State of art

The ability to estimate the passage of time is a key element involved in most daily activities, in fact, good temporal skills are essential for daily activities such as crossing a busy street, preparing a meal, or organizing the day's schedule. Although this topic has attracted many researchers and a great deal of evidence has been provided on the cognitive and neural bases of this ability, the exact way in which humans evaluate time is still a matter of debate. One of the most influential models of time processing, the Scalar Expectancy Theory (SET), supports the single mechanism hypothesis. In its more general form, this model assumes that individuals encode sub- and supra-second durations by means of a specialised mechanism, the so-called ‘internal clock’ (Treisman, 1963; Gibbon, 1977; Gibbon, Church, & Meck, 1984). Such a mechanism is multicomponential and acts by means of a three-stage process: a clock stage, a memory stage and a decision stage. The clock counts time through a pacemaker and an accumulator. The pacemaker (an oscillator) emits pulses at a certain rate, and the accumulator integrates these pulses. The flow of pulses from the pacemaker to the accumulator is regulated by a switch, which closes at the beginning of the interval which is to be timed. In the memory stage, the accumulated pulses are compared to previously learned durations which have been recorded in a long-term store, i.e. the reference memory, by means of a working memory process (Fortin & Rousseau, 1998; Ulrich, Nitschke, & Rammsayer, 2006). A decision regarding the duration of a particular interval is then made on the basis of the comparison between the actual duration and the duration stored in the reference memory. According to this model, distortions in estimated durations may originate from alterations in the rate of the pacemaker or from an altered latency period in the opening and closing of the switch.

Most studies have been dedicated to identify the properties of the internal clock and which variables might influence the speed of the pacemaker. However, others cognitive and environmental factors may influence time perception. The present project is aimed to further investigate time perception dedicating particular attention to the internal and external factors that influence the perception of temporal intervals. In particular, the present project is aimed to investigate the memory component (study 1) and the effect of the symbolic meaning of the stimuli presented on time perception (study 2).
Research program

Study 1

As previously introduced the Scalar Expectancy Theory (SET) is one of the most influential models of time processing. It is composed by three-stage processes: a clock stage, a memory stage and a decision stage. Most of the researches on time perception have been dedicated to investigate the operation of the internal clock and which factors operate at the clock stage. However, non-temporal factors, such as attention, may affect such mechanisms (Block & Zakay, 1996; Burle & Casini, 2001; Macar, Grondin, & Casini, 1994). In general, the higher the level of attention, the more promptly the switch will close. It is surprising that very little attention has been dedicated to the memory component considering the critical limitations associated with this component. Therefore, this project is aimed to further investigate the involvement of memory component on temporal processing.

Grondin (2005) investigates the memory component involvement in the processing of brief temporal interval by imposing multiple timing requirements. The results revealed that using two base durations, with intervals presented in a random order from trial to trial increases the number of discrimination errors, compared with the results obtained in sessions in which single-base duration was used. Moreover, the results showed that memory can process signals from different sensory modalities without having an impairing effect on temporal accuracy. More recently Gamache and Grondin (2010) further investigated the capacities of the clock and the memory separately with a time reproduction task either with visual and auditory stimuli. Moreover, a variable delay was introduced between the end of the target intervals and the beginning of the reproduction. Surprising the results showed higher performance when two overlapping intervals with different durations have to be reproduced when the two durations were the two modalities were the same (Auditory-Auditory and Visual-Visual compare to the mixed condition Auditory-Visual). Moreover, results showed more variance when only visual markers intervals were presented.

Objectives

The first part of this project is dedicated to further investigate the clock and memory components by comparing different tasks, durations and modalities. Previous studies have pointed out that each temporal task highlight different temporal characteristics and required different cognitive resources. Comparing different methodologies we can further investigate the clock and memory component. The memory component is also investigated by manipulating the delay between separating the presentation of the target and the temporal execution and by manipulating the duration of the temporal intervals.
I also investigate if the over-reproduction observed in Gamache & Grondin 2010 was caused by the overlapping of two temporal intervals, as proposed by the authors or by others factors. to this end I compare the conditions in which the secondary task was encoding a second duration or a non-temporal task (i.e. asking participants to say ‘la-la-la-la...’).

**Methodology**

Participants will be recruited and tested at Laboratoire de Recherche en Psychologie de la Perception de l’Université Laval. Twenty university students will be included in the study and the order of presentation will be at counterbalance according to the Latin square.

4 conditions :

1 – Only auditory stimuli
-2 blocks of 25 auditory trials. Durations: 500, 600, 700, 800, 900 ms

2 - Only visual stimuli
-2 blocks of 25 auditory trials. Durations: 500, 600, 700, 800, 900 ms

3- Auditory-Visual simultaneously
-2 blocks of 25 auditory trials. Durations: 500, 600, 700, 800, 900 ms
Auditory and visual stimuli will be presented simultaneously and participants will be asked to reproduce the duration of the auditory stimulus presented.

4 – Visual – Auditory simultaneously
-2 blocks of 25 auditory trials. Durations: 500, 600, 700, 800, 900 ms
Auditory and visual stimuli will be presented simultaneously and participants will be asked to reproduce the duration of the visual stimulus presented.

**Stimuli:**
Visual stimuli: black square 5 x 5 cm presented on a grey background
Auditory stimuli: 440Hz sinusoidal sounds presented binaurally through headphones, with an intensity of 70 dB SPL.

**Study 2**

Most of the studies conducted on time perception are laboratory researches; however, our activities are conducted in uncontrolled environment. The importance to investigate different
variables that could influence our temporal experience has theoretical and practical implications. For example how the symbolic meaning of the object we perceive in everyday life influence time perception is the primary aim of the second part of the present project. In particular, which is the symbolic meaning that we assigned to the imagines and how this symbolic meaning may influence temporal perception? How participants perceive movement and how watching vehicle moving affect participants time perception? Studies conducted with children have shown that younger participants generally under-reproduced the duration and that the magnitude of their under-reproduction is higher when the stimulus was a car (symbolic meaning of fastness) compare with the stimulus of truck (symbolic meaning of slowness). Limitation of these results is the size of the stimuli employed (see Figure 1), in fact the car and the truck had different size (both in real life situation and in the experiment) and this might have affected the results.

**Figure 1.** Stimuli included in the study (A) Car; (B) Truck.

**Objectives**

Aim of the second project is to further investigate the effect of symbolic meaning on time perception by employing different stimuli: bicycle and motorbike. These new stimuli can solve the problem of visual dimension observed in the previous study conducted (see Figure 2). To further investigate the effect of symbolic meaning on time perception the stimuli are either move (from one side to the other side of the computer screen) or be static (displayed at the centre of the computer screen).

**Figure 2.** Stimuli included in the study (A) bicycle; (B) motorbike.
We predict an effect of duration in the way that longer duration would be under-reproduced more than briefer one. We predict that observing a stimulus that recall the meaning of speed affects participant’s performance in the way that stimuli that recall the meaning of fastness will be under-reproduced and stimuli that recall the meaning of slowness will be over-reproduced. Data collected in this study will be discussed according to the Attentional-gate model. According to the Attentional-gate model duration judgments are strictly related to the amount of attention a person allocates to temporal information but also to the arousal level which influences the rate of the pacemaker (Zakay & Block, 1996; Block et al., 1999). The meaning of the stimulus presented could acts on different stages of the temporal process and different predictions could be made if the effect of meaning acts on the pacemaker or on the attentional gate. If the meaning of the stimulus act on the pacemaker, when a stimulus that recall the meaning of slowness is presented, speed rate should decrease; while, when a stimulus that recall the meaning of fastness is presented the speed rate should increase. If this is the case the stimulus “motorbike” (fastness) should be over-reproduced compared to the stimulus “bicycle” (slowness). However, if the meaning of the stimulus presented acts on the attentional gate, when a stimulus that recall the meaning of slowness is presented, the duration is perceived longer; while, when a stimulus that recall the meaning of fastness is presented the duration is perceived briefer. If this is the case, the stimulus “motorbike” should be under-reproduced compare to the stimulus “bicycle”.

Methodology

Thirty university students will be included in this study. Participants will be recruited and tested at Laboratoire de Recherche en Psychologie de la Perception de l’Université Laval. Time reproduction task is employed in this study. In the time reproduction tasks, participants experience a target duration and are subsequently required to reproduce that duration (Block et al., 1999). Three target durations will be employed: 11, 21 and 36 sec. Stimuli will be presented in two conditions: moving and static. In the moving condition the stimuli will move from one corner to the opposite corner of the computer screen, while in the static condition the stimuli will be presented at the centre of the computer screen. After the presentation of the target duration participants will be required to reproduce the duration of the target stimulus.
References


