Ad Intrusiveness, Loss of Control, and Stress: A Psychophysiological Study

Research-in-Progress

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Abstract

As Internet advertising has become increasingly important in supporting free content, advertisers are trying to find novel ad formats (such as timed pop-up ads) to compete for users' attention. Thus, it is becoming increasingly important to understand the effects of advertising characteristics on users' emotions. To this end, we examine the effects of the ad characteristics perceptual salience and interference with user control on users' perceived attentional and behavioral control, attentional and behavioral intrusiveness, and ultimately, stress. In this paper, we propose a theoretical model and report the results of a preliminary study that triangulates self-report measures with objective measures of psychophysiological activation. Preliminary data from a study using 36 participants indicates that the ad characteristics perceptual salience and interference with user control influence users' perceived attentional and behavioral control. Preliminary analysis of facial electromyography data also suggests an influence of ad characteristics on affective responses.

Keywords: Ad intrusiveness, loss of control, stress, psychophysiology

Introduction

Internet advertising has become pervasive, to the point that it is sometimes considered to be the "default business model on the web" (Zuckerman, 2014). As Internet advertising supports a variety of "free" content, advertisers increasingly have to compete for the attention of users, who try to avoid or ignore ads (sometimes referred to as banner blindness or ad avoidance; Benway 1999; Burke et al. 2005; McCoy et al. 2008; Sun et al. 2013), so as to save cognitive resources (Margarida Barreto 2013). Prior research has examined the influence of ads' content, form, and behavior on users' attention, and demonstrated that factors such as the fit between task and ad topic (i.e., content; Heinz et al. 2013), size and shape (i.e., form; Burke et al. 2005), timing of appearance (i.e., behavior; Chan et al. 2010), or a combination of factors such as informativeness, size, and animation (relating to content, form, and behavior; Sun et al. 2008) can influence users' attention. Given the increasing competition among online ads, advertisers are looking for other ways to make the ads more salient. While factors related to content, form, or behavior normally do not interfere with the users' freedom to act, some online advertisers deliberately attempt to take away control from the user, for example by using windows that force users' attention by popping up unrequested (Bayles and Chaparro 2001; Brajnik and Gabrielli 2010; Edwards et al. 2002), by forcefully obstructing the users' view and taking away the ability to navigate, or by only allowing to close an ad after a certain amount of time has passed – effectively taking away users' ability to navigate.

Whereas an ad's intrusiveness has been shown to positively affect recall and recognition (Yoo et al. 2004), it has also been linked to negative consequences, as feelings of intrusiveness (Chatterjee 2008; Truong and Simmons 2010) and irritation can influence attitudes and behavioral intentions (McCoy et al. 2008). For owners of websites and advertisers alike, understanding the impact of such ads on visitors is important. In particular, website owners and advertisers have competing goals: whereas website owners are interested in attracting visitors and enticing them to return, advertisers are often primarily interested in their ad's effectiveness, with less regard for the website users' long-term satisfaction. Therefore, it is important for both parties to understand the potential negative consequences of ad intrusiveness. In line with this, past research has examined the effect of perceived control on emotions and behaviors (see e.g. Beaudry and Pinsonneault 2005; Folkman 1984; Tang and Zhang 2013). In this study, we focus on the negative consequences of ad characteristics for two reasons: first, it is not yet fully understood what specific ad characteristics affect users negatively, and what their relative strengths are. Second, since most past research relies on self-reports, we contribute by triangulating self-report measures with objective measures of psychophysiological activation in response to these ad characteristics. We follow the call by McCoy et al. (2008) for further studying the relationship between stimuli characteristics and emotional and physiological consequences, and focus on the antecedents and immediate consequences of *losing* behavioral or attentional control, trying to answer the following research questions:

RQ 1: What causes *perceived loss of control* and what determines its strength?

RQ 2: How is *perceived loss of control* theoretically linked to *intrusiveness*?

RQ 3: What are the physiological and emotional consequences of *intrusiveness*?

We contribute to existing research in two ways. First, we open up the construct of *perceived control* and derive its theoretical determinants by theorizing on *attentional control* and *behavioral control*, and by examining their effects on perceived intrusiveness and ultimately stress, i.e., the mental and bodily response to a stressor exceeding mental resources (Lazarus 2006). Second, we contribute to research on coping, which emphasizes the role of controllability (Beaudry and Pinsonneault 2005), but has not yet fully explained its influence on stress and negative affect. While prior research has primarily relied on self-report measures, we combine self-report measures with psychophysiological measures in a laboratory experiment. This allows testing our hypotheses on stress activation with actual activation data of the autonomous-nervous-system and provides novel insights into stress perception in IS scenarios.

Theory

Following Tang and Zhang's (2013) model of *behavioral responses to ad features*, the ad characteristics content, form, behavior are inputs into two types of cognitive appraisals. Primary appraisal refers to evaluating the potential consequences of an event and whether it represents a potential gain or loss (Folkman and Lazarus 1988; Lazarus 1993). Secondary appraisal refers to evaluating available behavioral and cognitive responses to this event (Folkman and Lazarus 1988; Lazarus 1993). Together, primary and secondary appraisal lead to affective states and ultimately to different coping behaviors. Figure 1 depicts a simplified version of Tang and Zhang's model, which serves as a reference frame for this study. Whereas Tang and Zhang explicitly include perceived gain and positive affect, our research questions relate to a subset of their model, namely, the appraisal of unwanted and irrelevant advertisements and negative emotions (see the dotted box in Figure 1). Furthermore, we seek to advance the model in the following ways. The original model explains behavioral outcomes of positive and negative experiences in general, but does not provide an explanation of what particular negative affect arises and how it relates to losing control. Additionally, their model focuses on *behavioral* aspects of control only (perceived behavioral control and stimulus controllability), but does not account for *attentional* control. Arguably, forcefully taking someone's attention is of high relevance to studying online advertisements. We address this gap by elaborating on the nature of *loss of control* and its affective evaluations.

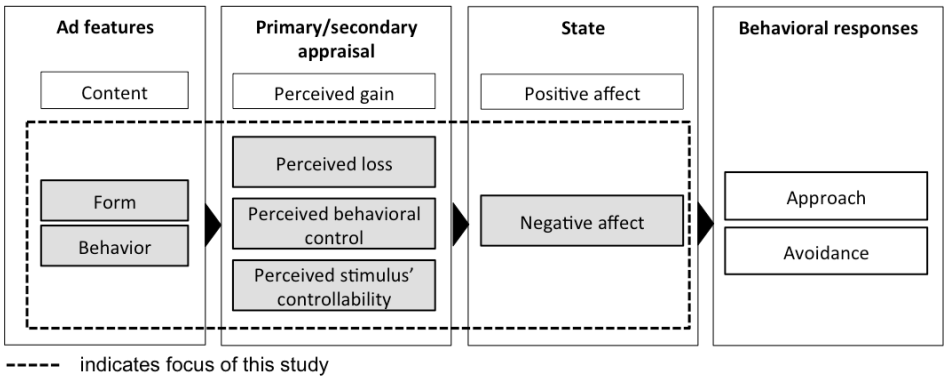

Figure 1. Focus of this Study (based on Tang & Zhang 2013)

Theoretical and Conceptual Background

The following section identifies the theoretical concepts relevant for answering the two research questions. Past research has examined the effects of perceived ad intrusiveness from various perspectives. For example, building on the theory of reasoned action and the theory of planned behavior, McCoy et al. (2008) studied the effect of *control* on perceived intrusiveness, irritations, attitudes, and behaviors. Other studies focused on the immediate psychological and physiological consequences of ad intrusiveness, often building on coping theory and the transactional model of stress (Galluch et al. 2015; Prestopnik and Zhang 2010, n.d.; Tang and Zhang 2013; Zhang 2000). Coping theory as well as the transactional model of stress relate to the *intrinsic characteristics* of the stimulus.

The *intrinsic characteristics* of a stimulus define its perceptual salience and potency for capturing attention (Taylor and Fiske 1978). Intrinsic characteristics of online ads can be broadly categorized into content, form, and behavior characteristics (Tang and Zhang 2013). Given our particular focus on diminished perceived control and its consequences, we follow McCoy et al. (2008) in concentrating on form and behavior characteristics. Specifically, we focus on the characteristics of perceptual salience and interference with users' control.

Perceived control is defined as the belief that an event can be controlled by oneself (Folkman 1984; Morimoto and Chang 2006). Past research has distinguished several types of perceived control. *Perceived attentional control* refers to a person's beliefs about the ability to control the focus of visual attention (Hopfinger et al. 2000). While shifts of attention are often deliberate and voluntary, the appearance of peripheral visual events leads to losing attentional control, causing involuntary shifts in attention (Jonides 1981). Attentional control theory refers to this as losing *inhibition*–the ability to deliberately suppress irrelevant stimuli (Miyake et al. 2000). Importantly, abrupt visual stimuli are likely to cause such shifts in attention (Jonides and Yantis 1990): the more salient, the more the stimulus attracts attention, and the more abrupt onset, motion, and color of a stimulus, the higher the loss of attentional control (Folk et al. 1994).

Another type of perceived control, *perceived behavioral control*, is defined as a person's beliefs about the ability to bring about good events and prevent bad events (Peterson and Stunkard 1989). In the context of the theory of planned behavior (Ajzen 1991) loss of behavioral control arises from external control constraints (Madden et al. 1992). Perceived loss of control thus refers to the belief that control is not in one's hands (Morimoto and Chang 2006).

Intrusiveness refers to perceptions of distraction, disturbance, interference, obtrusiveness, and being forced to do something (Edwards et al. 2002). Intrusiveness can thus relate to both intruding into someone's attention and intruding into someone's ability to act. We define attentional intrusiveness as the perception of one's attention being forcefully captured, and behavioral intrusiveness as the perception of one's ability to act being forcefully constrained. As intrusiveness may ultimately cause emotional and physiological reactions such as annoyance, frustration, irritation, and stress (Li et al. 2002), it is seen as

an inhibitor of perceived system quality (Cenfetelli, 2004). Understanding the relationship between ad characteristics, loss of control, and intrusiveness is thus a prerequisite for studying later stage emotional outcomes such as irritation (Edwards et al. 2002).

Stress is an organism's response to an event that exceeds perceived psychological or physiological resources (Lazarus 2006). According to coping theory, stress arises from the inability to cope with a situation due to constraints or lack of resources (Folkman 1984; Krohne 2001). Stress is considered a physiological (body) response and not an emotion per se (Krohne 2001; Lazarus 1991). However, stress and emotions stand in close "interdependence" (Lazarus 2006, p. 35). Experiencing stress causes certain emotions, and experiencing certain emotions can cause stress (Smith and Lazarus 1993). Table 1 summarizes the construct definitions.

Table 1. Construct Definitions

	Construct	**Definition**	**Based on**
IVs	Perceptual salience	Perceptual quality of "standing out" and grabbing attention.	Taylor and Fiske (1978)
	Interference with user control	Reduction of behaviors available to someone in a given situation	Brehm (1966)
Mediators	Perceived attentional control	Belief of having control over the focus of one's visual attention	Folk et al. (1992); Hopfinger et al. (2000)
	Perceived behavioral control	Belief of having the ability to cause and prevent events	Morimoto and Chang (2006)
	Attentional intrusiveness	Perception of one's attention being forcefully captured	Edwards et al. (2002)
	Behavioral intrusiveness	Perception of one's ability to act being forcefully constrained	Edwards et al. (2002)
DV	Stress	The mental and bodily response to a stressor exceeding mental resources	Lazarus (2006)

Hypotheses Development and Model

In the following we derive our hypotheses on how ad characteristics affect perception of control, intrusiveness, and ultimately stress. Figure 2 depicts our research model. The stimulus' characteristics are input to primary and secondary appraisals, where (unrequested) advertisements will influence perceptions of attentional and behavioral control, respectively. These, in turn, lead to perceptions of intrusiveness. As a physiological consequence, stress arises.

As discussed, highly perceptually salient stimuli trigger an autonomous and involuntary shift of attention (Jonides and Yantis 1990). Perceptually salient stimuli thus impair the functioning of the goal-directed attentional system and increase the stimulus-driven attentional system (Eysenck et al. 2007). Because this involuntary shift suppresses controlled attention, we hypothesize:

H1: The higher the perceptual salience, the lower the perceived attentional control.

According to the theory of planned behavior and coping theory, humans desire to maintain behavioral freedom (Ajzen 1991; Krohne 2001). The more possible behaviors are available, the higher the efficiency in coping with external events. Interference with the users' control takes away possible behaviors, limiting a user's perceived ability to cause or prevent events. We thus hypothesize:

H2: The stronger the interference with users' control, the lower the perceived behavioral control.

Intrusive behavior was defined as intruding someone's attentional or behavioral space. Forcefully shifting users' attention from the primary task to a possibly irrelevant stimulus limits *attentional* freedom and accordingly manifests an intrusion (Eysenck et al. 2007; Lavie et al. 2004). Correspondingly, limiting

behavioral choices is an invasion into someone's *behavioral* freedom. According to reactance theory (Brehm, 1966, 1981; Edwards et al. 2002), taking away control causes psychological reactance. The primary evaluative consequence is the perception of intrusiveness (Edwards et al. 2002). Based on the conceptual distinction of attention and behavior above, we expect reactance theory to apply to loss of attentional control as well as to behavioral control. Accordingly, we hypothesize:

H3: The lower the perceived attentional control, the higher the perceived attentional intrusiveness.

H4: The lower the perceived behavioral control, the higher the perceived behavioral intrusiveness.

In accordance with coping theory and the definition of stress, we expect that limiting the range of possible responses for coping with a stressor causes stress (Folkman 1984; Lazarus 2006; Weinert et al. 2013). More precisely, if secondary appraisal yields no adequate coping response, stress arises. The higher the attentional or behavioral intrusiveness, the fewer the remaining attentional and behavioral coping choices. We thus hypothesize:

H5: The higher the perceived attentional intrusiveness, the higher the stress.

H6: The higher the perceived behavioral intrusiveness, the higher the stress.

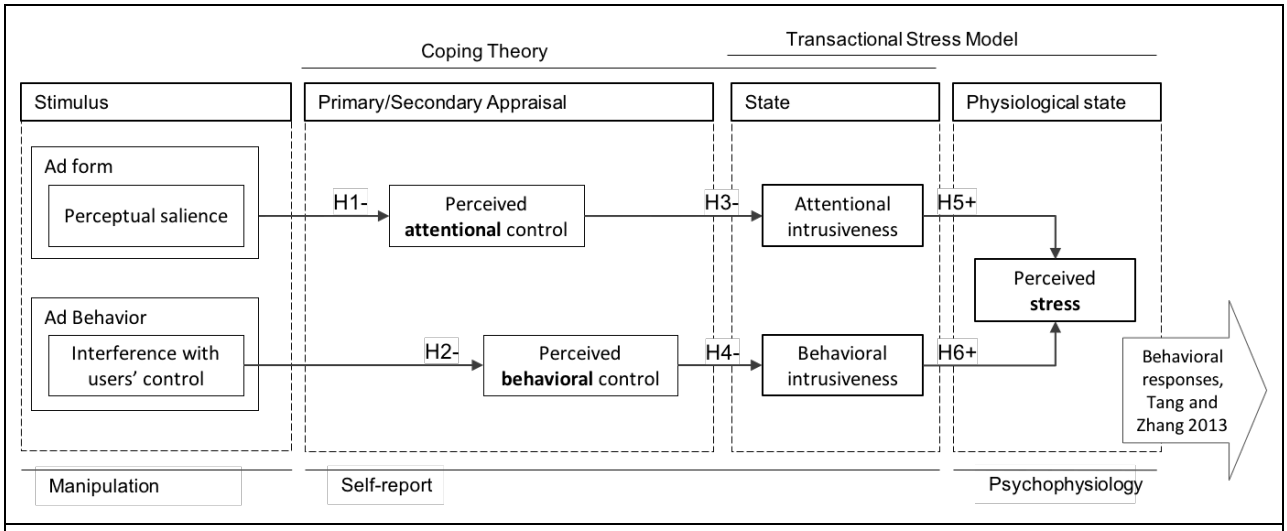

Figure 2. Research Model

Research Methodology

Experimental Design and Stimuli

The following describes a pre-test that we conducted in preparation for the main experiment. The pre-test data will be used for testing the efficacy of our stimuli and the feasibility of our measures. Once this is completed, the full experiment will build on this pre-test using a larger number of participants.

In the pre-test we conducted a within-subject experiment, manipulating *perceptual salience* and *interference with control* (cf. Table 2). The experiment consisted of three separate fact-finding tasks, each of which was presented in the context of one of three websites that mimicked the look-and-feel of three well-known banks. Although the look-and-feel of the sites differed (colors, logo), the general navigational structure (in terms of menu items and layout) was similar. Similar to McCoy et al. (2008), the ads were presented when participants arrived at the "target" pages containing the information needed to complete the task. We manipulated perceptual salience and interference with control using a 2*2 design. Following McCoy et al. (2008), we manipulated perceptual salience by presenting either a pop-up ad that appeared as a window and obscured the rest of the website (medium), or the same pop-up but with an additional animation when opening (high). We manipulated interference with users' control by requiring the user to

close the pop-up manually (medium), or forcing the user to close the pop-up manually and to wait an additional 15 seconds (countdown) before it disappears (high). We also included a baseline (control) condition, where both perceptual salience and interference with control were low; specifically, we presented the same ad content using a banner ad that did not pop up, nor did it interfere with users' control. The randomized repeated measures design of our study allows us to statistically control for differences in website design. In addition, we examined potential differences in the websites' usability and found that participants' post-hoc usability ratings were not significantly different.

Table 2. Stimulus Design

	Perceptual salience	**Interference with control**
Low (control)	Banner	None
Medium	Popping up	Obstructive to website but closeable
High	Animated popping up	Obstructive to website but closeable, disappears after 15 seconds countdown delay

Once the participants had found the information and completed the fact-finding task, a new fact-finding task on a new bank website was presented, for a total of three tasks on three bank websites. Bank websites, tasks, and stimuli were fully randomized. Figure 3 depicts the experimental procedure.

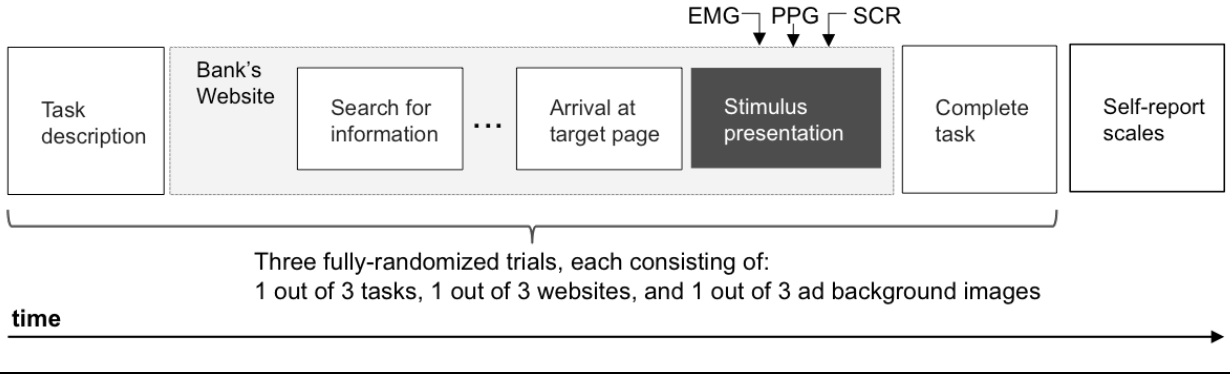

Figure 3. Experimental Procedure

Self-Report Scales

We based our scale for perceived *attentional* control on Sparks et al. (1997), and added items specifically related to the *attentional* aspects of control, such as "when the ad appeared, my attention got drawn to it"; further, we added items specifically related to the *behavioral* aspects of control, such as "the ad restricted my behavior". We based our scale for perceived *attentional* intrusiveness on Li et al. (2002) and Wells et al. (1971), and added items specifically related to the *attentional* aspects of intrusiveness, such as "I felt annoyed by how the ad took my attention"; further, we added items specifically related to the *behavioral* aspects of intrusiveness, such as "dealing with the ad felt forced". We measured perceived stress using the stress assessment measure by Peacock and Wong (1990). Testing for scale reliability revealed the measures to be reasonably internally consistent (Cronbach's alpha: attentional intrusiveness: α = .86, behavioral intrusiveness: α = .84, attentional control: α = .68, behavioral control: α = .72). We used 7-point Likert-type scales anchored at agree and disagree for our self-report scales.

Psychophysiological Measures

We used psychophysiological measures to assess the degree of the physiological stress. As humans perform badly when reporting fast-paced, short-lived, or subconscious cognitive, affective, or physiological states, the use of scales has its limitations, and it appears promising to use selected methods

from psychophysiology (Dimoka et al. 2012; Loos et al. 2010). Stress is not an emotion but a physiological response (Lazarus 2006). However, stress causes negative emotions (Krohne 2001; Lazarus 2006). Accordingly, two neurophysiological correlates can be measured: the physiological correlates directly relating to stress, and the emotional consequences of stress. In this paper, we make use of both correlates. The first relates to measuring physiological activation, the second relates to measuring the related (negative) emotion. We use electrodermal activity (EDA) and pulse plethysmography (PPG) to measure physiological activation, and facial electromyography (EMG) to assess negative emotion (valence). In the following, we describe both measurements in greater detail.

Electrodermal activity is a measure of the conducting properties of the skin. This method is very sensitive to minuscule physiological changes. It relies on measuring the skin's electrical impedance, which is affected by the skin's production of sweat fluid. As the autonomous nervous system triggers sweat gland activity in response to external and psychological events, EDA can be used as a measure for arousal. The recording of EDA yields skin conductance response (SCR), which are fluctuations in skin conductance that last several seconds (Adam et al. 2011; Boucsein et al. 2012; Figner and Murphy 2011). Increases in SCR indicate increases in arousal (Carbonnell et al. 2006; Cooper and Croyle 2007; Sequeira et al. 2009).

Pulse plethysmography (PPG) is used to measure blood flow and infer heart rate by illuminating the skin and detecting changes in light absorption. Because blood flow and heart rate respond characteristically to stress, they are regarded as a valid and reliable measure of stress activation (Carter et al. 2005). We thus rely on PPG measurement for obtaining objective data on physiological stress activation.

Electromyography is a measure of electrical muscle activation. It is very sensitive to minuscule muscle activations and is capable of measuring activity that is not visible to the human eye. Facial EMG measures the (involuntary) activity of specific muscle groups of the face (called rapid facial responses (RFR); Dimberg and Thunberg 1998), which are typically used for expressing emotions. In particular, activity of the corrugator supercilii muscle ("frowning muscle"), located above the eyelid, can indicate negative valence; typically, the corrugator supercilii muscle is activated 500 to 1000 ms after stimulus onset (Lanctôt and Hess 2007). As EMG signal amplitude is proportional to the strength of the muscle activation, higher amplitude of the EMG signal indicates higher corrugator muscle activation. Following past studies on e.g. frustration, anxiety, irritation, or stress (Aftanas et al. 2006; Huang et al. 2004; van Boxtel 2010), which have relied on measuring corrugator activity, we include the measurement of corrugator activity using facial EMG.

Execution of Measurement

We recorded EMG data at 1000 Hz using EMG equipment (Biopac EMG2, USA), applying a low-pass (400 Hz) and high-pass (20 Hz) filter (for a review of filter recommendations see De Luca et al. 2010), and rectified the filtered EMG signal. In particular, for each subject, we placed two Ag/AgCl electrodes over the corrugator muscle after preparing the skin with alcohol pads and abrasive paste and applying electrolyte gel to the electrodes, as well as a third (ground) electrode on the forehead. Further, we recorded electrodermal activity (SCR) at 1000 Hz, using two electrodes placed on the non-dominant hand, for eight seconds starting two seconds after stimulus onset using EDA equipment (Biopac BN-EDA, USA). We recorded PPG at 1000 Hz, using a finger clip (Biopac BN-PPGED, USA) on the non-dominant hand. We conducted all EDA, EMG, and PPG data preprocessing, cleaning, and analysis using the software package AcqKnowledge 4.3 (Biopac, USA). All physiological data was measured for discrete time windows after stimulus presentation (e.g. pop-up). The obtained activation data will be compared to the activation data of the same individual during a resting period.

Preliminary Results

We conducted a pre-test with 36 participants (18 female, mean age 23, SD = 6.2) to check the feasibility of the stimuli and the basic manipulations (H1 and H2). In line with our reasoning, a preliminary within-subject analysis of variance found significant main effects on all mediators: attentional control ($F(2,70)$ = 35.344, $p < .01$), behavioral control ($F(2,70)$ = 42.743, $p < 0.01$), attentional intrusiveness ($F(2,70)$ = 52.174, $p < 0.01$), and behavioral intrusiveness ($F(2,70)$ = 40.317, $p < 0.01$). Following the omnibus test, post-hoc comparisons using Bonferroni correction provided support for hypotheses H1 and H2. As predicted, lower perceptual salience and interference with control caused significantly ($p < 0.01$) lower

perceived attentional control (M = 3.59, SD = 1.96) and behavioral control (M = 3.32, SD = 1.98) than higher perceptual salience and higher interference with control (attentional control (M = 6.48, SD = 0.76) and behavioral control (M = 6.11, SD = 1.06)).

Though the neurophysiological data is not yet fully analyzed, we find preliminary indications that support our measurement expectations. Figure 4 depicts an actual EMG measurement over the corrugator supercilii muscle in the high intrusiveness condition. Arrows are added to illustrate the stimulus onset and the neurophysiological response. The onset of the highly intrusive forced 15s count-down phase is followed by three episodes of significant corrugator activations. Because this facial muscle stands in relationship to several affective constructs, it is necessary to combine this data with the PPG and EDA data to achieve a more reliable indicator of stress.

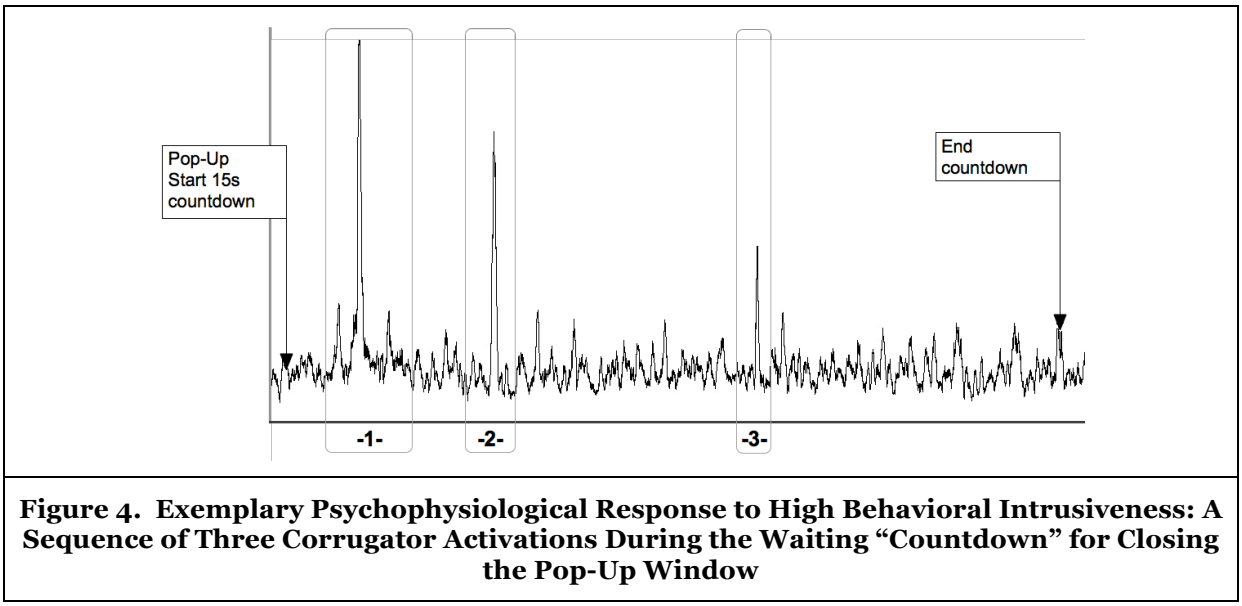

Figure 4. Exemplary Psychophysiological Response to High Behavioral Intrusiveness: A Sequence of Three Corrugator Activations During the Waiting "Countdown" for Closing the Pop-Up Window

Discussion and Conclusion

This research-in-progress seeks to explain why specific types of ads are perceived as more intrusive than others. It does so by opening up the constructs of *perceived control* and *perceived intrusiveness*, and introducing a distinction of their attentional and behavioral components. The paper then relates these constructs to the creation of physiological stress. It is theoretically grounded in previous HCI and IS work (Beaudry and Pinsonneault 2005; Prestopnik and Zhang 2010; Zhang et al. 2006), and specifically builds on coping theory. Beyond that, it contributes to a HCI research stream on intrusiveness and Web nuisances. This contribution is twofold: first, it contributes to theory by studying the relationships between stimuli characteristics, loss of control, and intrusiveness during primary and secondary appraisal, and how the introduced distinction between attentional and behavioral intrusiveness relates to physiological stress. Second, it contributes methodologically by demonstrating the use of neurophysiological methods in HCI research on intrusiveness and stress. Conducting and analyzing the full experiment will allow validating the research model (Figure 2). Depending on whether the theoretical claims can be supported empirically, the study would allow differentiating the effects of loss of *attentional* control and loss of *behavioral* control, as well as potential interaction effects.

For the full experiment, we plan to advance this study in several ways. As we currently limit our observations to utilitarian tasks future research should be also account for other task types. Further, as the pre-test was not designed for testing the discriminant validity of attentional and behavioral loss of control and intrusiveness, future research should attempt to incorporate the required treatment level combinations. Finally, we currently establish participants' baseline physiological levels during a resting period; incorporating a "no ad" condition will help to establish physiology baseline levels that account for the intrinsic properties of the task.

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