Journal of Economic Behavior and Organization 153 (2018) 143–152

Contents lists available at ScienceDirect

Journal of Economic Behavior and Organization

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

Age-induced acceleration of time: Implications for intertemporal choice☆

Derek Lemoine

Department of Economics, University of Arizona, McClelland Hall 401, 1130 E Helen St, Tucson, AZ 85721-0108, USA

ARTICLE INFO

Article history:
Received 22 July 2017
Revised 21 April 2018
Accepted 5 July 2018

JEL classification:
A12
C91
D91

Keywords:
Age
Discounting
Dynamic consistency
Hyperbolic
Intertemporal choice
Preference reversals
Time

ABSTRACT

Our perception of time is both nonlinear and nonstationary, which makes preference reversals possible. I decompose the sources of dynamic inconsistency into a time acceleration effect and a time compression effect. Standard economic models focus only on the second effect. I show that when the perceived flow of time accelerates with age, the two effects can offset each other for hyperbolic discounters but not for exponential discounters. Such hyperbolic discounters would report discount rates that seem to imply dynamic inconsistency but would nonetheless manifest dynamic consistency in actual choices over time.

1. Introduction

When as a child I laughed and wept,
Time crept.
When as a youth I waxed more bold,
Time strolled.
When I became a full grown man,
Time ran.
When older still I daily grew,
Time flew.
Soon I shall find, in passing on,
Time gone.
O Christ! wilt Thou have saved me then?
Amen.

"Time's Paces", Henry Twells (1901)

☆ I thank George Ainslie, Martin Dufwenberg, Asaf Plan, and participants at the 2016 Southwest Economic Theory Conference for helpful comments.
E-mail address: dlemoine@email.arizona.edu

https://doi.org/10.1016/j.jebo.2018.07.002
0167-2681/

People dislike waiting. This preference makes them discount future utility payoffs. The intensity of the distaste for waiting depends on how long the wait feels. Waiting three months for a vacation feels like an eternity to a child but trivial to an adult. We therefore may expect the child to discount the pleasure of the vacation more strongly. The intensity of the distaste for an additional period of waiting also changes with the duration of the wait. Waiting three additional months for a vacation feels less painful when one is already planning to wait a year rather than a week. We therefore may expect our self a year from now to discount the pleasure of the vacation more strongly over those same three additional months. Psychologists discuss both of these effects, but economists have primarily focused on the latter, as "hyperbolic" discounting.[1] In particular, hyperbolic discounters are said to be marked by dynamic inconsistency: they may be more willing to defer the vacation by three months if you ask them a year ahead of time than if you ask them a week ahead of time.[2] I extend economic analyses of discounting to allow for both aspects of time perception. I show that accounting for the effects of aging can reverse standard intuition about which types of agents are dynamically inconsistent.

I introduce psychological models of the subjective acceleration of time with age to the economics literature and formally explore their implications for discounting and dynamic consistency. Ever since the foundations of the modern field (James, 1890), psychologists have been interested in how the subjective perception of time changes with age.[3] Folk wisdom, reflected in the opening verse, holds that time passes more quickly as we age. Psychologists have proposed that the subjective length of an interval of actual (or clock) time is inversely proportional either to the amount of actual time one has lived (Doob, 1971; Janet, 1877) or to the accumulated subjective time one has lived, which works out to being inversely proportional to the square root of actual time lived (Lemlich, 1975). Some have proposed a biological basis for the effect of aging: for example, dopamine appears to speed up the body's internal clock, and dopamine production falls with age, so it is conceivable that our internal clock slows with age and thereby makes time appear to pass faster (Tien and Burnes, 2002). Other channels include age-related reductions in basal metabolism or brain temperature (Block et al., 1998).[4] A body of experimental evidence using survey measures such as recall of past intervals and using physical measures such as response times has supported the notion that time speeds as we age (e.g., Carrasco et al., 2001; Craik and Hay, 1999; Crawley and Pring, 2000; Joubert, 1990; Walker, 1977; Wittmann and Lehnhoff, 2005).[5]

Economists have devoted many experiments and much analysis to how time discounting changes with delay, but the discipline has mostly ignored how the perception of time changes with age.[6] Yet both should be important for discounting. I adapt standard psychological models for mapping clock time into subjective time, which an agent may then discount according to her distaste for delay. First, I show that psychological models of aging imply that agents become more patient as they age.[7] This result is consistent with much empirical evidence (Chu et al., 2010; Green et al., 1994; Read and Read, 2004; Rogers, 1994; Tanaka et al., 2010), though Meier and Sprenger (2015) report contrary results. Second, I explore the implications for intertemporal choice when agents are either naive or fully sophisticated about how aging affects their perception of time. Naive agents assume that time will always pass as rapidly as it does at the present moment, whereas sophisticated agents recognize that time will pass more rapidly in the future.[8]

I show that fully sophisticated agents are dynamically consistent if and only if they are exponential discounters, but naive agents are dynamically consistent only if they either discount hyperbolically or do not discount at all. Approaching closer to a future interval of time increases the discount rate that a hyperbolic discounter applies to the interval, which I call a "time compression effect". This change in the discount rate makes the hyperbolic discounter less willing to defer that interval's utility as she draws closer to it, which generates dynamic inconsistency in the standard model. However, as

[1] For reviews of the evidence in favor of hyperbolic discounting, see Ainslie and Haslam (1992) and Frederick et al. (2002). Much additional work has occurred since then. For contrary perspectives, see Rubinstein (2003) and Andreoni and Sprenger (2012). I will focus on discount rates that decline at all horizons rather than on present-biased preferences as in Laibson (1997) and O'Donoghue and Rabin (1999).

[2] The implication of dynamic inconsistency has long been a focal point of the economics literature (Laibson, 1997; Pollak, 1968; Strotz, 1955).

[3] "The same space of time seems shorter as we grow older—that is, the days, the months, and the years do so; whether the hours do so is doubtful, and the minutes and seconds to all appearance remain about the same." James (1890, Chapter XV)

[4] Another channel for the effect of aging is that we become more integrated with our future selves as we age. People with a stronger sense of self-continuity do tend to have smaller discount rates and greater savings (Ersner-Hershfield et al., 2009). Mitchell et al. (2011) provide a neurological basis for the relationship between self-reference and discounting, and Parfit (1984) provides a philosophical basis.

[5] Some suggest that these studies may actually be capturing the effects of time pressure (Friedman and Janssen, 2010; Janssen et al., 2013) or intensity of experience (Fraisse, 1984) rather than age per se. Droit-Volet and Wearden (2015) find that arousal more strongly affects perception of time's rate of passage than does age, though they also report evidence that people do in fact think time passes faster as they age. Block et al. (1998) suggest that time might actually slow for the more elderly. They interpret this effect in terms of the attentional resources devoted to the assigned task of estimating time intervals.

[6] Only a few economists have recognized the potential importance of accounting for the evolution of our subjective perception of time (McFadden, 2013; Samuelson, 1976; Wolf, 1970). Heal (1998, p. 106) briefly makes a point related to this paper's when he discusses logarithmic discounting. In complementary work, Aadland and Shaffer (2015) study the implications for savings decisions of time compression that changes with age, both endogenously and exogenously. They restrict attention to agents who discount exponentially and note the potential for dynamic inconsistency. I here study the implications for dynamic consistency of more general forms of time perception and discounting.

[7] I abstract from mortality risks, which can make agents less patient as they age (e.g., Yaari, 1965). Introducing mortality risks into the present setting would generate a U-shaped time profile for the mortality-adjusted discount rate. This type of profile is consistent with evidence in Read and Read (2004). Halevy (2008) shows that hyperbolic-like preferences and dynamic inconsistency can both emerge from a setting with constant mortality risk if the decision-maker does not behave according to expected utility.

[8] This distinction between naivete and sophistication mirrors a distinction common in the literature on hyperbolic and present-biased preferences (Laibson, 1997; O'Donoghue and Rabin, 1999).