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A further analysis of time bisection behavior in children with and without reference memory: The similarity and the partition task

Sylvie Droit-Volet [a,*], Anne-Claire Rattat [b]

[a] *Laboratoire de Psychologie Sociale et Cognitive, CNRS (UMR 6024), Blaise Pascal University, 34 avenue Carnot, 63037 Clermont-Ferrand Cedex, France*
[b] *J.-F. Champollion University, Albi, France*

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Abstract

Experiment 1 compared the temporal performance of 5-year-olds, 8-year-olds and adults in a bisection task with and without referent durations (similarity vs. partition). The results showed that temporal sensitivity was lower in the partition than in the similarity condition in children, whereas it was similar in these two conditions in the adults. In addition, the 5-year-olds produced a higher bisection point value in the partition than in the similarity task. Experiment 2, which examined changes in bisection performance over the trial blocks in the partition task, revealed that the 5-year-olds' bisection performance improved over the trial blocks, whereas the performance of the older participants did not. Further analyses revealed a greater variability in the establishment of the duration criterion in young children.

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1. Introduction

Although time is a fundamental dimension of life, we have up to now possessed little knowledge about the way children of different ages judge time. During the last few years,

* Corresponding author. Tel.: +47 3 406463; fax: +47 3 406482.
E-mail address: Sylvie.Droit@srvpsy.univ-bpclermont.fr (S. Droit-Volet).

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researchers have therefore commenced a systematic study of temporal behavior in children on the basis of temporal discrimination tasks initially used with animals and then with human adults (e.g., Clément & Droit-Volet, 2006; Droit-Volet & Wearden, 2001, 2002; McCormack, Brown, Maylor, Darby, & Green, 1999; McCormack, Brown, Smith, & Brock, 2004; Roitman, Brannon, & Platt, in press). One of the tasks used is the temporal bisection task (Church & Deluty, 1977). In the prototypical version of this task (i.e., similarity bisection), participants are familiarized with two referent stimulus durations, one short (S) and the other long (L). They are then required to judge whether a probe duration t ($S \leqslant t \leqslant L$) is more similar to the short ("short response") or to the long referent duration ("long response"). Since the referent durations are not available during the test trials, it is assumed that referent durations are stored and maintained in long-term memory. The final temporal judgment is thus governed by the comparison of the probe duration with the representation of these referent durations in memory.

In the similarity bisection task, the temporal behavior of children as young as 3 years conforms to the scalar properties of perceived time found in animals and human adults (Droit-Volet & Clément, 2005; Droit-Volet & Wearden, 2001, 2002; McCormack et al., 1999). They produce orderly psychophysical functions with a proportion of long responses (t identified as more similar to L than to S) that increase with the value of the probe duration (mean accuracy). Furthermore, the coefficient of variation of perceived time is approximately constant across different duration ranges (scalar variability). These data suggest that the basic internal clock mechanism used to estimate time, which is common to both animals and human adults, is functional at an early age (Brannon, Roussel, Meck, & Woldorff, 2004; Droit-Volet, Delgado, & Rattat, 2005). However, beyond the across-age group similarities, there are also differences in temporal bisection performance in children and adults. In particular, the Weber ratio, which acts as an index of the steepness of the bisection function, is larger in 3- and 5-year-olds than in 8-year-olds, the age at which it is close to that obtained in human adults, although some differences may still appear in certain situations (e.g., Droit-Volet, Clément, & Fayol, 2003; Droit-Volet, Tourret, & Wearden, 2004; McCormack et al., 1999). A larger Weber ratio indicates lower temporal sensitivity. Consequently, young children have a lower sensitivity to time in the similarity bisection task. The main purpose of this study was thus to clarify the sources of young children's lower temporal sensitivity in the bisection task.

The scalar timing based models used to simulate bisection data have provided an excellent account of the temporal behavior obtained in human adults as well as in animals (Allan & Gibbon, 1991; Gibbon, 1981; Penney, Gibbon, & Meck, 2000; Wearden, 1991). According to these models, the perceived duration is processed accurately and the most sensitive parameter controlling the slope of the bisection functions is the variability in the memory for referent durations which is produced by the storage process itself (Meck, 1983, 1996; Meck & Angell, 1992). In these models, the referent durations are represented in memory in the form of a Gaussian distribution of values with means equal to the values of the referent durations, and some coefficient of variation, c. The greater the coefficient of variation of these memory distributions is, the flatter the bisection function will be (Allan & Gibbon, 1991; Gibbon, 1981; Wearden, 1991). Using the scalar timing based models of bisection, Droit-Volet and her colleagues subsequently found that young children's flatter bisection functions are related to a greater c value, i.e. a greater variability in the representation of referent durations in memory (Droit-Volet et al., 2004; Droit-Volet & Wearden, 2001; Rattat & Droit-Volet, 2001, 2005). Indeed, the less precise the memory representation