Journal of Experimental Child Psychology 161 (2017) 148–160

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

High levels of time contraction in young children in dual tasks are related to their limited attention capacities

Quentin Hallez, Sylvie Droit-Volet *

Université Clermont Auvergne, Centre National de la Recherche Scientifique (CNRS), 63037 Clermont-Ferrand, France

ARTICLE INFO

Article history:
Received 6 October 2016
Revised 6 April 2017
Available online 18 May 2017

Keywords:
Timing
Time perception
Children
Attention
Dual task
Neuropsychology

ABSTRACT

Numerous studies have shown that durations are judged shorter in a dual-task condition than in a simple-task condition. The resource-based theory of time perception suggests that this is due to the processing of temporal information, which is a demanding cognitive task that consumes limited attention resources. Our study investigated whether this time contraction in a dual-task condition is greater in younger children and, if so, whether this is specifically related to their limited attention capacities. Children aged 5–7 years were given a temporal reproduction task in a simple-task condition and a dual-task condition. In addition, different neuropsychological tests were used to assess not only their attention capacities but also their capacities in terms of working memory and information processing speed. The results showed a shortening of perceived time in the dual task compared with the simple task, and this increased as age decreased. The extent of this shortening effect was directly linked to younger children's limited attentional capacities; the lower their attentional capacities, the greater the time contraction. This study demonstrated that children's errors in time judgments are linked to their cognitive capacities rather than to capacities that are specific to time.

* Corresponding author.
E-mail address: sylvie.droit-volet@uca.fr (S. Droit-Volet).

http://dx.doi.org/10.1016/j.jecp.2017.04.013
0022-0965/

Introduction

During recent decades, many researchers have spent much time demonstrating that humans, like all animals, possess an internal clock system that allows them to accurately measure time. However, humans often experience a dilatation or a contraction of time, with time being judged longer or shorter than it really is. Among the factors responsible for these time distortions, one can mention the attention allocated to the processing of time (Nobre & Coull, 2010). Time is indeed judged shorter when our attention is distracted away from the passage of time.

The contraction of time as a function of attention has been widely studied in human adults by means of the dual-task paradigm (for a meta-analysis, see Block, Hancock, & Zakay, 2010). In the dual-task paradigm, participants need to judge the duration of a stimulus while they perform a secondary non-temporal task. The non-temporal task has taken the form of a memory task (e.g., Champagne & Fortin, 2008; Fortin & Breton, 1995; Fortin, Rousseau, Bourque, & Kirouac, 1993), a Stroop task (Brown & Perreault, 2017; Zakay & Fallach, 1984), and another specific task (e.g., Casini & Macar, 1997, 1999; Coull, 2004; Fortin & Rousseau, 1998; Grondin & Macar, 1992; Hicks, Miller, & Kinsbourne, 1976; Kladopoulos, Hemmes, & Brown, 2004; Macar, Grondin, & Casini, 1994). Whatever the non-temporal task used, the results systematically show that the stimulus duration is judged shorter in the dual task than in the simple task when participants need only to judge time.

The resource-based theory of time perception suggests that this is linked to the processing of temporal information, which is a demanding cognitive task that consumes limited attention resources (Block et al., 2010; Brown, 1997; Thomas & Weaver, 1975; Zakay, 1989, 1992, 1993). According to the internal clock models (Gibbon, 1977; Gibbon, Church, & Meck, 1984; Treisman, 1963), the raw material for the representation of time consists of a number of pulses that are emitted by a pacemaker and transferred into an accumulator via an attention-controlled switch that closes at the beginning and opens at the end of the stimulus to be timed. Temporal shortening, thus, would result from a loss of temporal units (pulses) that underlie the representation of time. Lejeune (1998) explained this loss of pulses in terms of an attentional switch that would close early when the participant needs to perform a second task and/or would flicker more often between the onset and offset positions. This latter proposal is consistent with the idea of a succession of alternating attention phases between the non-temporal and temporal tasks. However, this explanation in terms of an "all-or-nothing" switch mechanism does not take into account the performance in a dual task when there is a continuous "sharing" of attention resources between two tasks rather than "a single excursion away from the timing of a duration while a non-temporal task is carried out" (Wearden, 2016, p. 90). Indeed, the judgment of time in a dual task also depends on the degree of attention allocated to temporal information. Thus, in their attentional gate model, Zakay and Block (1996, 1998) extended the clock system to include an attentional gate that controls the quantity of attentional resources allocated to time processing. The opening of the attentional gate, thus, would be smaller in the dual-task condition than in the single-temporal-task condition, thereby limiting the number of pulses passing into the accumulator.

Regardless of the way in which these authors conceive of attention (e.g., switch, gate), all of them consider that the time contraction in the dual task would occur at an early stage of temporal processing, namely during the online accumulation of pulses. However, other authors place the source of this time distortion at a later stage, at the level of memory, when temporal information (pulses) is maintained, or rehearsed, in short-term memory in order to make temporal decisions or temporal predictions (for discussions, see Fortin & Schweickert, 2016; Ivry & Schlerf, 2008; Taatgen, Van Rijn, & Anderson, 2007). For example, Fortin et al. (1993) showed that the accuracy of temporal reproduction decreased as the short-term memory requirements of concurrent tasks increased, and they concluded that the interference of the non-temporal task on temporal processing "may not be a matter of non-specific general purpose attentional resources, but rather of concurrent short-term memory processing demands" (p. 536). Several studies have indeed found a shortening of estimated durations as the retention interval in memory increases (e.g., Church, 1980; Rattat & Droit-Volet, 2010; Grant & Spetch, 1993). This is also explained by a loss of pulses during the reten-