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Research Report

Does time fly when you're counting down? The effect of counting direction on subjective time judgment

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Abstract

We show that counting downward while performing a task shortens the perceived duration of the task compared to counting upward. People perceive that less time has elapsed when they were counting downward versus upward while using a product (Studies 1 and 3) or watching geometrical shapes (Study 2). Furthermore, the counting direction affects peoples' attitude toward the product, their likelihood of using it again, and their purchase intentions. We test several plausible accounts for the counting direction effect and find preliminary evidence that downward counting feels shorter because it is more arousing than upward counting.

Keywords: Time perception; Duration estimation; Counting; Arousal

Introduction

Time perception plays an important role in shaping consumer behavior (Hornik, 1984). The purchase and consumption of many products span time, and the perception of this time affects consumer satisfaction (Jones & Peppiatt, 1996; Katz, Larson, & Larson, 1991; Sackett, Nelson, Meyvis, Converse, & Sackett, 2010). Yet time perception is subjective, may be inaccurate (Ariely & Loewenstein, 2000; Fraisse, 1984; Fredrickson & Kahneman, 1993; Graham, 1981; Zauberman, Kim, Malkoc, & Bettman, 2009), and is susceptible to cognitive, emotional, and perceptual influences (Angrilli, Cherubini, Pavese, & Manfredini, 1997; Block & Zakay, 1997; Mo, 1971, 1975).

This research identifies a new factor—the counting direction during a temporal interval—that affects time judgment, consumer attitudes, and intentions. We find that downward counting during a temporal interval leads to shorter duration judgments than upward counting. For example, 60 s appear to elapse more quickly when counting from 60 to 1 than from 1 to 60. Importantly, these differences in time perception affect attitudes toward the product used while counting. Downward counters associate a product experience with a shorter duration and express more favorable attitudes toward the product than upward counters.

The counting direction effect is surprising because counting should increase the accuracy of duration estimation (Gilliland & Martin, 1940; Hicks & Allen, 1979). Getty (1976) argued that counting increases accuracy because it divides the interval into sub-intervals; the time estimation-errors for each sub-interval sum to a smaller error than for the undivided interval. Likewise, Fraisse (1984) suggested that counting serves as an "internal clock" which helps in estimating time. Still, several differences between upward and downward counting may explain the counting direction effect.

First, downward counting may be cognitively more complex than upward counting. Complex tasks are sometimes judged to be shorter than simple tasks (Brown & West, 1990; Thomas & Weaver, 1975; Zakay, 1993). Thus, a task may feel shorter when associated with downward versus upward counting because of its complexity.

Second, within a given numerical range, downward counting ends in smaller numbers than upward counting. When counting concludes and duration estimates are provided, smaller numbers

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are more accessible following downward than upward counting. This could lead to shorter duration estimates, similar to how other numerical or physical anchors influence time estimates (Mo, 1971, 1975; Xuan, Zhang, He, & Chen, 2007).

Finally, downward counting may be more arousing than upward counting and arousal may affect time judgments (Block & Zakay, 1997; Noulhiane, Mella, Samson, Ragot, & Pouthas, 2007). Our research provides preliminary evidence supporting this account; we elaborate next on the reasons why (a) counting direction may affect arousal, and (b) arousal may affect time perception.

Although not tested in this research, three mechanisms may drive arousal differences between upward and downward counters. First, downward counting may increase arousal due to natural associations. After all, exciting events like rocket launches and New Year's celebrations are associated with countdowns. Second, downward counting can affect perceptions of goal progress, which can affect arousal. Counting down highlights the number of steps to the end point, and thus may lead to perceptions that the goal is more proximal than when counting up. Perceptions of goal proximity increase positive feelings (Carver & Scheier, 1990), motivation, and effort (Hull, 1932; Kivetz, Urminsky, & Zheng, 2006; Nunes & Dreze, 2006), which are all indicative of positive arousal (Russell, 1980). Third, counting up may decrease arousal as it is sometimes used as a calming technique. In the heat of an argument, people are sometimes advised to count to 10 before responding.

How should differences in arousal affect time judgments? The literature suggests that arousal can have two opposing effects. According to internal clock models (Gibbon, Church, & Meck, 1984; Killeen & Weiss, 1987; Zakay & Block, 1997) time perception during an interval depends on the number of pulses released by a pacemaker and accumulated by a cognitive counter. The more pulses accumulated, the more time the perceiver feels has passed. The rate of pulse emission is determined by the perceiver's arousal, with higher speeds of pulse release, and greater numbers of pulses accumulated at the cognitive counter under high versus low arousal. High arousal then lengthens time estimates relative to low arousal. This model is supported by diverse lines of research, showing that time perception increases with the rate of external tempo (Zakay, Nitzan, & Glicksohn, 1983), volume of auditory stimulus (Burle & Casini, 2001), emotionality evoked by experimental stimuli (Droit-Volet, Brunot, & Niedenthal, 2004; Tipples, 2008) and body temperature (Wearden & Penton-Voak, 1995), all of which are assumed to increase arousal. Similarly, Gorn, Chattopadhyay, Sengupta, and Tripathi (2004) show that a webpage's color affects feelings of relaxation, which in turn affects judgments of download quickness; relaxed (i.e., less aroused) people perceived that the download occurred more quickly than less-relaxed people.

In contrast, in attention focus accounts (Noulhiane et al., 2007) arousal shortens time judgment because it takes attention away from time. Increased arousal narrows the focus of attention so that individuals focus predominantly on the most salient cues in their environment (Bacon, 1974; Easterbrook, 1959; Gruber & Block, 2003). Since non-temporal information is usually more salient than temporal information, aroused individuals allocate a greater proportion of attentional resources to non-temporal information, which reduces time perception (Thomas & Weaver, 1975; Zakay & Block, 1997). Supporting this account, Campbell and Bryant (2007) demonstrated that excitement levels before and during skydiving are negatively correlated with time estimates. Noulhiane et al. (2007) found that emotionally arousing sounds of two seconds or less were judged to be shorter than non-arousing sounds. Gruber and Block (2003) found that caffeine consumption, known to increase arousal and enhance attention, reduced prospective duration estimates. Kellaris and Mantel (1996) found that stimulating music shortened retrospective duration estimates, but only when the task involved cognitively easy-to-process stimuli.

In sum, depending on its effect on the internal clock or on the perceiver's attention, arousal may increase or decrease time judgments. To the best of our knowledge, the opposing findings in the literature have not been reconciled by any model. Cognizant of the complexity of previous findings on arousal effects, we can merely propose that arousal is implicated in explaining the counting direction effect.

In our studies we find that downward counters are more aroused and perceive time as shorter than upward counters. While we do not find that arousal mediates the counting direction effect on time perception, our findings are more supportive of the attention account than the internal clock account.

On the face of it, our findings contradict those of Gorn et al. (2004). Their participants evaluated webpages that appeared to download. The page's color was either relaxing (e.g. blue) or exciting (e.g. yellow, red), and the relaxation induced by the color shortened the perceived quickness of the download. We acknowledge the similarities between our measures of time perception and arousal and Gorn et al. (2004) measures of perceived quickness and relaxation. Still, important differences between their measures and ours may explain our seemingly contradicting findings.

While the key constructs in our investigation—time perception and arousal—are neutral, Gorn et al. (2004) focus on evaluative and valenced constructs of experience quickness and relaxation. Their relaxation measure is composed of valenced items: relaxed, calm, peaceful, uneasy, tense, and anxious. In contrast, our arousal measure (see Study 3) is neutral and composed of items like energetic and aroused. Likewise, Gorn et al. measure perceived quickness by having participants rate whether the download speed was “slow/fast,” “not speedy/speedy,” and “not quick/quick,” while we measure perceived duration and perceived quickness of time passage. Possibly the evaluative measure of event quickness employed by Gorn et al. was more sensitive to the valenced measure of relaxation than a neutral time estimate. They advanced this possibility and suggested that “*perceived quickness is an evaluative construct, not just a time estimate. As such, it not only is better linked to the relaxation measure, which is a valenced construct, but also has managerially relevant consequences such as attitudes and intentions about the Web site*” (p. 218).

Further, quickness of download may not be the same as quickness of time, since the former is focused more on an event

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Table 1
Mean ratings on time judgments in Study 1.

Time judgments	Counting direction	
	Downward	Upward
Estimated duration (seconds)	26.59*	33.50*
Ln (estimated duration)	3.17*	3.44*
Subjective time (combined measure; 1 = short, 7 = long)	3.30**	4.15**
Perceived length (1 = short, 7 = long)	2.74*	3.53*
How quickly time went by (1 = slowly, 7 = quickly)	4.13*	3.23*

Note. *Denotes a row-wise difference at $p<.05$; **Denotes a row-wise difference at $p<.01$.

than on time itself. Gorn et al. examined the difference between time and quickness perceptions in their last study; all earlier studies only measured quickness perceptions. The results for the two measures diverged; while screen color and feelings of relaxation affected quickness judgments, they had no effect on time estimates. In contrast we find similar effect for time estimates and time perception measures.

We next report three studies that examine the counting direction effect on time perception, its downstream consequences, and potential mechanisms underlying it. We show that (a) downward counting results in shorter time judgments and more favorable product attitudes than upward counting, (b) the counting direction effect only manifests when the lower limit of the counting range is "1," (c) downward counting results in higher arousal than upward counting, and (d) the counting direction effect manifests using both prospective and retrospective time judgment measures.

Study 1: The counting direction effect

In this computer study, 63 undergraduates at a northeastern university squeezed a hand exercise ball 25 times. Participants were randomly assigned to count squeezes in an upward ("1, 2, …, 24, 25") or downward direction ("25, 24, …, 2, 1"). Prior to squeezing, the participants reported their general mood (1 = very good, 10 = very bad) and feelings using the PANAS scale (Watson, Clark, & Tellegen, 1988; 1 = not at all, 10 = very much). The participants hit a button to indicate the beginning and end of the product use session. The actual duration was registered in milliseconds. After completing the product use session, the participants estimated its duration in seconds, its perceived length (1 = short, 7 = long) and how quickly its time went by (1 = slowly, 7 = quickly). The correlation between the two time judgments was significant ($r=-.36$, $p<.01$), so we reverse coded the second measure and averaged it with the first into a *subjective time* measure. Since the correlation was low, we also report results for each measure in Table 1. To test for downstream consequences of the effect of counting direction on time perception, the participants indicated whether they would like to continue squeezing the ball, would be willing to squeeze the ball in the future, and whether they were happy to be done with the ball squeezing task (1 = disagree, 7 = agree). After reverse coding the last item, we averaged the three items ($\alpha=.70$) into a *perseverance intentions* index. The participants also indicated whether counting while squeezing was confusing (1 = disagree, 7 = agree). Finally, the participants again rated their overall mood and feelings using the same scales as earlier.

Results

Downward and upward counters took similar objective time to complete the product trial session (Mdown=30.69, Mup=32.63, $t(61)=.44$, $p=.66$). Downward counters found the task to be as confusing as upward counters (Mdown=1.91, Mup=2.03, $t(61)=.31$, $p=.76$), suggesting that task complexity does not drive the findings reported below.

Time judgments

Downward counters provided shorter duration estimates ($M=26.59$) than upward counters for raw ($M=33.50$; $t(61)=2.16$, $p=.04$) and log transformed seconds (Mdown=3.17, Mup=3.44; $t(61)=2.37$, $p=.02$). Similarly, downward counters perceived time as shorter ($M=3.30$) than upward counters ($M=4.15$; $t(61)=2.80$, $p<.01$).

Perseverance intentions

Downward counters reported marginally stronger perseverance intentions than upward counters (Mdown=3.80, Mup=3.20, $t(61)=-1.77$, $p=.08$).

Mood and PANAS

We conducted a series of mixed ANOVAs, with counting direction (upward vs. downward) as a between subjects factor, and mood/affect measurement (before vs. after the trial session) as a within subjects factor. We looked for affective differences between upward and downward counters *after*, but not before, the product trial session. To be succinct, we only report the significant and marginally significant results in Table 2 and below. The measures that yielded significant interactions were general feeling, nervous, attentive, enthusiastic, and active; irritable, strong, determined, and proud yielded marginally significant interactions. For all items but "irritable," the interaction was driven by post-trial differences between upward and downward counters. Following the product trial, downward counters felt better, stronger, more determined, more attentive, more enthusiastic, more active, and prouder than upward counters.

Discussion

Downward counting resulted in shorter time judgments than upward counting and in stronger future intentions to use the product. The results do not support the task complexity account. While we did not directly test the arousal account, the findings on the mood and PANAS measures are consistent with it. Counting direction affected general feeling and specific feelings like strength, activation, and enthusiasm—all of which involve high levels of arousal (Russell, 1980). A potential limitation of this study was the use of overt pre-experience

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Table 2
Adjusted means of mood and PANAS ratings in study 1.

Measure	Pre-trial		Post-trial	
	Down	Up	Down	Up
General feeling [b]	4.44	5.05	3.87*	5.10*
Irritable [a]	4.09*	5.73*	4.44	4.83
Strong [a]	5.09	4.88	5.35*	4.15*
Nervous [b]	2.70	3.65	2.78	2.80
Determined [a]	5.13	4.78	5.26*	4.10*
Attentive [b]	4.44	5.15	5.52*	4.28*
Enthusiastic [b]	4.39	4.13	4.57*	3.23*
Active [b]	4.61	4.38	5.17*	3.68*
Proud [a]	4.74	4.50	4.70+	3.50+

Note. The superscripts a, b refer to the counting direction by affect-measurement interaction effect.
+ Denotes a row-wise difference within a given measurement at $p<.10$;* denotes a row-wise difference within a given measurement at $p<.05$.
a Denotes an interaction significant at $p<.10$.
b Denotes an interaction significant at $p<.05$.

mood and PANAS measures, which may have influenced the participants' reports of post-experience mood and feelings or may have led them to pay more attention to their feelings. To rule this out, in Study 3 we only measure post experience feelings.

Study 2: The moderating role of counting range

Study 2 tests whether the counting direction effect depends on the count range in order to help determine its underlying mechanism. If arousal drives the effect, it should manifest only when the lowest number in the count range is "1" or "0" since counting down to other, higher, numbers is not associated with exciting events and is not indicative of distance to the goal. Likewise, when counting up to relax, people usually start with "1" rather than higher numbers. If task complexity is the underlying mechanism, then the counting direction effect should manifest across all numerical ranges; moreover, assuming that downward counting in a higher range is more complex than in a lower range, then the counting direction effect would be more likely to manifest in a higher range. Finally, Study 2 is designed to generalize the previous findings by using a different, more neutral domain, with careful control of actual task time.

Method

One hundred and thirty three undergraduates at a northeastern university participated in this study. They counted geometrical shapes that appeared at a constant rate in the center of a computer screen. The participants were randomly assigned to count either upward or downward within the range of 1-to-25 or 26-to-50. The participants were instructed to begin counting at a specified number and to hit the "Stop" button when they reached another specified number. Each shape appeared for 2000 ms, followed by a dark screen for 1500 ms. The main task was preceded by a short trial. After completing the main task, the participants estimated its duration in seconds. Next, the participants rated the length of the task (1 = short, 7 = long) and how many moments seemed to pass while they were counting (1 = a few, 7 = a lot). Since these measures were significantly correlated ($r=.38$, $p<.01$), we averaged them into a *subjective time* measure, and also report results for the individual measures in Table 3. Finally the participants indicated whether the counting task was easy (1 = disagree, 7 = agree) or confusing (1 = disagree, 7 = agree).

Results and discussion

Most participants (79%) accurately clicked the "Stop" button after the 25th shape appeared. Accuracy rates did not differ across conditions ($\chi^2(3)=4.34$, $p=.23$). However, some participants never clicked the "stop" button or clicked it too early. We excluded 13 participants, who counted less than 23 or more than 27 shapes, from the analyses. Since the number of shapes counted significantly correlated with the perceived length measure, we included it as a covariate in our analyses. However, we obtained nearly identical results with no adjustment for the actual count, when the sample consisted only of participants who counted exactly 25 shapes, and when no participants were excluded.

Time judgments

A 2 (counting range: 1–25 vs. 26–50) × 2 (counting direction: upward vs. downward) between subjects ANCOVA, adjusting for the number of counted-shapes, on estimated duration yielded a main effect of counting direction ($F(1, 115)=3.83$, $p=.05$) and a marginally significant interaction ($F(1, 115)=2.94$, $p=.09$). The counting range effect was not significant ($F(1,115)=.21$, $p=.68$). Only in the 1–25 range did downward counters provide shorter duration estimates ($M=47.48$) than upward counters ($M=66.45$; $F(1, 115)=7.80$, $p=.01$) (see Table 3). In the 26–50 range, duration estimates of downward ($M=58.38$) and upward counters ($M=59.80$) did not significantly differ ($F(1, 115)=.03$, $p=.86$). The pattern was the same for log of duration.

The same ANCOVA on the combined subjective time measure did not reveal any significant main effects (both

Table 3
Mean time judgments in Study 2.

	Counting range			
	1–25		26–50	
Counting direction	Down	Up	Down	Up
Estimated duration (seconds) [a]	47.48*	66.45*	58.38	59.80
Ln (estimated duration) [b]	3.80*	4.09*	3.98	3.96
Subjective time (combined measure) [b]	4.01*	4.69*	4.66	4.39
Perceived length (1=short, 7=long) [a]	4.48+	4.98+	4.68	4.42
Number of moments (1=a few, 7=a lot) [b]	3.54*	4.40*	4.64	4.37

Note. The superscripts a, b refer to the counting direction by counting range interaction effect.
+ Denotes a row-wise difference within a given range at $p<.10$; * denotes a row-wise difference within a given range at $p<.05$.
a Denotes an interaction significant at $p<.10$.
b Denotes an interaction significant at $p<.05$.

F's < 1), but did reveal a significant interaction ($F(1, 115) = 4.96$, $p = .03$). The counting direction effect only manifested when the counting range included "1." In the 1–25 range, downward counters judged the task to be shorter ($M = 4.01$) than upward counters ($M = 4.69$; $F(1, 115) = 5.80$, $p = .02$). In the 26–50 range, time judgments did not differ significantly for downward and upward counters ($M_{down} = 4.66$, $M_{up} = 4.39$; $F(1, 115) = .67$, $p = .41$).

Task complexity

If task complexity drives the counting direction effect, the task complexity item responses should mirror the time judgments. However, the interactions were not significant in the 2 (counting range: 1–25 vs. 26–50) × 2 (counting direction: upward vs. downward) ANOVAs on task ease ($F(1, 116) = .18$, $p = .68$) and confusion ($F(1, 116) = 2.53$, $p = .11$) and do not lend support to the task complexity account.[2]

In sum, the counting direction effect manifested only when the counting range included "1." The findings are in line with the arousal account, but inconsistent with the task complexity account. Nevertheless, since arousal was not measured in this study, its implication in the counting direction effect remains speculative. In addition, Studies 1 and 2 did not test the numerical anchoring account. We examine both in the next study.

Study 3: Downstream consequences of the counting direction effect

In Study 3 we seek to generalize the previous findings and demonstrate consumer-relevant downstream implications. We examine again the counting direction effect using a tangible product and measure consumer reactions to the usage experience. If time spent using a product passes more quickly when consumers count downward than upward, this perception may affect subsequent product attitudes (Sackett et al., 2010). Another goal of this study is to further test the arousal account using a specific set of arousal-related items. We also test whether the counting direction effect depends on the time perception measurement paradigm—i.e. prospective versus retrospective (Gruber & Block, 2003; Kellaris & Mantel, 1996). Studies 1 and 2 both involved retrospective time judgments since the participants did not know they would be asked about time until after the interval ended. In Study 3 we examine whether the counting direction effect generalizes to prospective time judgments. Finally, we also test the numerical anchoring account.

Method

Seventy nine participants, recruited in public locations (mostly university campuses and dorms), tried a sports product—an ergonomic hand grip—by squeezing it 25 times. The participants were randomly assigned to count either upward or downward, and to a prospective or retrospective time judgment type condition. In the *prospective (retrospective)* condition, the participants were instructed that, during the exercise, they should focus on the passing of time (the sensations evoked by exercising) because at the conclusion of the exercise they would be asked about the passing time (sensations evoked by exercising). The participants squeezed the hand grip at their own pace, while the experimenter counted aloud either in an upward or downward direction, following each squeeze. Using a hidden timer, the experimenter also measured the actual duration of the session in centiseconds.

To examine the numerical anchoring account, following the product trial the participants generated their own experiment ID by combining a number between 1 and 50 and a letter of their choice. We reasoned that if a smaller numerical anchor was accessible at the conclusion of the count for downward counters, they would generate smaller ID numbers than upward counters. Last, the participants provided time and experience judgments, post-experience mood and feelings ratings, and product attitudes and intentions.

The participants judged the time of the squeezing session using an 11-point scale (1 = short, 11 = long). They next indicated whether the hand grip squeezing was effortful or difficult (1 = not at all, 11 = very much). The two items ($r = .70$, $p < .01$) were averaged into a *task difficulty* index. The participants also indicated whether the count was difficult to follow while trying the hand grip (1 = not at all, 11 = very much). Since neither task difficulty (all F's < 1) nor counting difficulty (all F's < 1) differed with our manipulations, we do not discuss them any further.

The participants rated how *enjoyable* the hand grip squeezing was (1 = not at all, 11 = very much) and described their *mood* (1 = bad, 11 = good). The participants then rated the extent to which a set of feelings related to arousal (Kjellberg & Bohlin, 1974)—energetic, aroused, vital, strong, alert, determined, and focused—described them at the moment (1 = not at all, 11 = very). These items ($\alpha = .91$) were averaged into a *post-experience arousal* index.

Next, the participants indicated whether the hand grip was effective, of high quality, and convenient to use (1 = not at all, 11 = very). The three items ($\alpha = .70$) were averaged into a *product attitudes* index. The participants also indicated how likely they were to buy the hand grip (1 = not at all, 11 = very).

As a time judgment type manipulation check, the participants indicated how much they thought about the passing time while squeezing the grip (1 = not at all, 11 = very much).

Results and discussion

The time judgment type manipulation was successful. A 2 (time judgment type: prospective vs. retrospective) × 2 (counting direction: upward vs. downward) between subjects ANOVA on the time-related thoughts measure revealed a significant main effect of type ($F(1, 75) = 14.63$, $p < .01$). Prospective participants thought more about time ($M = 6.37$) than retrospective participants ($M = 4.22$). No other effects were significant (both F's < 1).

While the manipulation check yielded the desired results, the time judgment type manipulation did not affect other dependent

[2] Full results are available from the authors on request.

variables; thus, in Table 4, we only report the results by counting direction. We have no evidence that the counting direction effect differs for retrospective versus prospective judgments.

Objective duration

A 2 (type of time judgment: prospective vs. retrospective) × 2 (counting direction: upward vs. downward) ANOVA on the actual duration of the trial session did not reveal any significant effects (all p's $>$ .12, $M = 26.95$).

Self-generated code numbers

The same ANOVA on self-generated numbers did not reveal any significant effects (all p's $>$ .20), and thus did not support the numerical anchoring account.

Time judgment

The same ANOVA on time judgment revealed a main effect of counting direction ($F(1, 75) = 4.16$, $p = .05$). Downward counters judged the task to be shorter ($M = 4.44$) than upward counters ($M = 5.31$). No other effects were significant (F's < 1).

Enjoyment

The same ANOVA on enjoyment revealed a marginally significant main effect of counting direction ($F(1, 75) = 3.34$, $p = .07$). Downward counters enjoyed the product trial more ($M = 6.10$) than upward counters ($M = 4.98$). No other effects were significant (F's < 1).

Product attitudes and intentions

The same ANOVA on product attitudes revealed a significant counting direction effect ($F(1, 75) = 4.11$, $p = .05$). Downward counters held a more favorable attitude towards the product ($M = 7.59$) than upward counters ($M = 6.76$). No other effects were significant (F's < 1). The same analysis on purchase intentions revealed a marginally significant counting direction effect ($F(1, 74) = 3.29$, $p = .07$). Downward counters were more likely to buy the product ($M = 4.90$) than upward counters ($M = 3.77$). No other effects were significant (F's < 1)).

Table 4
Mean time judgments, enjoyment, downstream consequences, and post experience arousal ratings in Study 3.

	Counting direction	
	Downward	Upward
Time judgment		
Perceived length (1 = short, 11 = long)	4.44*	5.31*
Enjoyment and downstream consequences		
Enjoyable (1 = not at all, 11 = very much)	6.10^{+}	4.98^{+}
Product attitudes (1 = unfavorable, 11 = favorable)	7.59*	6.76*
Purchase intentions (1 = low, 11 = high)	4.90^{+}	3.77^{+}
Arousal		
Post-experience arousal index (1 = low, 11 = high)	7.68*	6.86*

Note. $^{+}$ Denotes a row-wise difference at $p < .10$; * denotes a row-wise difference at $p < .05$.

Post-experience mood and arousal

The same ANOVA on mood did not reveal any significant effects (F judgment type $(1, 75) = 2.38$, $p = .13$; Fdirection < 1; Finteraction < 1). However, the same analysis on arousal revealed a significant effect of counting direction ($F(1, 75) = 4.63$, $p = .04$). Downward counters were more aroused ($M = 7.68$) than upward counters ($M = 6.86$). The type of time judgment ($F < 1$) and the interaction effect ($F(1, 75) = 1.29$, $p = .26$) were not significant.

We also tested whether arousal mediates the relationship between counting direction and time judgment. While ideally we would have found mediation, we did not.

General discussion

Across the three studies, we demonstrate that downward counting results in shorter time judgments than upward counting. The effect manifested using both prospective and retrospective time judgments (Study 3) and when the actual duration of the interval was fixed (Study 2) and experimentally-controlled (Studies 1 and 3). In Studies 1 and 3 we find that the counting direction shapes consumers' product attitudes and intentions to buy. People held more favorable attitudes toward the product and greater intentions to buy following downward than upward counting. In addition, Study 2 reveals that the counting direction effect depends on the counting range, and only occurs when the lower end of the range is "1."

Our findings suggest that marketers can affect consumers' time perception and attitudes toward experiences that involve counting. Downward counting can shorten time perception and enhance attitudes towards important, yet monotonous, experiences such as physical exercising or tooth brushing. People might be more likely to complete exercises if their coach instructs them to count downward because they feel the task is less taxing. Children might feel that tooth brushing is less onerous and be more inclined to brush for two whole minutes if their dentist instructs them to count downward while brushing.

We tested three plausible explanations for the effect. According to the task difficulty account, downward counting may be cognitively more taxing than upward counting and therefore the associated time feels shorter. The results did not support this account. Our null results could be due to our measures which only approximated complexity (e.g., confusion), so future research on this is still warranted. According to the numerical anchoring account, downward counting increases the accessibility of small numbers compared to upward counting, which leads to shorter time judgments. However, in Study 3, where the participants wrote top-of-mind numbers following counting, downward and upward counters generated similar numbers, which is inconsistent with this account.

Our results point most strongly to an arousal account. Studies 1 and 3 demonstrate that downward counting is more arousing than upward counting. Study 2 also shows that the counting direction effect is more likely to manifest when the counting range goes down to 1 rather than 26; this is consistent with the arousal account because downward counting to 26 is

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not associated with exciting events, such as rocket launch or New Year countdowns, and does not highlight goal proximity.

Our findings should not be taken to suggest that any marketing act that increases arousal will shorten consumer's time perception; such a conclusion is overgeneralized and unwarranted in light of past findings. For example, Gorn et al. (2004) report that relaxation rather than arousal shortens download quickness judgments. Given the contradictory findings in the literature we can only point to the need for further exploration of the arousal-time perception link.

Past research has shown that arousal can increase or decrease time judgments. Our results are more consistent with attention focus research which posits that arousal decreases time judgments because it distracts attention away from time. Note though that our manipulation of the type of time judgment in Study 3 directed the participants' attention either to time or to the experience, but did not moderate the effect of counting direction on time judgments. However, this manipulation was primarily designed to inform people about whether they would later give a time judgment, and therefore may not have provided the best test for the role of attention focus. Also, counting naturally draws attention to time, so our research context is not ideal to test the role of attention division on time perception. Given this and the complexity of past findings, more research on the role of arousal on time perception is warranted.

The effect of arousal on time judgment may be sensitive to the operationalization of arousal. While neutral arousal may shorten time perception by shifting the perceiver's focus to nontemporal information, relaxation (e.g. Gorn et al., 2004) may also shorten time perception by inducing pleasant feelings which are then attributed to quick time passage.

Future research could examine the role of task valence. Task valence may moderate the effect of counting direction on product attitudes, but not on time judgment. None of our studies utilized pleasurable tasks; for dull or aversive tasks, consumers form more favorable attitudes when they perceive time to be shorter. However, for pleasurable experiences, consumers would likely prefer to savor the moment and longer durations could therefore result in more favorable attitudes. If true, then for positive experiences, marketers could recommend the consumers to count upwards to increase the perceived duration of the experience, resulting in more favorable attitudes.

While we looked at self imposed counting, future research should explore whether similar effects occur for externally supplied counters. For example, online videos are often accompanied by a timer, showing the elapsed time or the time remaining, which may affect perceived time. Retailers often provide counts in queue settings. Consumers may react more positively to wait time if their status in line is presented as the number of customers remaining ahead of them rather than as the number of customers that have been already served.

Uncited references

Q3

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