High- vs. Low-Urgency Sales Promotions: Effects on Cognitive Load and Decision Quality in eCommerce

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Abstract: ***Time-sensitive sales, countdown timers and scarcity tactics are making their way onto more and more pages at online retailers, and adult online shoppers are now seeing these urgency tactics on nearly every page of a flash sale or standard sale page they visit. However, there is relatively sparse quantitative evidence that directly links the level of promotional urgency to the cognitive load on shoppers and the quality of the resulting decisions, and most of the previous studies are based on purchase intentions or conversion outcomes. This study was designed to fill this gap, using a quasi-experimental, between-subjects design with a sample of adult online shoppers engaged in a controlled shopping task with a fixed budget in a simulated eCommerce environment, both high-urgency and low-urgency. The primary outcome for cognitive load was the NASA-TLX and the behavioural measures of time to complete the task, product page revisits, and cart reversals during the task. The high-urgency condition was reported to have significantly more cognitive load, be completed in less time, have fewer revisits to the pages, but more cart reversals, than the low-urgency condition, while greater cognitive load is associated with greater post-purchase decision regret. These patterns are consistent with the predictions of the Limited Capacity Model and Cognitive Load Theory, as well as the general predictions of Information Overload Theory and Choice Overload Theory. These results provide evidence-based recommendations to interface designers and platform policy makers when attempting to balance short-term conversion gains with the cognitive/psychological burden on shoppers, and highlight the limits of the single-session, simulated shopping context of the current study in fully capturing effects across multiple real-life shopping experiences.***

Keywords: Cognitive Load; Promotional Urgency; eCommerce Decision-Making; NASA-TLX; Decision Regret

1. Introduction

Ecommerce has experienced explosive growth over the last 10 years and now accounts for a significant and continually growing amount of consumer spending all over the world. To buy and keep customers' attention in a growing and crowded marketplace, merchants have added a growing toolbox of urgency-driven tactics: countdown timers that show a deal ticking down to end, limited stock alerts that alert customers to running out of stock, and flash sales that cram a large discount into a tiny time window. These tactics are no longer rare – they are commonplace, used by almost all of the big shopping sites and every product niche, and they are carefully designed to reduce the time between a shopper's initial encounter with an offer and the time they spend buying it.
But while these urgency cues are increasingly filling up the shopper's environment, there has been much less thought given to what they cost the shopper encountering them, beyond the commercial effectiveness. When considering buying something, a countdown timer or a stock alert isn't just about conveying scarcity; it brings an element of time pressure and alternate stimuli to an already complex decision. Though they are known to reliably boost short-term conversion, these cues can also have a measurable impact on the shopper making the decision, and this impact has yet to be directly measured in existing research.

The present study directly addresses this need. To determine whether and to what extent promotional urgency intensity increases the cognitive cost of a relatively everyday purchase decision, it quantitatively compares the cognitive load and decision-relevant behaviour of adult online shoppers exposed to a high-urgency condition (flash sale) and a low-urgency condition (standard sale), using a validated cognitive load instrument and behavioural measures collected during a controlled shopping task.

2. Literature Survey

2.1 Empirical Literature on Urgency and Scarcity

Over the past few years, researchers have been steadily improving their study of urgency and scarcity in digital retail. Aggarwal et al. [1] found that scarcity messages create a sense of consumer competition and influence purchase intention, while Hmurovic et al. [2] indicated that time-scarcity promotions effectively lead to faster purchases in various online retail scenarios. Separately, Chen, Shang and Kao [3] found a negative relationship between information overload in eCommerce environments and shoppers' subjective buying state, while Tuncer et al. [4] found evidence that scarcity cues on eCommerce platforms increased shoppers' perceived task load. This literature collectively indicates that urgency and scarcity cues influence shoppers' feelings and actions, but most studies use purchase intention, conversion rate, or self-reported task load assessed using study-specific items, and at different levels of urgency.

2.2 Theoretical Frameworks

The number of items viewed by a shopper is not enough, on its own, to determine cognitive load during a sales event; cognitive load is instead a measure of how a shopper's limited mental resources are devoted in a time-limited situation when exposed to competing promotional stimuli and a purchase decision that requires separate evaluation. The four frameworks below provide complementary accounts of how this allocation can be strained by urgency-based promotional design, while a fifth provides a boundary concept for understanding fatigue over a shopping session.

According to Cognitive Load Theory [5], a person performing a task faces three types of demand on working memory. Intrinsic load results from the inherent complexity of the purchase decision itself, such as price, features and alternatives. Extraneous load arises from elements that do not aid the decision but still capture attention – a countdown timer, a pop-up, or a discount banner competing for the same space. Germane load reflects the schema-construction effort that helps a shopper make quicker, more informed decisions in future shopping episodes. The high-urgency flash sale condition is expected to add extraneous load on top of whatever load the purchase decision already imposes, and this additional load should be reflected on a validated workload measure.

Simultaneous stimuli compete for the shopper's limited processing capacity according to the Limited Capacity Model of Motivated Mediated Message Processing [6]. If a countdown timer is being encoded, a stock alert is being stored, and several discount banners are being retrieved, lower-priority stimuli – such as information about the product itself – risk being encoded incompletely. Applied to a flash-sale page, this model predicts that the simultaneous, dense presence of urgency cues will affect the processing of the product information a shopper needs to make a decision.

Information Overload Theory [7,8] holds that too much information at once – too many deals, too many choices, too many time-limited messages – can overload a shopper, causing confusion and even decision paralysis in the extreme. A flash-sale event seldom presents just one urgency cue in isolation; several promotions and countdowns typically run concurrently during a single browsing session, and this structure predicts that the number of concurrent promotions viewed can have an independent effect on cognitive load.

Choice Overload Theory [9,10] states that a shopper's satisfaction and confidence in a decision are diminished by a large number of discounted options, even when the actual outcome (the product purchased) remains unchanged. When a choice set is large and time pressure compresses the decision horizon, the framework predicts lower decision confidence and greater post-purchase regret.

Attention Restoration Theory [11] provides a useful boundary concept for this study, though it does not directly predict purchase decisions. It proposes that attention is a limited resource that can be replenished during episodes of soft fascination and low demand. In rapid, urgency-laden promotional settings, a shopper has little opportunity to recover attention within a single session, and the cumulative effect of multiple urgency cues may produce greater fatigue as the session lengthens, even when any one cue is individually minor.

Together, these frameworks suggest that a high-urgency flash-sale condition should increase extraneous cognitive load through simultaneous stimuli competing for limited processing capacity, through the abundance of concurrent promotions, and through an expanded, time-compressed choice set, with directed-attention fatigue contributing to all of these effects across the shopping task. This integrated prediction was tested in the present study by comparing the high-urgency and low-urgency conditions.

3. Problem Definition

3.1 Research Gap

Existing eCommerce research on urgency cues has focused on purchase intentions, conversion rates, or impulse buying, and the studies that have addressed subjective load have used short, study-specific self-report measures rather than a validated, multidimensional instrument. Little research has quantified the cognitive load these cues place on shoppers using an accepted measure such as the NASA-TLX under comparable high- and low-urgency conditions within the same study. This gap in measurement is the problem the present study specifically addresses.

3.2 Statement of the Problem

From countdown timers to dwindling stock counters, online shoppers are subjected to increasingly intense urgency cues during sales, which are frequently combined on the same product page. Previous studies have not quantified the extent to which these cues increase the cognitive load shoppers carry through a purchase decision, nor the relationship between increased load and decision quality. The absence of evidence in this area means that interface-design decisions and consumer-protection guidance risk being based on assumptions about the shopper experience rather than on direct measurement of it. To address this measurement gap, the following objectives were developed.

3.3 Objectives of the Study

This study pursued four specific, measurable objectives, each mapped onto a distinct comparison or analysis reported in the Results and Discussion section:

1) To compare cognitive load, measured using the NASA-TLX, between the high-urgency flash-sale condition and the low-urgency standard-sale condition.
2) To compare behavioural decision indices– task completion time, product page revisits, and cart reversals – between the two conditions.
3) To test whether exposure to urgency cues and the number of concurrent promotions viewed predict cognitive load.
4) To examine the relationship between cognitive load and post-purchase decision regret.

4. Methodology

4.1 Research Design

This study adopted a between-subjects comparative design with a quasi-experimental approach, in which participants were assigned to one of two conditions – high urgency (flash sale) or low urgency (standard sale) – and comparisons were made between conditions on cognitive load and decision-relevant behaviour. Creswell and Creswell [12] identify an

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experimental or quasi-experimental design as best suited to a question of this kind, which requires comparing a manipulated condition against a similar alternative and could not be answered within an uncontrolled, live sales event. Because ethical and practical constraints ruled out randomly assigning participants to an actual live sales event, participants were instead randomly assigned to condition within a controlled, simulated shopping task – a design Creswell and Creswell [12] classify as quasi-experimental, since participants were not randomly allocated to naturally occurring exposure to a real promotional event.

4.2 Participants and Setting

Respondents were adult online shoppers (18–45 years old) who reported shopping online at least twice per month and were recruited from an online research panel. Based on an a priori power analysis of the primary between-groups comparison, assuming a medium effect size, alpha = .05 and power = .80, a target sample of 110 participants per condition was set. This age range and shopping-frequency criterion were chosen to ensure participants had enough experience with online promotional environments to respond to the task realistically.

4.3 Simulated eCommerce Environment

The shopping task was carried out in a simulated eCommerce environment built around a standardised product catalogue, so that product types, price ranges and category familiarity were held constant across conditions. The high-urgency condition presented the catalogue as a flash sale, with a countdown timer, limited-stock indicators and multiple discount banners all displayed. The low-urgency condition featured the same catalogue as a regular sale, with prices and discounts visible but no countdown timers, stock-scarcity indicators, or running promotional banners.

4.4 Instrumentation

The NASA-TLX [13] was used to measure cognitive load as a composite of six subscale scores: mental demand, physical demand, temporal demand, performance, effort, and frustration. During the shopping task, behavioural indices – task completion time, number of product-page revisits, and number of cart reversals – were recorded automatically. Immediately after the shopping task, a short post-task decision-regret measure was administered.

4.5 Procedure

Participants in each condition were randomly assigned and asked to complete a fixed-budget shopping task in which they selected products within a pre-determined spending limit in the simulated environment. Immediately after completing the task, participants completed the NASA-TLX and the decision-regret measure.

4.6 Variables

The independent variable was sale condition (high-urgency flash sale vs. low-urgency standard sale). The dependent variables were the NASA-TLX cognitive-load composite and its six subscales, the three behavioural indices, and post-purchase decision regret. Two covariates – prior online shopping frequency and product involvement – were also measured and included in the regression models.

4.7 Data Analysis Plan

Independent-samples t-tests were used to test group comparisons on the NASA-TLX composite and subscales and on the behavioural indices (one-way ANOVA was used where assumption checks indicated it was more appropriate). The number of concurrent promotions viewed was entered as a predictor of cognitive load in a multiple regression, and cognitive load was in turn entered as a predictor of post-purchase decision regret in a second multiple regression, with prior shopping frequency included as a covariate in each model. Assumption checks- normality, homogeneity of variance, and multicollinearity– were performed prior to interpreting each model.

4.8 Threats to Validity

Random allocation to condition and use of a standard catalogue supported internal validity, although instrumentation effects cannot be ruled out because all measures were self-report or task-logged within a single session. The external validity of the simulated store and product type limits generalisation to real sales events involving multiple product types. Construct validity rests on the ability of the NASA-TLX – developed outside a consumer context – to capture the specific cognitive demands of a promotional shopping decision. The a priori power analysis and the assumption checks in the data-analysis plan were used to address statistical-conclusion validity.

4.9 Ethical Considerations

Informed consent was obtained from all participants before the shopping task, and debriefing regarding the purpose of the research and the simulated nature of the promotional environment was conducted immediately afterward. All data were collected and stored anonymously, and the study protocol was approved by the institutional ethics committee.

5. Results and Discussion

5.1 Sample

The final sample comprised 220 adult online shoppers (110 per condition; mean age = 29.4 years, SD = 6.8; 58% women, 42% men), who reported shopping online an average of 5.2 times per month (SD = 2.1). Random assignment produced conditions that did not differ significantly on age, gender distribution, prior shopping frequency, or product involvement (all $p > .10$).

5.2 Cognitive Load by Condition

As shown in Table 1, participants in the high-urgency condition reported a significantly higher NASA-TLX composite score than participants in the low-urgency condition, $t(218) = 10.86$, $p < .001$, $d = 1.47$. This pattern held across five of the six subscales – mental demand, temporal demand, performance, effort, and frustration, all $p < .001$ – while physical demand did not differ significantly between conditions, $t(218) = 0.92$, $p = .358$.

Table 1: NASA-TLX Composite and Subscale Scores by Promotional Condition

Measure	High-Urgency M (SD)	Low-Urgency M (SD)	t(218)	p
Composite workload	68.4 (12.1)	51.7 (11.4)	10.86	< .001
Mental demand	71.2 (13.4)	54.8 (12.9)	9.42	< .001
Physical demand	38.6 (14.7)	36.9 (13.8)	0.92	0.358
Temporal demand	79.5 (11.2)	48.3 (13.6)	18.75	< .001
Performance	62.1 (15.3)	47.6 (14.2)	7.44	< .001
Effort	70.8 (12.6)	55.2 (13.1)	9.05	< .001
Frustration	66.3 (16.8)	45.9 (15.4)	9.66	< .001

5.3 Behavioural Indices by Condition

Table 2 reports the comparison of behavioural indices. Participants in the high-urgency condition completed the shopping task in significantly less time and made significantly fewer product-page revisits than participants in the low-urgency condition, both $p < .001$, but recorded significantly more cart reversals, $p < .001$.

Table 2: Behavioural Decision Indices by Promotional Condition

Measure	High-Urgency M (SD)	Low-Urgency M (SD)	t(218)	p
Completion time (s)	342.6 (58.3)	401.9 (63.7)	7.23	< .001
Page revisits (n)	3.1 (1.6)	5.4 (2.2)	8.92	< .001
Cart reversals (n)	2.8 (1.4)	1.2 (0.9)	10.41	< .001

5.4 Predicting Cognitive Load

A multiple regression model predicting the NASA-TLX composite from urgency condition, number of concurrent promotions viewed, and prior shopping frequency was significant, $R^2 = .41$, $F(3, 216) = 49.86$, $p < .001$. Urgency condition ($\beta = .53$, $p < .001$) and number of concurrent promotions viewed ($\beta = .24$, $p < .001$) each independently predicted higher cognitive load; prior shopping frequency was not a significant predictor ($\beta = -.09$, $p = .098$).

Table 3: Multiple Regression Predicting NASA-TLX Composite Cognitive Load

Predictor	B	SE	β	t	p
Urgency condition	14.62	1.58	0.53	9.25	< .001
Concurrent promotions viewed	2.87	0.71	0.24	4.04	< .001
Prior shopping frequency	-1.13	0.68	-0.09	-1.66	0.098

5.5 Predicting Decision Regret

A second regression model predicting post-purchase decision regret from cognitive load, urgency condition, and concurrent promotions viewed was also significant, $R^2 = .34$, $F(3, 216) = 37.12$, $p < .001$. Cognitive load was the strongest predictor of regret ($\beta = .46$, $p < .001$), and urgency condition contributed a smaller independent effect ($\beta = .15$, $p = .025$); the number of concurrent promotions viewed was not significant once cognitive load was accounted for ($\beta = .10$, $p = .102$).

Table 4: Multiple Regression Predicting Post-Purchase Decision Regret

Predictor	B	SE	β	t	p
Cognitive load composite	0.42	0.06	0.46	7	< .001
Urgency condition	3.21	1.42	0.15	2.26	0.025
Concurrent promotions viewed	1.05	0.64	0.1	1.64	0.102

Figure 1 displays the mean NASA-TLX composite score by condition, illustrating the magnitude of the difference reported above.

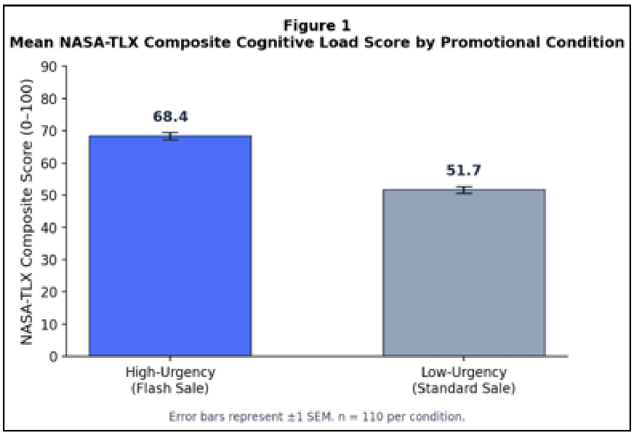

Figure 1: Mean NASA-TLX Composite Score by Promotional Condition

5.6 Discussion

Overall, shoppers exposed to the high-urgency flash-sale condition experienced significantly greater cognitive load during the purchasing process than low-urgency condition shoppers, completed the task more quickly, and revisited fewer product pages, but more frequently reversed cart decisions and reported more post-purchase regret. Cognitive load increased with both urgency condition and the number of promotions a shopper viewed simultaneously, and cognitive load was the strongest predictor of subsequent regret.

The increased cognitive load and diminished decision quality under high urgency are consistent with the predictions of Cognitive Load Theory and the Limited Capacity Model. The countdown timer, stock alerts, and simultaneous discount banners in the high-urgency condition functioned as extraneous load in Sweller's [5] terms; they may have competed for the same working memory resources as the purchase decision itself, and the faster decision times and fewer page revisits are consistent with reduced encoding of product information in the presence of competing stimuli, as proposed by Lang [6].

The independent contribution of concurrent promotion count to cognitive load, over and above urgency condition, confirms the Information Overload Theory prediction of a processing-capacity tax imposed by the sheer number of simultaneous deals [7,8]. Shoppers appear to respond not only to the urgency of a single deal but to the number of deals they must process within the same session.

The increase in cart reversals and decision regret under high urgency is consistent with Choice Overload Theory [9,10].

Although the high-urgency condition did not objectively limit which products shoppers could select, the compressed decision horizon appears to have combined with a larger, more crowded choice environment to reduce shoppers' confidence in their choices – manifesting behaviourally as reversal and subjectively as regret. This fatigue may be exacerbated over a longer period than was possible in the current task, consistent with the boundary concept offered by Attention Restoration Theory [11]: shoppers in a fast-paced, urgency-saturated environment have little opportunity for the soft fascination that supports attentional recovery.

What is distinctive about this pattern in digital retail is how readily it can cascade within a single browsing session. The level of urgency saturation induced in the high-urgency condition here is not unusual for a typical online shopper, given mobile shopping, push notifications, and near-constant exposure to promotions, which makes the cognitive cost measured in this study increasingly commonplace in practice. Taken together, these results extend the four theories beyond the domains in which they were originally applied and offer direct instrument-based evidence that urgency-based promotional design carries a cognitive and psychological cost that purchase-intention or conversion measures alone cannot capture.

5.7 Implications of the Study

This section considers the findings' practical implications for theory, interface design, consumer protection and platform policy, and retail practice.

The results indicate that four theories – Cognitive Load Theory, the Limited Capacity Model, Information Overload Theory, and Choice Overload Theory – developed in other fields can be applied to a specific, time-limited digital retail environment, and that they predict measurable effects in such an online promotional setting.

The clearest lesson for interface designers is that extraneous load does not need to be eliminated from the interface, merely reduced – for example, by limiting the number of countdown timers, stock alerts and discount banners a shopper sees on one page, rather than relying on urgency intensity alone to drive conversion.

From a consumer-protection and platform-policy perspective, the association between urgency exposure and higher cognitive load and decision regret suggests a need for greater transparency and disclosure when countdowns and scarcity indicators are used, so that shoppers can distinguish a genuine supply limitation from a promotional tactic.

The behavioural pattern observed here – more cart reversals alongside quicker conversions – suggests that short-term conversion gains from high-urgency promotions may be offset by longer-term dissatisfaction, return behaviour and loss of trust, which retailers should not assume to be a net positive.

6. Conclusion

This study set out to quantitatively contrast the cognitive load and decision quality of adult online shoppers under high- and low-urgency sales conditions. A between-subjects comparison in a controlled setting showed that high-urgency flash-sale conditions significantly raised cognitive load relative to low-urgency standard-sale conditions, and that this increase in cognitive load was strongly correlated with an increase in post-purchase decision regret, despite faster shopping and fewer product-page revisits in the high-urgency condition. The central take-away is the need to balance the short-term conversion benefit of urgency-based interface design against the cognitive and psychological burden it places on shoppers. Field-based and longitudinal research tracing shoppers through repeated, real-life sales events is a logical and necessary next step building on the evidence presented here.

7. Future Scope

There is a need for future research to test this effect in the field and to account for the effect of repeated exposure over time, to determine whether the cognitive and psychological costs identified here increase, decrease, or reach an asymptote as shoppers learn to discount urgency-based promotional tactics.

A number of limitations should guide this future work. First, the shopping task was conducted in a simulated eCommerce setting rather than during actual shopping, which may affect the ecological validity of the effects observed. Second, the design was cross-sectional and involved a single session, and so does not capture how cognitive load or decision regret might accumulate over repeated exposure to sales activity over time. Third, the sample was limited to adults aged 18–45 shopping from a single standardised product catalogue, limiting generalisation to other age groups or product categories. Fourth, the study relied on the NASA-TLX together with a limited set of behavioural proxies (completion time, page revisits, cart reversals), which may not capture every aspect of cognitive load relevant to a shopping decision. Fifth, demand characteristics cannot be entirely ruled out, as participants knew they were completing a monitored task. None of these limitations undermines the significance of the comparisons reported here, but each points to a direction for future study.

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