Back and forth tin time? Exploring the effect of direction of time

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Abstract

Human beings are always performing tasks under time pressure. In this research we question whether the direction in which the time is monitored during such tasks has an impact on the perceptions and behaviours of people performing those tasks. Through three studies, we infer that downward (upward) time-keeping results in a higher (lower) preference for calorie-rich foods, and higher (lower) risk-aversion and lower (higher) helping intentions. It is also found that resource deficiency induced by the direction of time-keeping is compensated for in a domain-general manner by seeking or saving resources in other domains, such as calories, money, and effort. This effect is attenuated by recalling instances of resourcefulness. Related alternate explanations are addressed. We contribute to the extant research by eliciting and explaining the consequences of the otherwise mundane activity of time-keeping.

Keywords: direction of time-keeping, resource deficiency, time scarcity

Introduction

Despite technological and economic advances, time is an increasingly scarce resource (Caroll, 2008). Individuals are often in situations where they have limited time to perform tasks (deadlines, grocery shopping, exercise, online payment windows), must wait for a task to be completed (software downloads, waiting in a queue) or must wait for an event to occur (product launch, sports events, flash sales). All such situations require keeping time, and this can be performed in two ways: upwards, in which the time is tracked in a forward-moving direction and the emphasis is on time elapsed (waiting in a queue, routine time-keeping, etc.), or downwards, in which time is tracked in a backward-moving direction and the emphasis is on the time remaining (software downloads, product launch countdowns, etc.). While upward time-keeping is the norm, many consumption situations, such as online payment windows (in which payment must be done in a finite time), online streaming of videos and songs (in which the bottom panel on the screen shows the time left in the video/song), flash-sale launches (sale begins in 59 minutes…), waiting time in tele-calling services (call will be answered in two minutes…), online games, etc., display time in a downward direction. There are also tasks in non-consumption contexts in which individuals are exposed to a downward time-keeping direction, such as workouts (running for 20 minutes using a countdown timer), specific time-management techniques (such as the Pomodoro clock, which uses a clock running backwards; Nöteberg, 2009), performance of tasks (number of push-ups in a minute), online professional consultations, or exams (GMAT).

The preference for a particular direction of time-keeping seems arbitrary, and there is no a-priori understanding of whether mere exposure to a particular direction of time-keeping has any effect on cognition and preferences. Since time-keeping is ubiquitous and both types of time-keeping (upward/downward) are sufficiently observed, we believe that exploring the effects of the direction of time-keeping can uncover an important dimension of temporal cognition and provide meaningful theoretical and practical insights.

Time is an abstract concept, and there are multiple ways in which it can be interpreted (Lakoff & Johnson, 1980). While previous research has examined several aspects of temporal cognition, no research, to our knowledge, has examined the impact of the direction of time-keeping on cognition and preferences. Specifically, we propose and test the impact of the direction of time-keeping on perceived resource deficiency and related downstream consequences, such as a preference for calorie-rich foods and risky options, willingness to help and actual consumption. The results from four studies show that downward (upward) time-keeping results in a higher (lower) perceived resource deficiency, as manifested in a higher

(lower) preference for calorie-rich foods, risk averse (seeking) preferences, a lower (higher) willingness to help and a higher (lower) consumption of candies. The effect is attenuated by recalling instances of resourcefulness. Additionally, we address the alternate explanations of arousal, mood, stress and the presence of zero as a hard-stop. This research is possibly the first to demonstrate that the mere direction of time-keeping can influence resource deficiency and such resource deficiency is compensated by seeking resources in a domain-general manner. The resource deficiency of time is compensated by seeking (or saving) resources in the domains of calories, money, and effort. We hope that these findings contribute to the broader literature on time perception and numerical cognition (May & Monga, 2013; Monga & Bagchi, 2011; Zakay & Block, 1997), and inspire further curiosity among researchers by uncovering an important dimension of temporal cognition.

Conceptual Development

This research spans the broad domains of numerical cognition and temporal cognition. In the domain of numerical cognition, extant literature suggests that numbers and the sequence of their presentation have a significant impact on cognition and behavior. This literature covers phenomena such as anchoring and adjustment (Tversky & Kahneman, 1974), numerosity (Wertenbroch, Soman, & Chattopadhyay, 2007), and unitosity (Monga & Bagchi, 2011; Pandelaere, Briers, & Lembregts, 2011). In the domain of temporal cognition, there is research on intertemporal choices (Loewenstein & Thaler, 1997), the anthropomorphism of time (May & Monga, 2013), temporal search costs (Monga & Saini, 2009), and temporal value asymmetry (Caruso, Gilbert, & Wilson, 2008), and on factors that alter subjective time perception such as goal conflict (Etkin, Evangelidis, & Aaker, 2015), arousal (Zakay & Block, 1997), task complexity and construal (Siddiqui, May, & Monga, 2014), and counting of tasks (Shalev & Morwitz, 2013). Most of the prior research has investigated the broad categories of time valuation and the perception of time passage (fast/slow). We could not find any work that investigates the effects of the direction of time-keeping on preferences and choices in non-temporal domains. We hope to contribute by eliciting and explaining the effects of this under-researched yet common phenomenon of the direction of time-keeping.

Our central argument concerns the impact of the direction of time-keeping on perceived resource deficiency. Extant research shows that time is considered a resource in many decision-making scenarios (Becker, 1965; Festjens & Janiszewski, 2015; Leclerc, Schmitt, & Dube, 1995). Casual observation regarding several time management lessons and individuals complaining about perpetual time shortages corroborates that time is a scarce resource. Since

time is considered a resource in several everyday contexts, the key premise of our research is that the direction in which its consumption is monitored will systematically influence resource deficiency perception, which will produce downstream effects. Specifically, we argue that downward time-keeping, compared to upward time-keeping, results in higher resource deficiency perception. This is because decreasing sequences are implicitly associated with a reduction in quantity, value or resources (Pelham, Sumarta, & Myaskovsky, 1994; Pandelaere, Briers, & Lembregts, 2011). Moreover, there is a general association of decreasing sequences with scarcity and reduction (reduction in stock prices, bank balances, etc.), and by definition, decreasing sequences always involve moving from a higher to a lower value. Importantly, when such decreasing sequences represent a particular resource (such as time), it is likely to signal a resource reduction more strongly than would an increasing sequence. Additionally, decreasing sequences imply impending resource exhaustion because whatever is reducing will eventually exhaust. This implicit meaning of impending exhaustion is not present in increasing sequences. Based on the above premise, we argue that downward (upward) time-keeping (60…59...58…vs…58…59...60) is more (less) likely to induce resource deficiency perception. Extending the above theorization, it can be further argued that such resource deficiency will lead to preferences and behaviors aimed towards compensating for the perceived resource-deficient state. Such resource-deficient states can lead to a higher tendency to consume calorie-laden foods because calories represent an important resource that can be used to compensate for a perceived resource deficiency (Briers & Laporte, 2013; Cheon & Hong, 2016; Read & Van Leeuwen, 1998; Tal & Wansink, 2013). Additionally, this state can lead to higher risk aversion because in resource-deficient states, conserving available resources is more important than seeking risky resource avenues (March & Shapira, 1992; Haushofer & Fehr, 2014). It can also lead to more self-focused behaviors, as a resource-deficient state would induce concern about oneself over others (i.e., helping self over others, reduced donations and helping intentions; Levontin, Ein-Gar, & Lee, 2014). Thus, based on extant research, we argue that downward (upward) time-keeping will lead to more (less) resource deficiency, as manifested in a higher (lower) preference for calorie-rich food, more (less) risk aversion, less (more) willingness to help and higher (lower) consumption. We test these hypotheses through four studies and address related alternative explanations.

Study 1: Preference for Calorie-Rich Foods

The objective of study 1 is to examine the effect of time-keeping direction on the preference for calorie-rich/lean foods. If downward (upward) time-keeping results in more

(less) resource deficiency, it should be manifested in a higher (lower) preference for calorie-rich foods because they symbolize high resources (i.e., calories) and might compensate for momentarily induced resource deficiency. Such a difference should not be observed for calorie-lean foods, as they are not associated with high calories. The study design was 2 (Upward/downward time-keeping) x 2 (Evaluation of calorie-rich/lean food) between-subjects design.

Participants and Procedure

Participants (N = 93) from a local university were randomly assigned to one of the four cells. For the timed task, participants crossed the letter 'e' (Baumeister, Bratslavsky, Muraven, & Tice, 1998) in a large text within 60 seconds, and the time was shown on a screen moving in an upward (1,2,3,…) or downward (60,59,58,…) direction. The text was long enough that it was impossible to cross out all the 'e' in 60 seconds. The participants then evaluated either a chocolate cake (calorie-rich) or a fruit salad (calorie-lean) on a purchase likelihood scale (two items; adapted from Dodds, Monroe, & Grewal, 1991). Finally, participants completed the demographic questions.

Results and Discussion

A 2 (direction of time-keeping) x 2 (evaluation of calorie-rich/lean food) ANOVA on the purchase likelihood revealed a main effect of evaluation of calorie-rich/lean food such that calorie-rich food was evaluated favorably than calorie-lean food (F (1, 89) = 46.5, $p < .001$; $M_{\text{calorie-rich}}$ = 7.47; $M_{\text{calorie-lean}}$ = 5.59). Relevant to our prediction, a significant interaction occurred between the time-keeping direction and the evaluation of food item (F (1, 89) = 7.195, p = .009), such that the calorie-rich food item was evaluated favorably in the downward time-keeping condition than in the upward time-keeping condition ($M_{\text{upward-time-keeping}}$ = 6.97, $M_{\text{downward-time-keeping}}$ = 8.02, t (89) = 2.65, p = .004). No differences were found for the evaluation of the calorie-lean food item in the two time-keeping conditions ($M_{\text{upward-time-keeping}}$ = 5.82, $M_{\text{downward-time-keeping}}$ = 5.37, t (89) = 1.14, p = .126). No other effects were significant. Figure 1 shows the findings of this study.

_____Insert Figure 1 here_____

Study 1 provides the initial evidence that downward (upward) time-keeping results in a higher (lower) resource deficiency, as manifested by a more (less) favorable evaluation of calorie-rich foods. Such a favorable evaluation shows a greater tendency of participants exposed to a downward (vs. upward) time-keeping condition to seek resources such as calories.

However, prior research suggests that arousal can also explain these effects. We test this alternate explanation in the next study.

Study 2: Time-keeping, Risk Aversion and Non-zero Endings

Extant research suggests that countdowns (for items/tasks) are possibly associated with arousal because countdowns lead to a sense of goal achievement and goal proximity, leading to arousal (Shalev & Morwitz, 2013). Higher levels of arousal are associated with an increased tendency for hedonic consumption (Di Muro & Murray, 2012; Gardner & Rook, 1988). Therefore, an increased preference for a calorie-rich food in a downward time-keeping condition could be driven by arousal. To address this explanation, we study the effect of the direction of time-keeping on risk preferences. While arousal can lead to risk seeking (Horvath & Zuckerman, 1993; Mano, 1994), resource deficiency can lead to risk aversion (Haushofer & Fehr, 2014; March & Shapira, 1992). Accordingly, if downward time-keeping results in resource deficiency perception (or arousal), participants should exhibit risk-avoiding (or risk-seeking) behaviors. Since individuals are usually risk averse for gains (Kahneman & Tversky, 1979), differences in risk seeking and risk aversion should be observed for choices in which the expected payoff of the risky option is greater than that for the safe option, and the effect should be mild or absent when the expected payoff of the safe option is greater than that of the risky option. Thus, an individual's risk preference should help us discern between explanations of arousal and resource deficiency.

Moreover, we test whether the effects of downward time-keeping are driven by its decreasing sequence or by the presence of zero as an impending hard-stop. Since zero symbolizes exhaustion, it is possible that the presence of zero as the end-point in downward time-keeping, rather than a decreasing sequence, induces a resource deficiency perception. If the effects are driven by the presence of zero as a hard-stop, the effects found in the previous study should not be observed in the downward time-keeping condition with a non-zero ending. However, if these effects are due to a decreasing sequence *per se*, the effects should be replicated in the downward time-keeping condition with a non-zero ending. The study design was 2 (upward/downward time-keeping; between-subjects) x 2 (Zero/Non-zero containing; between-subjects) x 2 (Expected payoff higher in: Risky/safe option; within-subjects) design.

Participants and Procedure

Participants (N = 182) from a local university were randomly assigned to one of four conditions and were asked to solve as many anagrams (of 4-5 letter words; displayed on a

screen) as possible in sixty seconds. The time was shown on the side of the screen from 0-60 or 60-0 seconds (from 5-64 or 64-5 seconds) for time-keeping conditions containing zero (non-zero). Then, participants responded to a risk preference scale (Hsee &Weber, 1999) involving choices between a fixed amount (600, 800, 1000, 1200, or 1400 units of local currency) and a 50% chance of winning 2000 units (five items). We expected the risk preference to vary more for below-median items (i.e., for 600 and 800 units against a 50% chance of winning 2000 units) than for above-median items (i.e., for 1200 and 1400 units) because larger values had a higher expected payoff than did the gamble, leading to clear preference for the sure amount. Lastly, participants completed the arousal-calmness index of the brief mood introspection scale (Mayer & Gaschke, 1988) for an explicit measurement of arousal.

Results and Discussion

For each item in the risk preference scale, a score of 1 was assigned if the participant chose the risky option (or 0 for the sure amount). We calculated the risk score for items below (600 and 800 units) and above (1200 and 1400 units) the median fixed payoff of 1000 units. Thus, the added score for above- or below-median items can range from 0 (sure amount chosen in both items) to 2 (50% gamble for 2000 units chosen in both items). A 2 (time-keeping: upward/downward) x 2 (zero/non-zero containing) x 2 (above/below-median risk scores, within-subjects) mixed ANOVA revealed an interaction between time-keeping direction and above/below-median risk preferences (F (1, 178) = 4.23, p = .041), such that for below-median risk choices, participants were less risk seeking in the downward time-keeping condition than in the upward time-keeping condition ($M_{\text{downward-time-keeping}}$ = 1.28, $M_{\text{upward-time-keeping}}$ = 1.51, t (178) = 2.01, p = .022). No such differences were found for the above-median risk choices ($M_{\text{downward-time-keeping}}$ = 0.34, $M_{\text{upward-time-keeping}}$ = 0.24, t (178) = 0.875, p = .191). The main effect of risk preference was also significant (F (1, 178) = 186.7, p < .001; $M_{\text{below-median}}$ = 1.40, $M_{\text{above-median}}$ = 0.29) such that participants generally chose the sure (risky) option when its expected value was more than that of the risky (sure) option. No other effects were significant. Lastly, the arousal scores did not differ significantly across the four conditions.

We found that downward time-keeping results in reduced risk preferences compared to upward time-keeping, providing support for the explanation of resource deficiency over arousal. Moreover, this effect was not influenced by the presence or absence of zero in the downward time-keeping condition, suggesting that it is the decreasing sequence rather than the presence of zero that is driving such effects. In the next study, we test for the underlying process and evaluate the effects on different but related dependent measures.

Study 3: Willingness to Help and Resource Deficiency Mediation

Study 3 tests for the underlying mediation of perceived resource deficiency and replicates the effects conceptually with a related dependent measure and a different timed task. If downward time-keeping results in perceived resource deficiency, that deficiency should be manifested as a reduced willingness to donate money and help others, as prior research suggests that resource deficiency is associated with reduced generosity (Levontin, Ein-gar, & Lee, 2014). Also, one might argue that the above effects are driven by stress or mood, such that downward time-keeping is more stressful or results in a negative mood, and a preference for calorie-rich food or a risk averse option is a way to alleviate the negative mood or stress. To address this explanation, we measure affect using the PANAS scale (Watson, Clark, & Tellegen, 1988). The study design was 2 (upward/downward time-keeping) factor between-subjects design.

Participants and procedure

Participants (N = 132) from a local university were randomly assigned to one of two time-keeping conditions. A word-block task included a 60-second timer (moving in upward/downward direction) on the side of the screen and instructions to identify as many words as possible from the word block. This was followed by a scenario in which a charitable organization sought financial support, with responses indicating a willingness to donate money and a willingness to help this organization measured using a 1 (very low) to 9 (very high) scale. Lastly, participants completed a 5-item resource deficiency scale (adapted from Levontin, Ein-Gar & Lee, 2014) and the PANAS scale, and were debriefed.

Results and Discussion

The willingness to donate money and the willingness to help were averaged for a composite measure of helping intention (*correlation* > 0.7). An independent sample t-test revealed a significant effect of time-keeping direction such that participants in the upward (downward) time-keeping direction condition were more (less) willing to help ($M_{\text{upward\_time-keeping}} = 7.25$, $M_{\text{downward\_time-keeping}} = 6.73$, $t\ (130) = 2.27$, $p = .012$). Responses on the resource deficiency scale were averaged (Cronbach's alpha = 0.78), and it was found that participants in the upward (downward) time-keeping condition were less (more) resource deficient ($M_{\text{upward\_time-keeping}} = 6.31$, $M_{\text{downward\_time-keeping}} = 5.95$, $t\ (130) = 2.13$, $p = .017$; a lower score indicates greater resource deficiency). Mediation analysis (Hayes, 2013) supported the mediation of perceived resource deficiency between the time-keeping direction and the helping

intention (95% CI for indirect effect: 0.0158-0.3089). We did not find any significant difference in the positive or negative affect scores or in the stress-related item scores (distressed, upset, irritable, nervous, and jittery) in the two time-keeping conditions ($p > .20$).

Study 3 shows that upward (downward) time-keeping results in greater (lesser) helping intentions and that perceived resource deficiency mediates such effects. Moreover, alternate process explanations through mood or stress are addressed. These results, in conjunction with earlier studies, provide evidence for the domain generality of resource deficiency such that perceived deficiency in a one resource domain percolates to other resource domains. In the next study, we examine the impact of the time-keeping direction on actual consumption and attempt to attenuate the effect based on our underlying theory.

General Discussion

This research adds to the literature on temporal cognition by illustrating the impact of the direction of time-keeping on perceived resource deficiency and on downstream preferences for calorie-rich foods, risky choices, the willingness to help, and actual consumption. The results also support that time-induced resource deficiency is domain general such that a deficiency in one resource type (time) results in seeking or saving resources of other resource types (calories, money, etc.). The differential effects produced by the direction of time-keeping, along with the domain generality of resource deficiency, provide an interesting and important understanding of the otherwise mundane activity of time-keeping. Lastly, we show that the effects are attenuated upon recalling instances of resourcefulness and that it is the direction (upward/downward) of time-keeping and not the presence of zero (as hard-stop) that results in the effects. The results are summarized in Table 1.

Although this work is possibly the first to investigate the direction of time-keeping, it builds on some of the insightful research done earlier. May and Monga (2013) elicited the effects of a non-temporal property of time, i.e., anthropomorphism, on patience. We also elicit the effects of a non-temporal aspect of time (i.e., its direction) on resource deficiency. Moreover, Shalev and Morwitz (2013) showed the impact of the counting direction of tasks (like hand-grip squeezes) on subjective time perception. We examine the aspects of counting direction, but of a resource such as time on the downstream effects of saving or seeking resources. Similarly, Aaker, Rudd and Mogilner (2011) posited that spending time in specific ways can increase well-being. We show that spending the same objective time under different

conditions of time-keeping can influence well-being by altering the experienced resource deficiency.

This research also has some limitations, and it provides several interesting directions for future research. We employed simple tasks (crossing out e's, word blocks, anagrams), using a specific unit of time (seconds). It would be interesting to explore whether the effects vary if the units are seconds, minutes, or hours (Monga & Bagchi, 2011; Siddiqui, Monga & Buechel, 2017). Future research can also examine the effects of time-keeping direction on tasks with varying levels of involvement. The impact of time-keeping direction can also be explored regarding satisfaction with a task, patience, time-discounting, etc. Since we found domain-general effects of time-induced resource deficiency, some types of resources (such as money) may induce stronger resource deficiencies. Future research could contrast the downstream effects of a count-up or count-down of different resources. To explore these research directions, our work provides the initial insights and can inform the development of research in this subdomain of temporal cognition.

Practitioners might find this research relevant for designing appropriate customer service designs (which involve waiting periods), deciding the manner of time presentation and compensation if there are delays, designing online purchase windows, etc. Consumers might use these insights to time their tasks appropriately by being cognizant of the effects of time-keeping on subsequent preferences. This research shows that the decision to use a direction of time-keeping is not trivial and can influence a variety of downstream preferences.

Time-keeping is pervasive in today's modernist societies. We hope that the initial insights from this research provide direction for more elaborate research into the effects of resource monitoring.

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