and impulsivity***

The two types of impulsivity as defined and measured within the Dickman Impulsivity Scale (adapted for children) were significantly related to several aspects of the time perspective inventory. Scores on the Functional impulsivity scale correlated with scores on the Present Hedonistic dimension of the ZTPI ($r = .33, p < 0.05$). They also correlated negatively with scores on the Past Negative dimension of the ZTPI ($r = -.33, p < 0.05$).

Dysfunctional Impulsivity correlated positively with both of the dimensions of the ZTPI reflecting orientation to the present: Present Hedonistic ($r = .35, p < 0.05$); Present Fatalistic ($r = .56, p < 0.001$). The relatedness of these dimensions is consistent given that there are similarities between the characteristics that these dimensions are proposed to reflect (hedonistic, risk-taking 'devil may care' versus fatalistic and helpless) whilst the two sub-scales can still be seen to reflect different attitudes.

Dysfunctional impulsivity also correlated positively with Past Negative dimension of the ZTPI ($r = .36, p < 0.05$) in contrast to the negative relationship seen between Functional Impulsivity and this time perspective dimension. The relationship of both types of impulsivity and Past Negative was consistent with the report by Lennings (1994) that impulsivity was associated with a negative view of the past.

There was also a negative correlation between Dysfunctional Impulsivity and scores on the Future dimension of the ZTPI ($r = -.52, p < 0.001$). This negative association of dysfunctional impulsivity and Future TP is theoretically consistent given that dysfunctional impulsivity, by definition, involves a lack of planning for the future

(Dickman, 1990). Lennings and Burns (1998) had previously not found any association between impulsivity and Future TP, which they commented on as unexpected. However, their impulsivity measure did not separate out functional from dysfunctional impulsivity and this difference in measures may account for the difference in results.

Overall the associations between the ZTPI and on the mood and impulsivity measures supported the final hypothesis. The correlational analyses did reveal a pattern of associations which was largely as expected. These showed that in depression people tend to view the past negatively, to feel helpless about the present and to have problems orienting to the future.

**General Discussion**

The results reported here indicate that the timing performance of adolescents, in whom sad mood was induced, was only slightly less accurate than the performance of control participants. This result differs from the findings of previous investigators whose research has demonstrated comparatively large affects attributable to either depressed mood or hopelessness (e.g., Dillung & Rabin, 1967; Kuhs et al., 1991; Mundt et al., 1998; Neuringer & Harris, 1974; Wyrick & Wyrick, 1977; Tysk, 1984). However, the existence of even a slight difference between the two groups is not consistent with the rejection of the idea that objectively measured timing is affected by negative mood as proposed by Hawkins et al., (1988). The magnitude of the affect shown, which was relatively small, could be due to the short durations used. Other studies which have shown a greater affect have used longer durations. For example, in

the study by Neuringer and Harris (1974) suicidal patients produced significantly longer estimates of elapsed time over durations of 30 seconds and 300 seconds and Kuhs et al. (1991) used intervals of between 10 and 30 seconds. If the length of duration is important it would indicate that mood affects timespans differentially with inaccuracies in timing only coming to light over longer periods of time with durations of seconds or minutes. Alternatively, it could be due to the temporary and inevitably mild nature of the induced sad mood. Bech (1975), Blewett (1992) and Kitamura and Kumar (1982) have all suggested that disturbances in time perception are associated with levels of severity of depressed or hopeless mood. If this is the case then it is unsurprising that the affects found here in a normal adolescent population are not as evident as those found previously using clinical samples.

In order to address the question of whether disturbed time perception is associated more with enduring or naturally occurring moods as opposed to temporarily induced low mood, comparisons were made with responses on the mood questionnaires. It had been predicted that there would be an association between scores on the BDI-II, the BHS and timing performance. There were some indications that naturally occurring low mood was related to poorer timing performance, but this was shown on the Time Reproduction task only.

Given that timing performance was only slightly affected by the mood induction, but did seem to be related overall to low mood, it is likely that altered perception of time happens more when low mood is a medium to long term trait than a moment-to-moment state. Although the number of participants on whose responses this observation was made was too small to draw any firm conclusions, this finding would be consistent with previous research using clinical samples in which timing performance has been found to vary in depressed mood (e.g., Dillung & Rabin, 1967;

Kuhs et al., 1991; Mundt et al., 1998; Neuringer & Harris, 1974; Wyrick & Wyrick, 1977; Tysk, 1984). It is also consistent with the fact that the other study mentioned here which used induced negative mood in a normal population, that by Hawkins et al. (1988), did not report altered estimates of time. Further research could explore the association between depressed mood and timing performance variability by comparison of a clinically depressed population and a non-depressed control group using similar durations to those reported in the present study in order to confirm or reject the notion of this association.

The hypothesis that differences would be found between the experimental and control groups' responses on the Zimbardo Time Perspective Inventory, was not supported. Overall, this result was not shown and the only difference that was found between the groups (on the Past Negative dimension) was difficult to explain in the light of the predicted affects of the sad mood induction. In considering the pattern of ZTPI results overall (which did not show any difference) it could be concluded that time perspective as measured by the ZTPI is not effected by mood. Alternatively, time perspective may alter only in more enduring mood states. However, given that the ZTPI was always presented at the end of the experimental tasks which took approximately 10 minutes, and that induced mood has generally been found to last between 6-8 minutes (Green & Sedikides, 1999; Sedikides, 1994) it seems likely that at least part of the reason that the mood induction did not have any effect on responses was because of the decay of the induced sad mood.

The lack of any associations between Time Perspective and performance on the timing tasks was unexpected. It was, however, consistent with the result reported by Lennings and Burns (1998). This lack of association between timing and TP calls into question the nature of the attitudes measured by the ZTPI. The absence of any

correlations between the separate dimensions of TP and performance on either of the timing tasks indicates that although, separately, both disturbed timing and the tendency to focus on the present and less on the future may be related to depression, there is no straight-forward way in which these two experiences are connected.

Despite this, the final hypothesis - that responses on the ZTPI and on the mood and impulsivity measures would show some association – was supported, confirming that the ZTPI is measuring constructs of relevance to depressed and hopeless mood. The pattern of association between TP and mood was generally as expected, showing an association between depression and negative views of the past, fatalistic attitudes towards the present and problems orienting to the future. This pattern of association is consistent with the proposition from other investigators that future directed thinking is important in depression and hopelessness (Lennings, 1994; MacLeod et al., 1997; MacLeod et al., 1993) whilst also reflecting the fact that negative cognitions are intrinsic to depression and the development of hopelessness (e.g., Beck & Hollon, 1979; MacLeod et al., 1992). The pattern of correlations is also similar to that found previously by Zimbardo and Boyd (1999). Therefore, whether or not the two facets of time perception which have been discussed here are related, both seem to show some relation to mood and both may be important in different ways.

The study reported here has a number of limitations. The use of a counterbalanced retrospective pair comparison, although an established technique for other types of timing research, may, in hindsight, not have been the most suitable method to employ, particularly as it does not allow comparison with more straightforward time estimation tasks such as used by Hawkins et al. (1988), Tysk (1984), and Wyrick and Wyrick (1977). As mentioned, the design did not allow differentiation of whether the results found were due to the relative weakness of the

induced mood in comparison with more enduring mood states, or whether distortions in timing abilities are less apparent for very short durations. The decay in effects of the mood manipulation may also have hindered comparison of the experimental tasks and questionnaires. This decay in induced mood is similar to that found by other researchers (e.g. Sedikides, 1994). It may have been possible to repeat or prolong the mood induction procedure, but each of the methods of doing so also have disadvantages (e.g. Green & Sedikides, 1999). Finally, some of the conclusions drawn from the findings presented here are inevitably tentative given the small sample size from which these observations were made.

In drawing out implications from these findings for clinical practice not only must the limitations of this particular study been borne in mind, but caution needs to be exercised in interpreting the existing data too far in the light of the lack of theoretical underpinning of the area. Studies of time perception in relation to mood, , are informed by theories of our innate timing abilities and theories of hopelessness and depression – but there is a lack of theoretical understanding of the role of time perception specific to mood and mental health. In the absence of an understanding of why it is that timing is distorted in depressed mood or hopelessness the clinical implications are at best vague. One means of bridging some of this gap would be for further research to include more studies with clinical samples. A repetition of the study reported here using a clinically depressed sample would allow the issues discussed above to be addressed.

Despite these limitations the results provide limited support for the existence of potentially important disturbances in people's time perception in depressed mood.

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**Musical References**

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Chopin, F. (1839/2000) Preludes, Opus 28, (6. B minor) E. Kissin (Pianist). Frieburg, Germany: RCA Red Seal.

Table 1. Means, Standard Deviations and Ranges for all Measures by Group.

| | Mood Induction | | | Control | | | BDI-II >19 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Range | Mean | SD | Range | Mean | SD | Range |
| Age | 14.96 | 1.04 | 3 | 15.05 | 1.24 | 3 | 14.80 | 0.84 | 2 |
| Gender | 7male 17 female | | | 9 male 12 female | | | 5 female | | |
| BDI score | 7.46 | 4.39 | 16 | 8.00 | 5.19 | 19 | 31.40 | 8.79 | 21 |
| BHS score | 3.71 | 2.51 | 11 | 4.14 | 2.56 | 9 | 13.20 | 3.90 | 10 |
| Functional Impulsivity | 6.13 | 2.07 | 7 | 5.86 | 2.43 | 8 | 3.80 | 2.17 | 5 |
| Dysfunctional Impulsivity | 4.54 | 2.50 | 10 | 4.48 | 2.54 | 10 | 7.00 | 2.24 | 6 |
| Past Negative | 24.61 | 5.94 | 21 | 28.43 | 5.60 | 20 | 37.40 | 2.41 | 5 |
| Present Hedonistic | 54.26 | 5.94 | 24 | 52.52 | 6.69 | 24 | 52.40 | 10.64 | 28 |
| Future | 37.35 | 5.17 | 23 | 39.24 | 4.52 | 17 | 32.00 | 4.36 | 10 |
| Past Positive | 28.65 | 3.21 | 14 | 28.81 | 3.31 | 12 | 27.40 | 5.03 | 11 |
| Present Fatalistic | 24.61 | 3.87 | 15 | 24.52 | 5.64 | 23 | 31.20 | 4.49 | 11 |
| Estimation task mean | 468.37 | 40.04 | 145.70 | 449.65 | 44.85 | 163.23 | 427.79 | 73.21 | 187.27 |
| Estimation task SD | 281.07 | 157.69 | 490.16 | 225.65 | 130.69 | 517.18 | 352.16 | 100.42 | 237.84 |
| Estimation task WF | 0.62 | 0.37 | 1.30 | 0.52 | 0.32 | 1.14 | 0.88 | 0.45 | 1.12 |
| Repro. task mean diff. | -0.19 | 0.13 | 0.49 | -0.12 | 0.10 | 0.43 | -0.23 | 0.08 | 0.21 |
| Repro. task SD of diff. | -0.84 | 0.04 | 0.14 | -0.82 | 0.04 | 0.19 | -0.79 | 0.04 | 0.09 |
| Reproduction task WF | 0.20 | 0.04 | 0.14 | 0.21 | 0.05 | 0.20 | 0.28 | 0.02 | 0.06 |

Note: SD = standard deviation. WF = Weber Fraction.

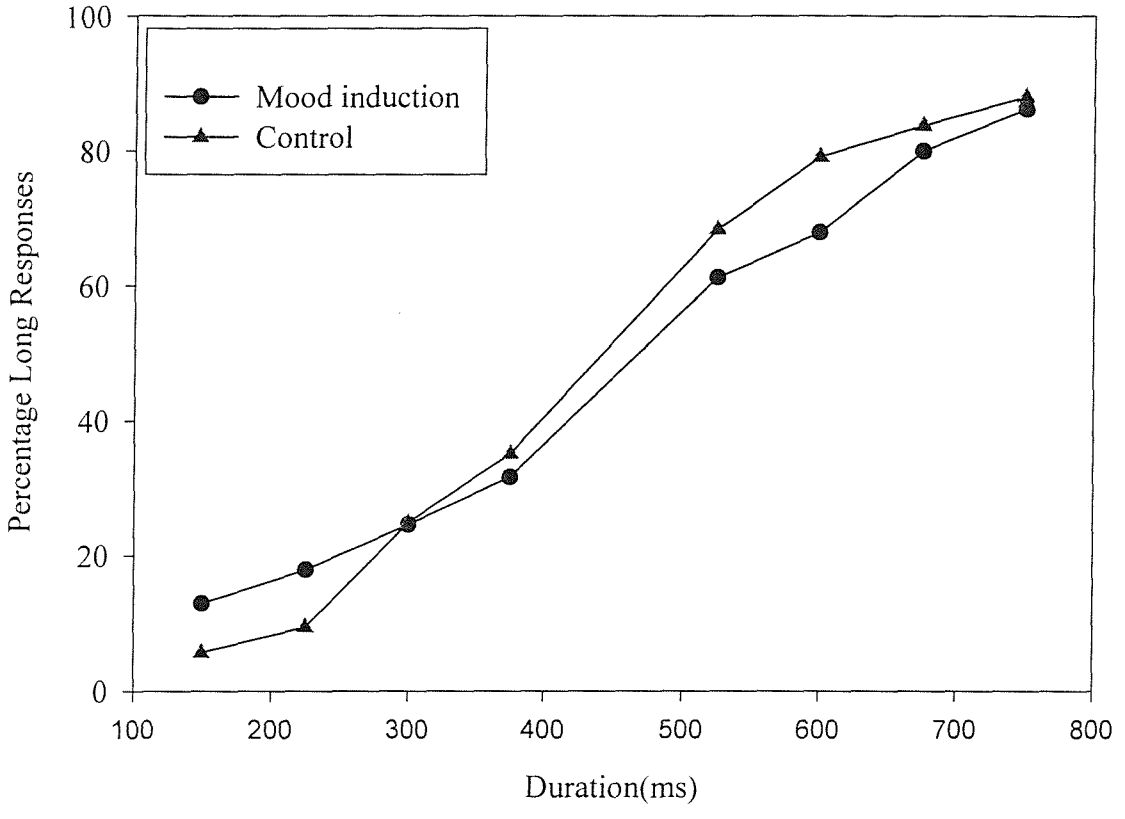



Figure 1. Psychometric functions showing percentage long responses as a function of stimulus duration.

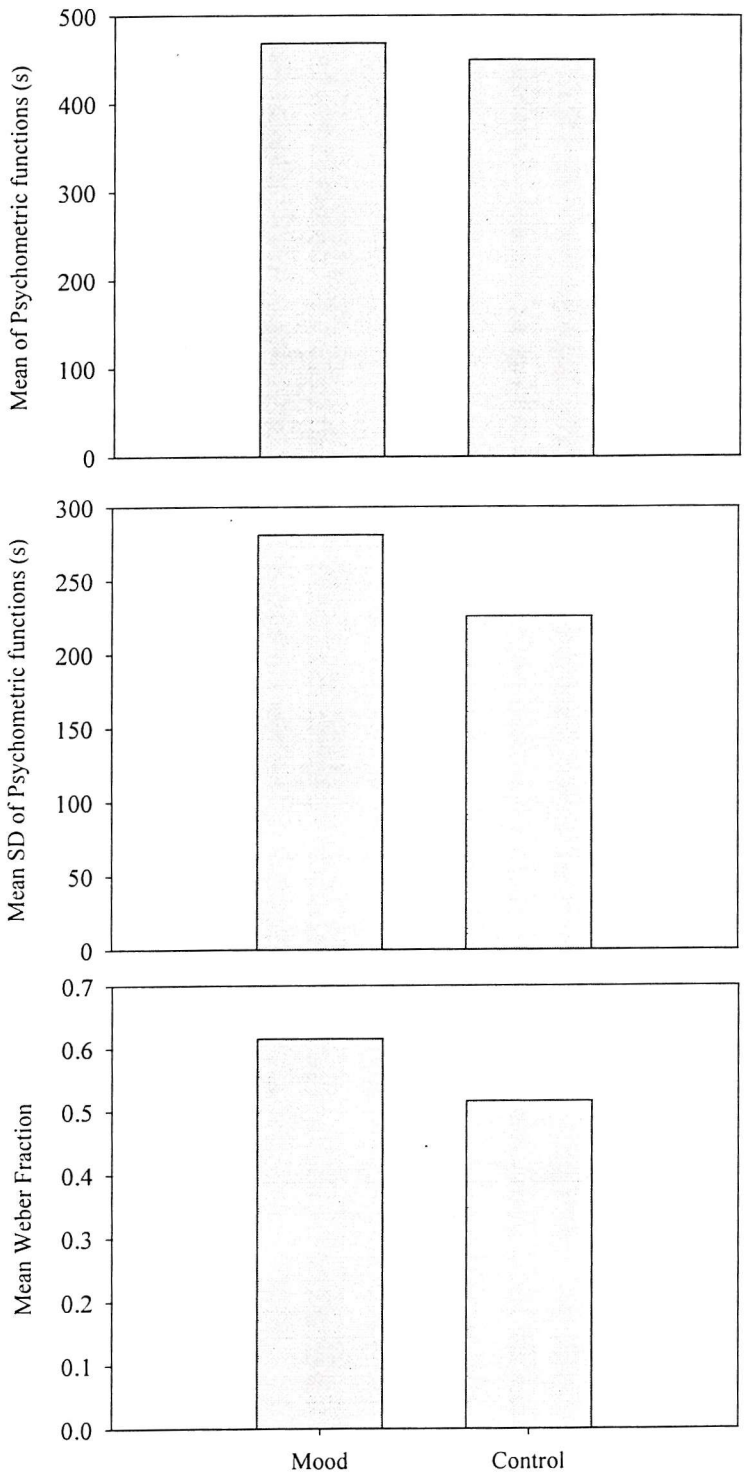



Figure 2. Bar charts to show mood induction and control groups means (top panel), standard deviations (middle panel) and Weber Fractions (bottom panel) for the Discrimination Task.

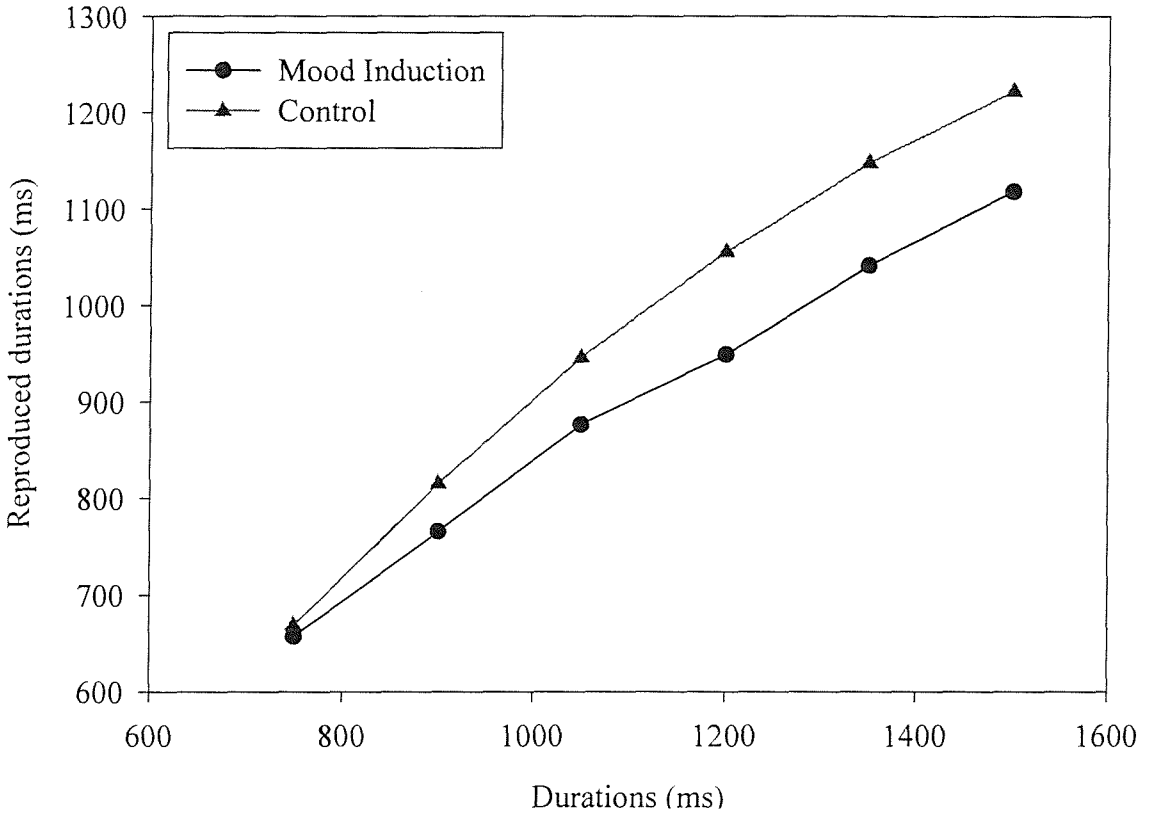



Figure 3. Mean Reproduced duration plotted as a function of target duration.

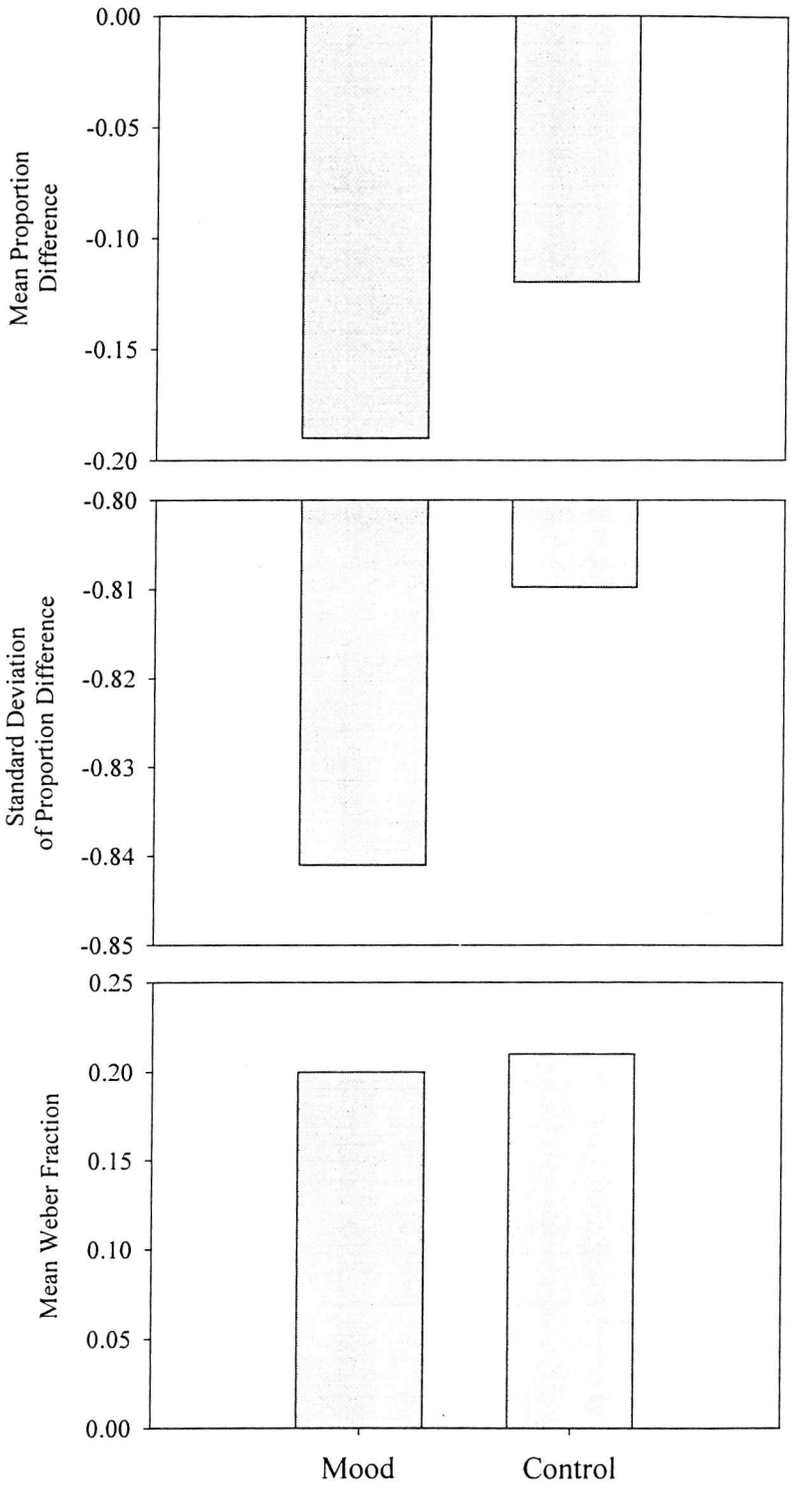



Figure 4. Bar charts showing mood induction and control groups' means, (top panel) standard deviations (middle panel)and mean Weber Fractions (bottom panel) for the Reproduction Task.

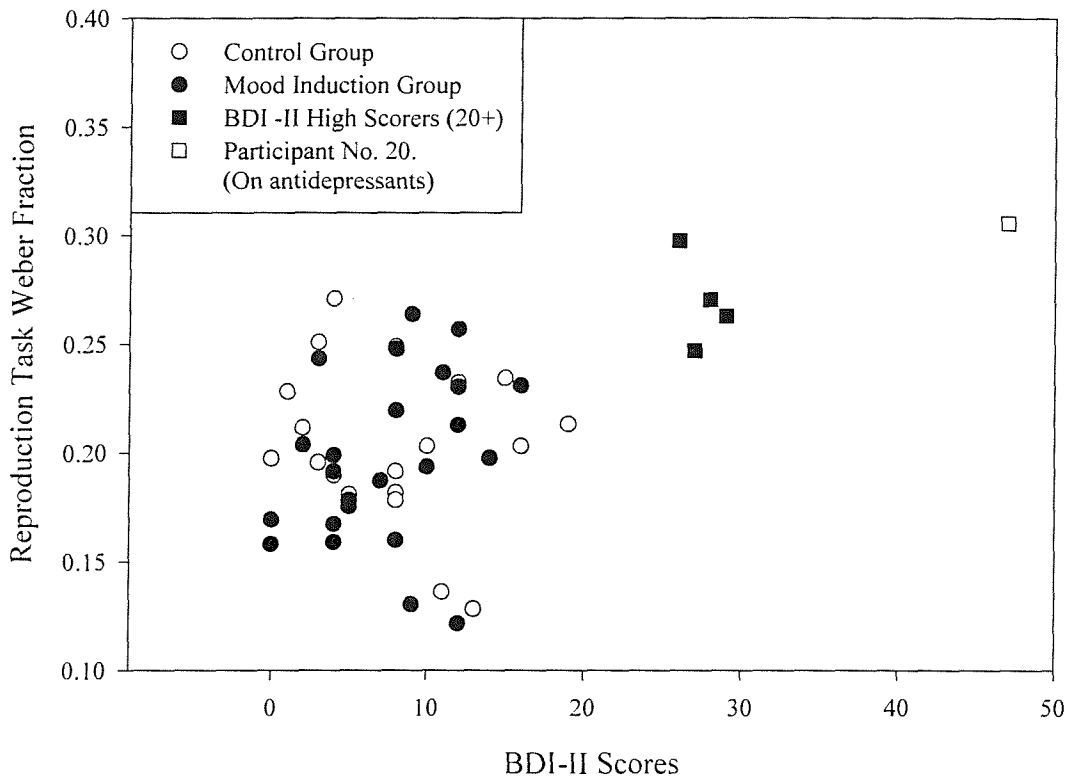



Figure 5. Scatterplot of Weber Fractions for the Reproduction Task plotted Against BDI-II Scores.

## Appendices

Appendix I: Ethical Approval from the University of Southampton

Appendix II: Letter to parents and reply slips (two versions for mixed and single sex schools)

Appendix III: Zimbardo Time Perspective Inventory

Appendix IV: Powerpoint slides showing mood induction vignettes.

Appendix V: Diagram of apparatus

Appendix VI: Instructions to participants as presented via computer screen

Appendix VII: Standardised verbal instructions

Appendix VIII: Table of means, standard deviations and variance for the Time Discrimination task

Appendix IX: Correlation matrix for all measures

Appendix X: Psychonomic Society Publications guidelines for authors

Appendix I: Ethical Approval from the University of Southampton

University of Southampton

Department of Psychology

*University of Southampton*
*Highfield*
*Southampton*
*SO17 1BJ*
*United Kingdom*

*Telephone +44 (0)23 8059 5000*
*Fax +44 (0)23 8059 4597*
*Email*

17th October 2000

Sara Melly
Department of Clinical Psychology
University of Southampton
Highfield
Southampton SO17 1BJ

Dear Sara,

**Re: Application for Ethical Approval**

I am writing to confirm you that your ethical application titled "An investigation of the effect of mood on the perception of time in adolescents", has been given approval by the department.

Should you require any further information, please do not hesitate in contacting me on (023) 80 593995.

Yours sincerely,

Kathryn Smith
Ethical Secretary

Appendix II: Letter to parents and reply slips (two versions for mixed and single sex schools)

University of Southampton

Department of Psychology

Training Course in Clinical Psychology

University of Southampton
Highfield
Southampton
SO17 1BJ
United Kingdom

Telephone +44 (0)23 8059 5321
Fax +44 (0)23 8059 2588
Email

Dear Parent/Guardian,

**A Study of Time Perception in Adolescents**

We are conducting a study investigating the perception of time in young people and are writing to ask if you would give your permission for your son or daughter to participate in this research.

If you agree to your child's participation he or she will be visited during school time by arrangement with your child's Head teacher. Participation will involve listening to some music and using imagery to imagine themselves in different situations (using happy or sad statements, e.g. "No-one remembers your birthday"). If sad statements are used, these will be followed by happy images. The task itself will then be to answer some questionnaires and play a computer-like game that involves estimating time durations.

Participation should take about 30 - 45 minutes in total.

All the information we collect will be kept anonymously and your son/daughter can decide at any time that they wish to discontinue. Please note that we will check at the time that your child feels happy to participate.

If you want to know more about the study we would be pleased to discuss it with you. You can contact Dr Bizo on 023 80 594582.

If you agree to your child's participation in the study then you need take no further action. If you would rather your son or daughter did **not** participate, then please return the attached slip so that we know not to include them.

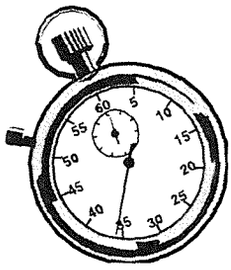
Thank you for your assistance.

Yours sincerely,

Sara Melly,
Trainee Clinical Psychologist
University of Southampton

Dr Tony Brown
Chartered Clinical Psychologist
Training Course in Clinical Psychology
University of Southampton

Dr Lewis Bizo
Academic Supervisor
Department of Psychology
University of Southampton



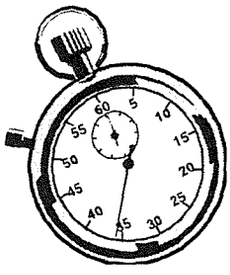
*Reply Slip*

**A Study of Time Perception in Adolescents**

Please exclude my son/daughter .....(Name) in Class.....

from the above study. Signed..... Date .....

Printed Name.....



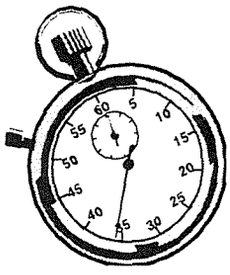
*Reply Slip*

**A Study of Time Perception in Adolescents**

Please exclude my son/daughter .....(Name) in Class.....

from the above study. Signed..... Date .....

Printed Name.....



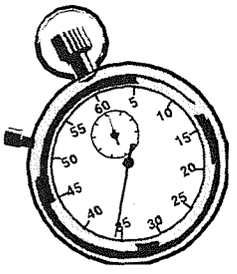
*Reply Slip*

**A Study of Time Perception in Adolescents**

Please exclude my son/daughter .....(Name) in Class.....

from the above study. Signed..... Date .....

Printed Name.....



February 2001

Dear Parent/Guardian,

**A Study of Time Perception in Adolescents**

We are conducting a study investigating some aspects of perception of time in young people and are writing to ask if you would give your permission for your daughter to participate in this research.

If you agree to your child's participation she will be visited during school time by arrangement with your child's Head teacher. Participation will involve answering some questionnaires about mood and playing a computer-like game that involves estimating time durations. Participation should take about 45 minutes in total.

All the information we collect will be kept anonymously and your daughter can decide at any time that she wishes to discontinue. Please note that we will check at the time that your child feels happy to participate. Because we are asking questions about mood there is a slight chance that we may find out that some children are depressed. If there are any problems arising from participation in the study we will of course inform you by letter.

If you want to know more about the study we would be pleased to discuss it with you. You can contact Dr Bizo on 023 80 594582.

If you agree to your child's participation in the study please sign and return the attached postcard. Without this, we cannot ask your daughter to take part.

Thank you for your assistance.

Yours sincerely,

Sara Melly,
Trainee Clinical Psychologist
University of Southampton

Dr Tony Brown
Chartered Clinical Psychologist
Training Course in Clinical Psychology
University of Southampton

Dr Lewis Bizo
Academic Supervisor
Department of Psychology
University of Southampton

## A Study of Time Perception in Adolescents

## PARENTAL CONSENT

I, ....., give my consent for my daughter,

....., Class....., to take part in

the above study that has been described to me by letter.

Signed ..... Date .....


## A Study of Time Perception in Adolescents

## PARENTAL CONSENT

I, ....., give my consent for my daughter,

....., Class....., to take part in

the above study that has been described to me by letter.

Signed ..... Date .....

## A Study of Time Perception in Adolescents

## PARENTAL CONSENT

I, ....., give my consent for my daughter,

....., Class....., to take part in

the above study that has been described to me by letter.

Signed ..... Date .....

Appendix III: Zimbardo Time Perspective Inventory

## Zimbardo Time Perspective Inventory

Subject Number:_____

***Read each item and, as honestly as you can, answer the question: "How characteristic or true is this of you?" Check the appropriate box using the scale. Please answer ALL of the following questions on both sides.***

| | Very Untrue 1 | 2 | Neutral 3 | 4 | Very Tru 5 |
|---|---|---|---|---|---|
| 1. I believe that getting together with one's friends to party is one of life's important pleasures. | | | | | |
| 2. Familiar childhood sights, sounds, smells often bring back a flood of wonderful memories. | | | | | |
| 3. Fate determines much in my life. | | | | | |
| 4. I often think of what I should have done differently in my life. | | | | | |
| 5. My decisions are mostly influenced by people and things around me. | | | | | |
| 6. I believe that a person's day should be planned ahead each morning. | | | | | |
| 7. It gives me pleasure to think about my past. | | | | | |
| 8. I do things impulsively. | | | | | |
| 9. If things don't get done on time, I don't worry about it. | | | | | |
| 10. When I want to achieve something, I set goals and consider specific means for reaching those goals. | | | | | |
| 11. On balance, there is much more good to recall than bad in my past. | | | | | |
| 12. When listening to my favorite music, I often lose all track of time. | | | | | |
| 13. Meeting tomorrow's deadlines and doing other necessary work comes before tonight's play. | | | | | |
| 14. Since whatever will be will be, it doesn't really matter what I do. | | | | | |
| 15. I enjoy stories about how things used to be in the "good old times." | | | | | |
| 16. Painful past experiences keep being replayed in my mind. | | | | | |
| 17. I try to live my life as fully as possible, one day at a time. | | | | | |
| 18. It upsets me to be late for appointments. | | | | | |
| 19. Ideally, I would live each day as if it were my last. | | | | | |
| 20. Happy memories of good times spring readily to mind. | | | | | |
| 21. I meet my obligations to friends and authorities on time. | | | | | |
| 22. I've taken my share of abuse and rejection in the past. | | | | | |
| 23. I make decisions on the spur of the moment. | | | | | |
| 24. I take each day as it is rather than try to plan it out. | | | | | |
| 25. The past has too many unpleasant memories that I prefer not to think about. | | | | | |
| 26. It is important to put excitement in my life. | | | | | |
| 27. I've made mistakes in the past that I wish I could undo. | | | | | |
| 28. I feel that it's more important to enjoy what you're doing than to get work done on time. | | | | | |
| 29. I get nostalgic about my childhood. | | | | | |
| 30. Before making a decision, I weigh the costs against the benefits. | | | | | |

## Zimbardo Time Perspective Inventory

| | Very Untrue 1 | 2 | Neutral 3 | 4 | Very Tru 5 |
|---|---|---|---|---|---|
| 31. Taking risks keeps my life from becoming boring. | | | | | |
| 32. It is more important for me to enjoy life's journey than to focus only on the destination. | | | | | |
| 33. Things rarely work out as I expected. | | | | | |
| 34. It's hard for me to forget unpleasant images of my youth. | | | | | |
| 35. It takes joy out of the process and flow of my activities, if I have to think about goals, outcomes, and products. | | | | | |
| 36. Even when I am enjoying the present, I am drawn back to comparisons with similar past experiences. | | | | | |
| 37. You can't really plan for the future because things change so much. | | | | | |
| 38. My life path is controlled by forces I cannot influence. | | | | | |
| 39. It doesn't make sense to worry about the future, since there is nothing that I can do about it anyway. | | | | | |
| 40. I complete projects on time by making steady progress. | | | | | |
| 41. I find myself tuning out when family members talk about the way things used to be. | | | | | |
| 42. I take risks to put excitement in my life. | | | | | |
| 43. I make lists of things to do. | | | | | |
| 44. I often follow my heart more than my head. | | | | | |
| 45. I am able to resist temptations when I know that there is work to be done. | | | | | |
| 46. I find myself getting swept up in the excitement of the moment. | | | | | |
| 47. Life today is too complicated; I would prefer the simpler life of the past. | | | | | |
| 48. I prefer friends who are spontaneous rather than predictable. | | | | | |
| 49. I like family rituals and traditions that are regularly repeated. | | | | | |
| 50. I think about the bad things that have happened to me in the past. | | | | | |
| 51. I keep working at difficult, uninteresting tasks if they will help me get ahead. | | | | | |
| 52. Spending what I earn on pleasures today is better than saving for tomorrow's security. | | | | | |
| 53. Often luck pays off better than hard work. | | | | | |
| 54. I think about the good things that I have missed out on in my life. | | | | | |
| 55. I like my close relationships to be passionate. | | | | | |
| 56. There will always be time to catch up on my work. | | | | | |

Appendix IV: Powerpoint slides showing mood induction vignettes.

Sad Mood Induction

You read in the newspaper that a teacher you used to house-sit for recently passed away.

You are told by a young relative that she has cancer and only six months to live.

You have been going out with someone and you thought it looked quite promising, when the person calls you up and tells you that he/she doesn't want to see you any more.

A pet you were really fond of has died.

Your best friend's father just changed job and their family is moving far away.

No-one remembers your birthday.

A relative of yours, who you were close to, has been diagnosed as having cancer and only has a short time to live.

A beloved pet dies of old age. You have very fond memories of your pet and are reminded of them every time you see a similar breed.

Happy Mood Induction

You just got a Saturday job that's even better than you expected.

You are out with your mum or dad who buys a lottery ticket and wins £100 instantly.

You and a friend go to a nice restaurant. The meal, the conversation, and the atmosphere are all perfect.

You wake up on a Saturday morning after a number of wintry-cold rainy days, and it is warm and sunny.

School ends early. It's a beautiful day and you and some friends go for an ice cream.

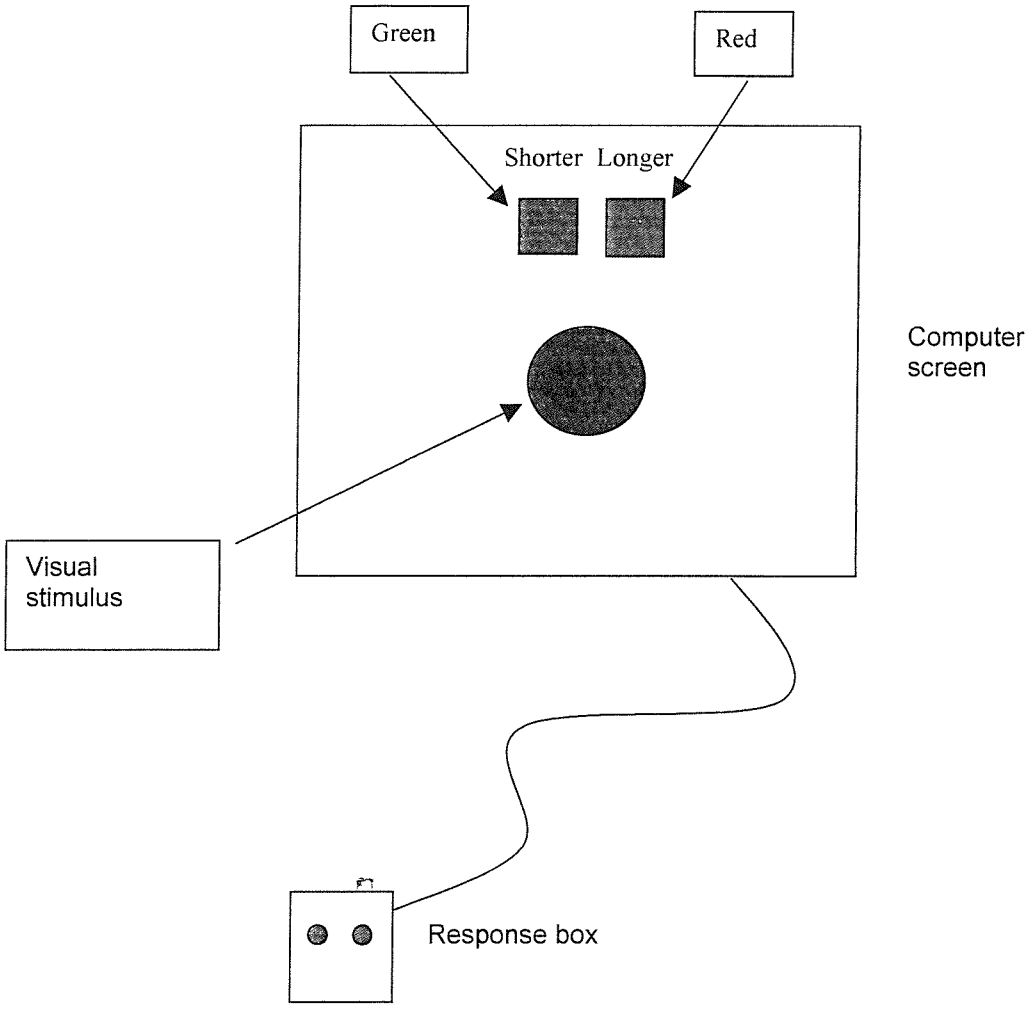
You spend a day in the countryside; the air is clean and sharp, the day sunny, and you take a swim in a beautiful lake.

You unexpectedly run into someone you like. You go for a coffee and have a great conversation. You discover you think alike, and share many of the same interests.

It's your birthday and friends throw you a terrific surprise party.

Appendix V: Diagram of apparatus

## Diagram of Apparatus



Appendix VI: Instructions to participants as presented via computer screen

Instructions for Discrimination Task

Press the black button when you are ready to start. Two circles will then be presented, one after the other.

Your task is to decide if the SECOND circle was presented for a shorter or longer time than the FIRST circle.

If the SECOND circle was shorter, press the GREEN button.

If the SECOND circle was longer, press the RED button.

Do you have any questions about your task?

We are going to start with some practise trials.

Please do not respond until prompted.

Well done. Those were the practise trials. The experimental trials will now begin. Your task is the same as before, but there are more trials this time.

If the SECOND circle was shorter, press the GREEN button.
If the SECOND circle was longer, press the RED button.

This time you will not be told whether you are right or wrong.

Do you have any questions about your task?

Keep going until the programme stops.
Please do not respond until prompted.

Instructions for Reproduction Task

Press the black button when you are ready to start.
One circle will appear on the screen. Your task is to try to produce a second circle for the same length of time by holding down the RED button.

Are you clear what you have to do?

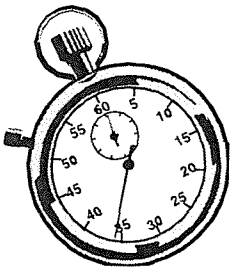
Here are some practise trials.

Good. Those were the practise items, now comes the same task again, but this time you will not be told whether you are right or wrong.

There are more circles this time, but the task is the same. Hold down the RED button to make the second circle appear for as long as the first circle.

Keep going until the programme stops.

# Appendix VII: Standardised verbal instructions



A Study of Time Perception in Adolescents

## Verbal Instructions

I want to explain the experiment I'm doing and then ask you whether you feel happy to take part or not.

This experiment is looking at whether people experience time differently. If you agree to take part it will take about half an hour. I will play some recorded sentences to you while you listen to some music on the computer. Then there are some questionnaires to fill out – which I will help you with - about your mood and how you feel. After that there are two computer tasks about judging time. Then, finally, there are some more recorded sentences and music.

If *at any time* during the experiment you want to stop – for any reason - you can, without having to say why. Nobody will mind if you do.

As you know I sent a letter home to your parents who have agreed to you taking part. Your teachers have also agreed. However, even though your parents and teachers have said you *can* take part, **you do not have to**. It is up to you.

Would you like to take part in this experiment?

**If No** – take back to class.

**If Yes** – O.K. first of all I would like to check a few things. Explain Confidentiality - All the information that you give me will be kept confidential, that is I won't be telling anyone else what you tell me except the other researchers who are working on this study.

- Can I confirm your name and age.
- Do you ever have to take any medicines? What are they for? (Exclude if antidepressants etc.)
- Do you know if you are colour blind?
- How do you feel today? Do you feel O.K. about answering some questionnaires about your mood? **- If No –** return to class; **If Yes –** Continue.

Appendix VIII: Table of means, standard deviations and variance for the Time Discrimination task

Table of Time Discrimination Task Means, Standard Deviations and Variance Accounted For

| Condition | Subject Number | Mean | SD | R square | Stnd Error of Est |
|---|---|---|---|---|---|
| 1 | 3 | 458.65 | 197.51 | 0.91 | 12.73 |
| 1 | 8 | 470.38 | 205.93 | 0.97 | 6.53 |
| 1 | 19 | 431.06 | 200.21 | 0.90 | 12.44 |
| 1 | 24 | 434.30 | 112.72 | 0.96 | 9.83 |
| 1 | 25 | 532.73 | 205.09 | 0.93 | 9.64 |
| 1 | 30 | 433.96 | 225.90 | 0.86 | 13.75 |
| 1 | 10 | 301.39 | 495.89 | 0.51 | 18.66 |
| 1 | 14 | 369.50 | 399.04 | 0.52 | 21.12 |
| 1 | 35 | 372.18 | 180.14 | 0.95 | 8.77 |
| 1 | 9 | 454.08 | 329.90 | 0.90 | 9.11 |
| 1 | 40 | 475.53 | 135.13 | 0.98 | 6.65 |
| 1 | 41 | 439.49 | 146.77 | 0.98 | 5.87 |
| 1 | 46 | 400.90 | 466.04 | 0.58 | 18.79 |
| 2 | 2 | 421.29 | 180.68 | 0.95 | 9.25 |
| 2 | 7 | 435.23 | 267.93 | 0.78 | 17.70 |
| 2 | 23 | 429.37 | 194.95 | 0.91 | 12.14 |
| 2 | 28 | 424.66 | 369.85 | 0.89 | 9.30 |
| 2 | 29 | 467.12 | 394.55 | 0.52 | 23.41 |
| 2 | 34 | 462.66 | 35.87 | 0.96 | 9.50 |
| 2 | 13 | 461.22 | 531.14 | 0.55 | 17.51 |
| 2 | 12 | 531.85 | 156.89 | 0.93 | 10.99 |
| 2 | 17 | 459.59 | 409.01 | 0.78 | 12.31 |
| 2 | 39 | 528.12 | 13.97 | 0.97 | 9.13 |
| 2 | 44 | 426.04 | 146.14 | 0.94 | 11.74 |
| 2 | 45 | 471.70 | 190.03 | 0.95 | 9.01 |
| 2 | 20 | 488.66 | 258.05 | 0.87 | 13.19 |
| 3 | 1 | 450.73 | 572.60 | 0.80 | 8.94 |
| 3 | 6 | 494.54 | 131.60 | 0.97 | 8.30 |
| 3 | 22 | 489.25 | 103.92 | 0.99 | 5.62 |
| 3 | 27 | 461.70 | 123.74 | 0.82 | 19.85 |
| 3 | 33 | 391.94 | 594.08 | 0.50 | 17.25 |
| 3 | 16 | 485.77 | 189.20 | 0.95 | 9.12 |
| 3 | 11 | 400.00 | 349.53 | 0.68 | 18.21 |
| 3 | 18 | 479.62 | 105.47 | 0.96 | 9.44 |
| 3 | 38 | 511.66 | 112.98 | 0.98 | 6.29 |
| 3 | 43 | 515.33 | 213.46 | 0.93 | 9.50 |
| 3 | 50 | 511.66 | 525.16 | 0.68 | 13.38 |
| 4 | 4 | 433.63 | 273.15 | 0.88 | 12.21 |
| 4 | 5 | 537.64 | 147.01 | 0.97 | 6.60 |
| 4 | 21 | 429.45 | 269.81 | 0.81 | 14.78 |
| 4 | 26 | 404.62 | 405.78 | 0.75 | 13.71 |
| 4 | 31 | 497.82 | 231.46 | 0.92 | 10.55 |
| 4 | 15 | 453.72 | 236.49 | 0.92 | 10.11 |
| 4 | 36 | 434.67 | 433.40 | 0.62 | 18.26 |
| 4 | 37 | 525.37 | 550.27 | 0.65 | 13.18 |
| 4 | 42 | 474.97 | 234.45 | 0.78 | 19.25 |
| 4 | 47 | 474.30 | 232.44 | 0.84 | 15.04 |
| 4 | 48 | 455.06 | 182.72 | 0.96 | 8.25 |
| 4 | 49 | 463.07 | 246.00 | 0.77 | 18.65 |
| | | 456.29 | 263.55 | 0.84 | 12.36 |

Appendix IX: Correlation matrix for all measures

Table of Pearson's Product Moment Correlations for Measures of Mood, Impulsivity, Time Perspective and Timing Performance

| | Age | BDI score | BHS score | Functional Impulsivity | Dysfunctional Impulsivity | Past Negative | Present Hedonistic | Future ZTPI | Past Positive | Present Fatalistic | Estimation task mean | Estimation task | Estimation task Weber | Reproduction task mean | Reproduction task | Reproduction task |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Age | 1.000 | .025 | -.088 | -.304* | -.074 | .055 | .082 | .256 | .274 | .138 | .188 | -.249 | -.265 | .030 | -.166 | -.203 |
| BDI score | .025 | 1.000 | .814** | -.464** | .385** | .690** | -.101 | -.405** | -.135 | .424** | -.040 | .101 | .122 | -.092 | .331* | .448** |
| BHS score | -.088 | .814** | 1.000 | -.351* | .385** | .634** | -.176 | -.391** | -.279 | .437** | -.071 | .108 | .149 | -.061 | .320* | .408** |
| Functional Impulsivity score | -.304* | -.464** | -.351* | 1.000 | .036 | -.334* | .328* | -.030 | -.045 | -.145 | -.108 | .001 | .008 | .006 | -.133 | -.173 |
| Dysfunctional Impulsivity | -.074 | .385** | .385** | .036 | 1.000 | .359* | .352* | -.520** | -.226 | .559** | .046 | -.089 | -.090 | -.087 | .047 | .101 |
| Past Negative | .055 | .690** | .634** | -.334* | .359* | 1.000 | .109 | -.249 | .018 | .424** | -.102 | -.056 | -.012 | -.122 | .165 | .267 |
| Present Hedonistic | .082 | -.101 | -.176 | .328* | .352* | .109 | 1.000 | -.129 | .172 | .332* | -.192 | -.016 | .016 | -.239 | -.269 | -.139 |
| Future | .256 | -.405** | -.391** | -.030 | -.520** | -.249 | -.129 | 1.000 | .277 | -.289* | -.123 | .042 | .036 | .106 | .019 | -.056 |
| Past Positive | .274 | -.135 | -.279 | -.045 | -.226 | .018 | .172 | .277 | 1.000 | -.047 | -.259 | .095 | .152 | .042 | .076 | .058 |
| Present Fatalistic | .138 | .424** | .437** | -.145 | .559** | .424** | .332* | -.289* | -.047 | 1.000 | -.214 | .058 | .092 | -.220 | -.008 | .155 |
| Estimation task mean | .188 | -.040 | -.071 | -.108 | .046 | -.102 | -.192 | -.123 | -.259 | -.214 | 1.000 | -.365** | -.558** | .060 | -.187 | -.243 |
| Estimation task standard deviation | -.249 | .101 | .108 | .001 | -.089 | -.056 | -.016 | .042 | .095 | .058 | -.365** | 1.000 | .964** | -.099 | .446** | .536** |
| Estimation task Weber Fraction | -.265 | .122 | .149 | .008 | -.090 | -.012 | .016 | .036 | .152 | .092 | -.558** | .964** | 1.000 | -.083 | .448** | .532** |
| Reproduction task mean difference | .030 | -.092 | -.061 | .006 | -.087 | -.122 | -.239 | .106 | .042 | -.220 | .060 | -.099 | -.083 | 1.000 | .406** | -.202 |
| Reproduction task standard deviation of diff. | -.166 | .331* | .320* | -.133 | .047 | .165 | -.269 | .019 | .076 | -.008 | -.187 | .446** | .448** | .406** | 1.000 | .805** |
| Reproduction task Weber Fraction | -.203 | .448** | .408** | -.173 | .101 | .267 | -.139 | -.056 | .058 | .155 | -.243 | .536** | .532** | -.202 | .805** | 1.000 |

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Appendix X: Psychonomic Society Publications guidelines for authors

# Psychonomic Society Publications
# GUIDELINES FOR AUTHORS

## General Information

**Journals**: *Animal Learning & Behavior*; *Behavior Research Methods, Instruments, & Computers*; *Cognitive, Affective, & Behavioral Neuroscience*; *Memory & Cognition*; *Perception & Psychophysics*; *Psychonomic Bulletin & Review*.

**Submissions**: Submissions should be sent to the Editor of the relevant journal. In general, only printed copies should be submitted to the appropriate editor. Note, however, that submission procedures vary among the journals. For specific requirements and addresses, see the inside cover of the journal or www. psychonomic.org/editors.htm. Package manuscripts with care (in a padded envelope, if possible), especially if the package must cross any borders.

**Manuscript Format**: Manuscripts should, in general, adhere to the conventions described in the *Publication Manual of the American Psychological Association* (4th ed.), except in the abbreviation of physical units, for which the style of the American Institute of Physics is followed. When in doubt, consult a recent issue of a Psychonomic Society journal. See also the Psychonomic Society Publications Guidelines for References (available at www.psychonomic.org/ref.htm).

**Printed Manuscript**: The printed manuscript, including the abstract, references, and notes, should be double-spaced *throughout* ($2\frac{1}{2}$–3 lines per inch), with $1\frac{1}{2}$-in. margins.

In addition to the main text, manuscripts (both hard copy and disk) should include: TITLE PAGE—with (a) title, author name(s) and affiliation(s), (b) mailing address, telephone number, and e-mail address of the author contact, and (c) a suggested running head; ABSTRACT of 100–150 words; AUTHOR'S NOTE; list of FIGURE CAPTIONS; REFERENCES—complete and correct (with all journal names written out); NOTE(S)—if needed; TABLE(S)—if needed; APPENDIX(ES) and LISTING(S)—if needed. Approximate locations of the figures should be noted within the text (e.g. "Figure 1 about here"). These sections should be on separate pages, and the pages should be numbered consecutively from the abstract on. *The figures should also be on separate pages.*

Brief Reports for *Psychonomic Bulletin & Review* are restricted to a maximum of 4,000 words of text, excluding title page, abstract, references, figures, and tables. Authors of Brief Reports should be sparing with regard to figures and/or tables.

**Permissions**: It is the author's responsibility to determine from the copyright owner whether or not permission is required for quoting text or for reproducing or adapting all or part of a table or figure from a copyrighted source. Authors must obtain any necessary written permission and enclose a copy with the submitted or revised manuscript.

**Proof**: A copy of the edited manuscript will not be included when proof is sent to the author. It is therefore incumbent upon the author to read and mark the proof *carefully*. Please use a pen to mark proof, print all comments clearly, and always include a mark in the margin next to the change.

**Reprints**: Reprints should be ordered when the proof is returned to the Publications Office. Institutional purchase orders can follow later, but the *number* of reprints desired should be indicated when the proof is returned.

For general questions regarding publication, call or e-mail the Publications Office at (512) 462-2442; cinnamon@psychonomic.org or jbellquist@psychonomic.org. For questions regarding computer disks and figures, see below.

## Computer Disks

After a manuscript has been conditionally accepted and a revision requested, authors must also submit a disk containing the text that **agrees exactly** with the latest printed revision sent to the editor. These are to be sent either to the journal editor or to the Publications Office, according to requirements of each journal. If any further changes or additions are to be made, please send to the

Publications Office a letter that lists the further changes, or, if the changes are extensive, a revised disk and a revised printed version of the manuscript with the changes indicated.

**Disk Label** — Indicate the following on the disk label:

(1) Disk type: PC or Macintosh.
(2) Software used and version number.
(3) Document name, and whether graphics (figures) are included.
(4) Our production number, if known; if not, the editor's manuscript number (if neither is known, use first author's surname).

**Disk Contents** — On the disk itself, include the following:

(1) **An ASCII document** of the manuscript. From this document, all printing/formatting commands other than paragraph breaks will have been deleted. This is especially important if you work in TEX or LATEX. (Note: Many word processing programs define ASCII as "text only"; e.g., in Microsoft Word, simply save the document as "text only.").
(2) **A "normal" text document.** This includes the hidden printing/formatting commands (e.g., for running heads, page numbers, italics, etc.) that produce the printed version of the manuscript.
(3) **Graphics.** Please provide documents for all figures and illustrations composed on computers, in addition to camera-ready versions (see "Figures"). Formats such as TIFF, EPS, PICT, and JPEG are usually compatible. Documents created in Macintosh Photoshop, Illustrator, Microsoft Word, and QuarkXpress are the most reliable.

Please call or e-mail the Publications Office if you have questions regarding typesetting or computer disks (512-462-2442; dgrenier@psychonomic.org).

## TABLES

The *Publication Manual of the American Psychological Association* (4th ed., pages 120–141) gives excellent instructions for constructing tables. The following will emphasize areas that are particularly important and will explain Psychonomic journal departures from APA style.

**General:** Make sure the table is necessary. Small tables with few entries can often be dealt with just as effectively in a line or two of text. Do not combine two tables of dissimilar format into one table (e.g., if sections A and B of Table 1 are not of similar format, section A should be Table 1 and section B, Table 2). However, do combine small tables of identical format with few entries (i.e., provide one table with, say, four columns and four rows, one for each experiment, rather than four tables of four columns and one row giving data for each of four experiments).

Keep the material as simple and straightforward as possible. Double-space all tables for easy editing and typesetting. Number all tables in the order in which they are mentioned in the text. Make sure all tables are mentioned in the text.

**Table Arrangement:** Instead of a column of 0.00±.00 entries, use two columns with separate appropriate headings (e.g., *M* and *SE* or *SD*). Arrange tables so that similar numbers fall into separate columns. That is, if possible, do not mix, in one column, such numbers as 0000, 00.00, .0000.

Avoid unnecessary repetitions throughout the table. Columns with the same numerical entries throughout the table or throughout sections of the table can be put in footnotes (e.g., "In Condition 1, $n = 20$ for each group; in Condition 2, $n = 30$ for each group"). Units of measurement can simply be abbreviated in headings—"RTs (in msec)"— or explained in footnotes ("RTs are given in milliseconds").

**Other Requirements:** Define all measurements used for values in the table (e.g., "Thresholds are given in decibels"). Define (or avoid using) all abbreviations. Do not use material in tables that should normally be placed in figures (e.g., graphic objects, photographic reproductions).

Define, in the table footnotes, all asterisks, daggers, and other symbols used. General footnotes (denoted by "Note—...") qualify, explain, or provide information relating to the table as a whole or to a major section of the table (e.g., a column or a group of columns). Specific footnotes (denoted by *, †, ‡, §, ||, #, **, etc.) relate to individual entries or give probability levels. Do not use aster-

isks, daggers, and other symbols to denote anything other than footnotes pertaining to particular entries in the body of the table. Psychonomic journals do not normally use superscripted footnotes (raised a, b, c, etc.) in tables.

All major words of table titles and column headings should be capitalized. Column headings refer *only* to entries in the column(s) below them. A column heading may *never* refer to other column headings to its right across the top of the table.

Do not print a table in a visible "cellular" format: Vertical rules are *never* used in Psychonomic journals; horizontal rules are never used within the body of the table.

## FIGURES

**All figures should be supplied in printed form.** They should be original prints (*not* a photocopy), preferably from a high-quality printer and on high-quality glossy stock. Each should be clear, sharp, and in focus. An additional set of photocopied figures would be helpful.

Figures should be sized at 100% and be no wider than 19 picas ($3^1/_6$ in.) to fit into a single column, or between 26 picas ($4^1/_3$ in.) and 39 picas ($6^1/_2$ in.) for a double-column space. Figures similar in configuration should be similar in size. Optimal size for letters and numerals is 10 point (font size), and fonts in a single figure should vary by no more than four points. Use Helvetica or Helvetica Bold, or a similar typeface that is downloadable or will scan cleanly.

**Each figure should be clearly identified on the back by figure number and author's name**, with the top of each figure clearly indicated. A list of figure captions should be included on a separate sheet, not on the figure itself.

**Digital Figures:** Figures created in or imported to Macintosh versions of **Photoshop**, **Illustrator**, **Microsoft Word**, and **QuarkXpress** are most readily compatible with Psychonomic production facilities, and will yield the highest quality reproduction. However, digital figures saved in a cross-platform format (e.g., TIFF, EPS, PICT, or JPEG) can usually be captured. TIFF- and EPS-formatted graphics should be saved with a high-resolution header or preview, if available. When possible, graphics should be submitted as separate files in their original applications. As a general rule, database and spreadsheet software such as Excel do not offer graphics formats such as these, and should be avoided.

Figures should be created at a resolution of at least 600 pixels/inch. This is especially important for photographs and other figures that include halftone information such as grayscale patterns or gradients. They should be submitted on standard $3^1/_2$ in. or ZIP100 disks.

With rare exceptions, Psychonomic journal figures are printed in black and white. Digital figures prepared in color should be converted to black and white or grayscale before submission. Be sure to check any converted color figures for clarity and contrast before you submit them.

**Scanned Figures:** If figures are not submitted digitally, or if we are unable to capture them digitally, the camera-ready art will be scanned. Line art can be scanned easily, but lines and symbols should be proportionately the same weight, without breaks in solid lines. When contrasting fills are required (e.g., in bar graphs or symbol identification), use fills with distinct lines or wide dot patterns. Do not use fills of similar shades of gray.

Refer to the *Publication Manual of the American Psychology Association* (4th ed., pp. 141–163) for additional guidelines on the preparation of figures.

If any changes are to be made in a figure, a new, corrected version must be submitted to the Publications Office.

Please call or e-mail the Publications Office if you have questions regarding figures (512-462-2442; molly@psychonomic.org).