How Consumer Impulsiveness Moderates Online Trustworthiness Evaluations: Neurophysiological Insights

Research-in-Progress

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Abstract

With the emergence of new technologies, in particular the Internet, the opportunity for impulsive purchases have expanded enormously. In this research-in-progress, we report the current status of an fMRI-project in which we investigated differences between neural processes in the brains of impulsive and non-impulsive shoppers during the trustworthiness evaluation of online offers. Both our behavioral and fMRI data provide evidence that the impulsiveness of individuals can exert significant influence on the evaluation of online offers, and can potentially affect subsequent purchase behavior. We show that impulsive individuals evaluate trustworthy and untrustworthy offers differently than do non-impulsive individuals. With respect to brain activation, both experimental groups (i.e., impulsive, non-impulsive) exhibit similar neural activation tendencies, but differences exist in the magnitude of activation patterns in brain regions that are closely related to trust and decision making, such as the DLPFC, the insula cortex, and the caudate nucleus.

Keywords: Brain, communication, consumer behavior, consumer impulsiveness, electronic commerce, empirical analysis, fMRI, human behavior and IS, trust, trustworthiness

Introduction

With the emergence of new technologies, in particular the Internet and convenient online payment systems (e.g., credit cards, debit cards, etc.), the opportunity for purchases have expanded enormously in the past decade (Dittmar and Drury 2000; Dittmar et al. 2007; Kacen and Lee 2002; Rook 1987; Vohs and Faber 2007). As a result, consumer expenditures on the World Wide Web have also grown considerably during the same period (Ho et al. 2007). Although online shopping may result in considerable benefits for consumers (e.g., low information search costs, no limitation of store hours), the negative consequences of imprudent purchases may offset these benefits. The ease of purchasing online with just a few clicks, and without the need to physically go to a store, means that imprudent purchases are more likely to happen online than in traditional bricks-and-mortar businesses (Dittmar et al. 2007).

An important antecedent of non-personal interaction—as it occurs in online environments millions of times every day—is trust (e.g., Gefen 2000; Gefen et al. 2008). Trust in online environments is crucial, because using the Internet may be perceived as uncertain and risky (Huston and Spencer 2002; Pavlou et al. 2007). All other factors being constant, without trust or the implementation of trust-building mechanisms, the number of Internet transactions would be much lower than it currently is. Considering the importance of trust in online shopping, as well as the facts that (i) consumers themselves indicate that 30-50% of their purchases are impulsive (Dittmar and Drury 2000; Hausman 2000; Luo 2005; Rook and Fisher 1995) and (ii) the Internet abets impulse purchases, which may lead to negative consequences for consumers (i.e., spending more money than intended), it is astonishing that, to the best of our knowledge, the two research topics of impulsiveness and of trust in online shopping have not yet been investigated simultaneously.

Against the background of this significant research gap, we examined the relationship between consumer impulsivity and trustworthiness evaluations of Internet offers. Following prior research in related fields, this paper refers to highly impulsive shoppers as hedonic shoppers, and refers to shoppers with low degrees of impulsiveness as prudent shoppers (Puri 1996). Specifically, this research-in-progress paper reports the current status of a functional magnetic resonance imaging (fMRI) research project in which we investigate differences between processes in the brains of hedonic and prudent shoppers during trustworthiness evaluations of online offers. Studying brain processes is informative because they affect both shoppers' trustworthiness evaluations (e.g., of online offers) and behavior (purchase behavior in particular); for a review see Riedl and Javor (2012).

Theoretical Background

Impulsive Buying Behavior and Neurobiological Correlates

Research on impulsive buying in offline environments has been extensive, and many studies exist that investigate the determinants of impulsive buying behavior (e.g., Hubert et al. 2013; Kacen and Lee 2002; Rook 1987; Rook and Fisher 1995). One component of impulsive buying is the focus on immediate positive affect, pleasurable feelings, and disregard for the long-term consequences of the decision (Beatty and Ferrell 1998; O'Guinn and Faber 1989; Vohs and Faber 2007). Indeed, impulsive buying often involves a hedonic component. For example, consumers frequently report that they feel elated during impulsive buying (Peck and Childers 2006). Moreover, evidence shows that impulsive buying can provide such hedonic pleasures as fun, novelty, and surprise (Hausman 2000). Another aspect related to impulsive buying is a low level of cognitive control (Ramanathan and Menon 2006; Verplanken and Herabadi 2001; Vohs and Faber 2007).

Even though impulsive buying in online environments has not yet been fully investigated as impulsive buying offline (Parboteeah et al. 2009; Zhang et al. 2007), recent studies have shown increased research interest in the topic (Floh and Madlberger 2013; Ozen and Engizek 2014; Shen and Khalifa 2012; Shirmohammadi et al. 2014;). It follows that the investigation of online impulsive buying is highly relevant, primarily because new technological accomplishments (e.g., mobile commerce, high-speed Internet) steadily improve the possibilities for shopping online (Kau et al. 2003; LaRose and Eastin 2002; Parboteeah et al. 2009; Phau and Lo 2004; Wells et al. 2011; Zhang et al. 2007). Generally, shopping online may trigger impulsive buying for several reasons, including the speed and convenience of online shopping (i.e., click and buy) (Koufaris 2002), the possibility of dynamic retargeting (i.e., an Internet advertising strategy that personalizes ad impression) (Lambrecht and Tucker 2013), the lack of cash transactions (e.g., the use of PayPal), the possibility of buying at any time and from any location (Madhavaram and Laverie 2004), and the anonymity of the Internet (Koufaris 2002). Another important factor that influences the likelihood of impulsive buying is the design of the webpage (Parboteeah et al. 2009; Phau and Lo 2004).

Research has begun to focus on investigating webpage attributes that may trigger cognitive and affective reactions, and thereby may influence the urge to buy impulsively (Adelaar et al. 2003; LaRose and Eastin 2002; Madhavaram and Laverie 2004; Parboteeah et al. 2009; Wells et al. 2011; Zhang et al. 2007). Important webpage characteristics that facilitate browsing and buying on the Internet—and thus that stimulate impulsive buying—are, for example, security-enhancing mechanisms, the possibility of paying after receiving the product (immediate reward with delayed consequences), or ease of navigation (Parboteeah et al. 2009). Generally, while studies show that consumers' impulsiveness can trigger more online purchases (Zhang et al. 2007), research has also found that the quality of a website and specific website attributes may significantly affect the behavior of impulsive consumers (Liu et al. 2013; Park et al. 2012). A consumer with high buying impulsiveness who interacts with a high quality webpage is more likely to experience an urge to buy impulsively than is a less impulsive consumer; in contrast, during interaction with a low quality webpage, a consumer with high impulsiveness is less likely to experience an urge to buy impulsively compared to a low impulsive consumer (Wells et al. 2011). It follows that high quality website attributes trigger a positive relationship between impulsiveness and online buying, whereas low quality website attributes give rise to a negative relationship (Wells et al. 2011).

From a neurobiological perspective, pleasurable feelings and approach impulses are processed by brain structures that are typically referred to as the "reward system" (Elliott et al. 2000; Walter et al. 2005). This complex network of different brain areas seeks out rewards and evades punishments by evaluating the stimulus value and predicting when a certain event will occur (O'Doherty 2004; Walter et al. 2005). The reward system drives goal-directed behavior, and corresponds to a closely linked network of brain areas that include the orbitofrontal cortex (OFC), the medial prefrontal cortex, the anterior cingulate cortex, the amygdala, and the ventral striatum (McClure et al. 2004; Sanfey 2007; Walter et al. 2005). Bechara (2005) argues that this amygdala-ventral-striatal-dependent system is highly important for the pursuit of hedonic aspects, thereby constituting an essential neurobiological substrate for impulsiveness. It modulates rapid automatic responses toward positive and negative stimuli such as large monetary gains or losses, and links features of a perceived stimulus to affective attributes (Bechara 2004; Büchel et al. 1998). Furthermore, Bechara (2005) proposes that impulsive approaches, or avoidance responses, are evoked through visceral motor structures such as the hypothalamus and autonomic brain nuclei, as well as through structures associated with behavior activation, such as the striatum, the periaqueductal gray, and other brainstem nuclei (Damasio 1994).

Another observation put forth by Bechara (2005) is that a hyperactive impulsive system that is overly sensitive to immediate prospects can overwhelm the control of the reflective system (the system responsible for more deliberate thinking), leading to impulsive behavior. In a similar vein, Bechara (2005) argues that cognitive deliberation and consideration of long-term outcomes are associated with processing in the reflective system (Lieberman 2007; Strack et al. 2006). Building on the understanding that the reflective system corresponds to brain areas such as the ventromedial prefrontal cortex (VMPFC) and the dorsolateral prefrontal cortex (DLPFC) which, in combination with brain stem nuclei and somatosensory cortices (e.g., insula cortex), trigger signals based on prior behavioral outcomes (Büchel et al. 1998; Damasio 1994), Bechara (2005) hypothesizes that a dysfunction in the reflective system that usually inhibits impulsive responses can evoke impulsive behavior. In this view, the reflective system is no longer able to control the impulsive system, and behavioral responses are then predominantly determined by signals emerging from the impulsive system.

Several neuroscientific studies (Boes et al. 2009; Chen et al. 2007; Potts et al. 2006) support Bechara's (2005) theories. Prefrontal structures such as the VMPFC and the DLPFC are frequently associated with reflective processes and deliberate decision making (Ridderinkhof et al. 2004). In contrast, damage to and dysfunction of the prefrontal cortex has been associated with disadvantageous decisions and the inability to suppress impulsive behavior, especially with regard to addiction and pathological behavior (Chen et al. 2007; Dawe et al. 2004; Jentsch and Taylor 1999; Tanabe et al. 2007). Boes et al. (2009) add further evidence in a study demonstrating that the size of the VMPFC varied in boys who differed in rated motor impulsivity and non-planning behavior. As well, Potts et al. (2006) provide evidence that impulsive behavior is associated with reduced punishment sensitivity and a lack of control.

Trust in Online Settings and Neurobiological Correlates

In the last decade the Internet became an important platform that changed the way people work and communicate. Along with these developments, the explosion of possibilities for purchasing online have dramatically changed the way people shop (Ba and Pavlou 2002). With the widespread adoption of the Internet, trust in online settings became a central research topic (e.g., Ba and Pavlou 2002; Gefen et al. 2003; Jarvenpaa et al. 1999; McKnight et al. 2004; Pavlou and Gefen 2004; Riedl et al. 2010a). Even though it is possible, at least to some degree, to explain online consumer behavior using traditional approaches (e.g., questionnaires, field studies), there are important differences between online and offline purchase situations that enhance the role of trust in online settings (Heijden et al. 2003).

First, if a buying transaction is conducted over the Internet, the interacting parties usually do not meet in reality. It is very difficult to evaluate personal characteristics in the way that a typical face-to-face interaction makes possible (Ba and Pavlou 2002; Gefen et al. 2003; Riedl et al. 2014). Second, in e-commerce consumers not only interact with the e-vendor, but they also interact with information technology, which means that they also need to trust the safety of the transaction medium—for example, when providing sensitive personal data (Heijden et al. 2003; Lee and Turban 2001; Moody et al. 2010). Third, another important point where trust is required is the security of online payments. From a consumer perspective, without face-to-face interaction, online consumers have limited ability to control how their sensitive personal and financial data are handled, and they cannot readily control unauthorized tracking of transactions by the vendor (Gefen et al. 2003; Lee and Turban 2001). Fourth, the customer is confronted with a different shopping situation when the physical shop environment is replaced by an online store (Heijden et al. 2003). The ability to physically check the quality of the purchased product is so limited as to seem nonexistent, preventing haptic information processing. This information asymmetry, obviously, may give rise to opportunistic behavior (Ba and Pavlou 2002; Lee and Turban 2001). Altogether, these four differences increase the risk for consumers and show that a higher trust level is required for purchases made on the Internet than for traditional shopping if perceived risk and feelings of uncertainty are to be reduced (Heijden et al. 2003). Furthermore, by assuming that the company or another individual (e.g., on eBay) will not behave opportunistically, trust can mitigate social complexity that would otherwise prevent the consumer from purchasing (Gefen et al. 2003). If trust is lacking, consumers are less likely to buy from e-vendors (Lee and Turban 2001).

Several published fMRI-studies have identified various brain regions associated with trust (Baumgartner et al. 2008; Delgado et al. 2005; Dimoka 2010; King-Casas et al. 2005; Krueger et al. 2007; Winston et al. 2002; for a review see Riedl and Javor 2012). In general, this review shows that limbic and prefrontal structures, as well as the striatum and the insular cortex, are crucial for the generation of trust. With regard to limbic structures, the anterior cingulate cortex is associated with trust situations (Baumgartner et al. 2008; King-Casas et al. 2005; Riedl et al. 2010b) and may play an important role in processing information during online shopping by being involved in weighing the benefits and risks of online offers. Dimoka (2010), Krueger et al. (2007), and Riedl et al. (2014), among others, have identified the anterior paracingulate cortex as linked to mentalizing and to predicting whether the interaction partner will behave in a trustworthy way. Furthermore, prefrontal brain areas have been found to be important in trust situations (Krueger et al. 2007). For example, the dorsolateral prefrontal cortex (DLPFC) plays a central role for linking information about rewards to actual behavior (Heekeren et al. 2006). This process is very important for the evaluation of trustworthiness. Riedl et al. (2010b) found DLPFC activation during decision making in both trustworthy and untrustworthy eBay offers. During browsing and shopping on the Internet, the evaluation of risks and benefits, which would include anticipation of consequences, is important for making an advantageous decision. Another prefrontal structure associated with trust situations is the OFC (Baumgartner et al. 2008; Delgado et al. 2005; Dimoka 2010; King-Casas et al. 2005; Krueger et al. 2007; Winston et al. 2002).

In addition to limbic and prefrontal structures, studies show that the striatum is important in reward situations. Activity changes in the striatum are often linked to the processing and anticipation of rewards (O'Doherty et al. 2004). With regard to trust situations, investigations reveal that major structures of the striatum, such as the putamen and caudate, are important for the intention to trust and for social cooperation (Baumgartner et al. 2008; Delgado et al. 2003). A study conducted by Kosfeld et al. (2005) shows that the administration of oxytocin, a small peptide that acts as a neuroactive hormone and neurotransmitter in the striatum increases the level of trust. Contrasting negative emotions such as disgust and uncertainty are often associated with the insular cortex (Aimone et al. 2014; Baumgartner et al. 2008; Delgado et al. 2005). Riedl et al. (2010b), for example, found that untrustworthy Internet offers activate the insular cortex, in both men and women.

Investigating the Relationship of Trust and Consumer Impulsiveness

From a behavioral perspective, studies show that online shopping often triggers impulsive buying decisions (Floh and Madlberger 2013; Liu et al Zhang et al. 2007). Also, studies show that trust in online offers is an important factor for online shopping and successful online transactions (Gefen et al. 2003; Salo and Karjaluoto 2007). Chen (2011) provides evidence that both the propensity to trust and buying impulsiveness are strong predictors of consumers' willingness to engage in online purchasing, and Hsu et al. (2011) shows that the greater the trust propensity, the stronger the relationship between flow experience and impulsive buying. Thus, we argue that both trust and impulsive buying influence the willingness of consumers to buy online and, therefore, a joint investigation of trust and impulsivity in online settings is of significant interest for information systems (IS) research (Ling et al. 2010).

With regard to neurophysiological insights, IS research in recent years has revealed the growing importance of neuroscience and psycho-physiological methods and tools. A major objective is to better understand how the brain operates in IS-relevant contexts (e.g., human-computer interaction; see Dimoka et al. 2011; Riedl et al. 2010a), and to use this information for system design (e.g., vom Brocke et al. 2013). For the investigation of the relationship between trust perceptions and consumer impulsiveness, it is important to note that empirical investigations have revealed that brain regions associated with trust and impulsivity partially overlap (e.g., caudate nucleus, dorsolateral prefrontal cortex). It follows that it is possible for trust and impulsivity to functionally share a common neural basis that might influence the way people shop on the Internet.

On this basis, we expect that impulsiveness, here conceptualized as a personal trait, will moderate the neural activity pattern during perception and evaluation of online offers that differ with regard to their trustworthiness. Moreover, we expect that different neural activation patterns—especially within prefrontal areas (DLPFC, iFG) and the striatum (i.e., caudate nucleus)—will lead to behavioral differences. Next, we present methodological details of our research-in-progress paper, and continue with the presentation of preliminary, yet promising, results on the relationship between impulsivity and online trustworthiness evaluations.

Method

Ten male and ten female healthy, right-handed subjects participated in the fMRI study (M_{age} = 31.8 years, SD =1.73, range = [30, 35]; no gender differences in age, $t(18) = -1.610$, $p=.125$). All participants provided written informed consent prior to the scanning sessions. Participants were informed that the examination could potentially reveal medically significant findings, and they were asked whether they would like to be notified in such a case. For their participation, all subjects received 20 Euro in cash and one of the USB flash drives (selected randomly) that were used as stimulus material.

After the fMRI experiment, we asked participants to complete the prudence subscale of Puri's (1996) Consumer Impulsiveness Scale, which was used as moderator for our main analysis (CI_{group}). This scale has been frequently applied in previous related research (Ramanathan and Menon 2006; Wertenbroch 1998). Participants indicated how seven attributes (self-controlled, farsighted, responsible, restrained, rational, methodical, a planner) described them on a 7-point scale from 1 (*Usually would describe me*) to 4 (*Sometimes would describe me*) to 7 (*Seldom would describe me*). Following Puri's (1996) methodology, we applied a median split (Median=24.5) of the prudence scale (M=24.7, SD=6.913, alpha = 0.740) for all participants (Ramanathan and Menon 2006).

Next, we divided the participants into two groups: 10 of 20 participants with a score below the median of 24.5 were defined as group "prudent" (CI_{PG}), and the remaining 10 participants with a score above the median of 24.5 were defined as group "hedonic" (CI_{HG}). A two-sample independent t-test revealed a significant difference between both groups (M_{PG}= 19.4, SD=4.599; M_{HG}= 30, SD=4.163, $t(18)=5.403$, $p < .001$; no age differences were found: $t(18) = 0.925$, $p = .315$).

Furthermore, to avoid potential confounding effects, we used established survey instruments to measure general trust level (Rotter 1967: 25 items, range = [25,125]; *M*=65.6, SD=8.159); familiarity with the Internet ((i)duration of Internet usage per week (in hours), *M*=12.55, SD=7.46; (ii) duration of Internet usage overall (in months), *M*=92.15, SD=48.49; (iii) duration of eBay affinity overall (in months), *M*=44.72, SD=32.3), the average value of successful auctions (in €, *M*=38.11, SD=60.56), as well as attitude and experience towards eBay (five-point Likert scale with 1 = "extremely positive" to 5 = "extremely negative", $M_{attitude}$=2.55, SD=0.068; $M_{experience}$=2.45, SD=0.51). As no outliers were observed, data from all participants were included in the analysis.

The development of stimulus material (i.e., product description texts) was based on Toulmin's model of argumentation (Toulmin, 1958), and was embedded in realistic eBay offers. In essence, Toulmin's (1958) model proposes a layout containing four interrelated components for analyzing arguments: claim, data, backing, and rebuttal. We used these components to manipulate the independent variable (i.e., trustworthiness of eBay offers) in our experiment. Specifically, we used five trustworthiness classes (A = "*no description*", B = "*claim only*", C = "*claim + data*", D = "*claim + data + backing*", E = "*claim + data + backing + rebuttal*"). Thus, based on the application of Toulmin's model, we manipulated the independent variable (more details on stimuli development and validation are available in Riedl et al. 2010b).

The study was executed on a 3T fMRI-scanner (Magnetom Trio, SIEMENS, Erlangen, Germany). The task for the participants was to press one of two corresponding buttons on a response box to indicate, at the end of a time frame (12 seconds), whether they considered an offer to be trustworthy or untrustworthy. After the 12 seconds, participants saw a fixation cross for 3 seconds. Then the next offer was presented, and the displays continued in this way. The sequence of the offers was pseudo-randomized for every subject. In total, every subject had to evaluate 120 offers (30 stimuli repeated four times). We recorded the responses with the use of specific software (COGENT), and calculated the mean evaluation (individual trustworthiness share ($indTS_{class}$)) of all five trustworthiness classes for each participant. Values ranged from 0 to 1. High values indicate that participants perceived the eBay offers in the respective class to be trustworthy; low values indicate that the eBay offers were perceived as untrustworthy. Analysis of the present data was conducted with the SPM8 freeware (Friston 1996; Friston et al. 1994) using MatLab as a working base. To correct for artifacts due to participant head movement in the scanner, all images were realigned by a "rigid body" transformation to the first image of the session (realignment). All images were normalized and re-sampled to the standard Montreal Neurological Institute (MNI) template (normalization) and smoothed with an 8-mm Gaussian kernel (smoothing) (Ashburner et al. 1997).

With regard to the main analysis, for each subject a General Linear Model (GLM) modeled an event of interest (trustworthiness classes: A, B, C, D, E) by using a parametric modulator for the corresponding trustworthiness share for each stimulus (the aggregated sample mean for each stimuli based on the individual trustworthiness shares for each stimulus). We then calculated the following first-level single-subject contrasts of interest: 1) positive correlations between parameter and brain activity, and 2) negative correlations between parameter and brain activity. On the second level, for extracting differences of single-subject contrasts between subjects, we computed a one-sample t-test over all subjects. We generated statistical parametric maps for the given contrast that displayed the *t*-value of each peak voxel meeting a $p < .001$ (uncorrected) significance level with an extent threshold of 10 voxels.

In the following, for a brain-behavior-independent analysis we extracted the parameter estimates (beta values) for each trustworthiness class (A, B, C, D, E) due to an independent region-of-interest (ROI's) following the procedure in Litt et al. (2011). In particular, for each subject *i* we identified a peak voxel for the contrast of interest by selecting the voxel within the anatomical area of interest that exhibited peak activity for the contrast in a mixed-effects analysis which included all subjects except for *i*. For each subject, we computed an average parameter estimate over the sessions, using a spherical mask centered on the MNI coordinates with a 6mm radius. The set of extracted parameter estimations (beta values) was then averaged and plotted with a concentration on effects between the five trustworthiness classes with respect to participants' consumer impulsiveness (CI_{PG}/CI_{HG}).

Results

With regard to behavioral differences in trustworthiness ratings between the selected trustworthiness classes and consumer impulsiveness groups, we entered the individual trustworthiness shares ($indTS_{class}$) and $Group_{PG/HG}$ as between subject factor into an one-way ANOVA (with trustworthiness classes: A, B, C, D, E) corrected for repeated measures using the Greenhouse-Geisser (GG) correction criterion, and found a significant main effect for trustworthiness class (manipulation check); $F(2.630, 47.337) = 21.240$, $p < .001$, $\eta_p^2 = .541$, a significant main effect for $Group_{PG/HG}$; $F(1, 18) = 4.245$, $p = .054$, $\eta_p^2 = .191$, but no interaction effect of trustworthiness class*$group_{PG/HG}$; $F(2.630, 47.337) = 0.249$, $p = .837$, $\eta_p^2 = .014$. Pairwise corrected comparisons showed significant differences between all trustworthiness classes with regard to their trustworthiness shares ($0.001 < p < .014$), except for A versus B ($p = .208$). Additionally, with respect to participants consumer impulsiveness (CI_{PG}/CI_{HG}), we found differences for each group in their changes in trustworthiness evaluation between each trustworthiness class (B to A; C to B; D to C; E to D), especially in more significant changes for group CI_{PG} (Figure 1).

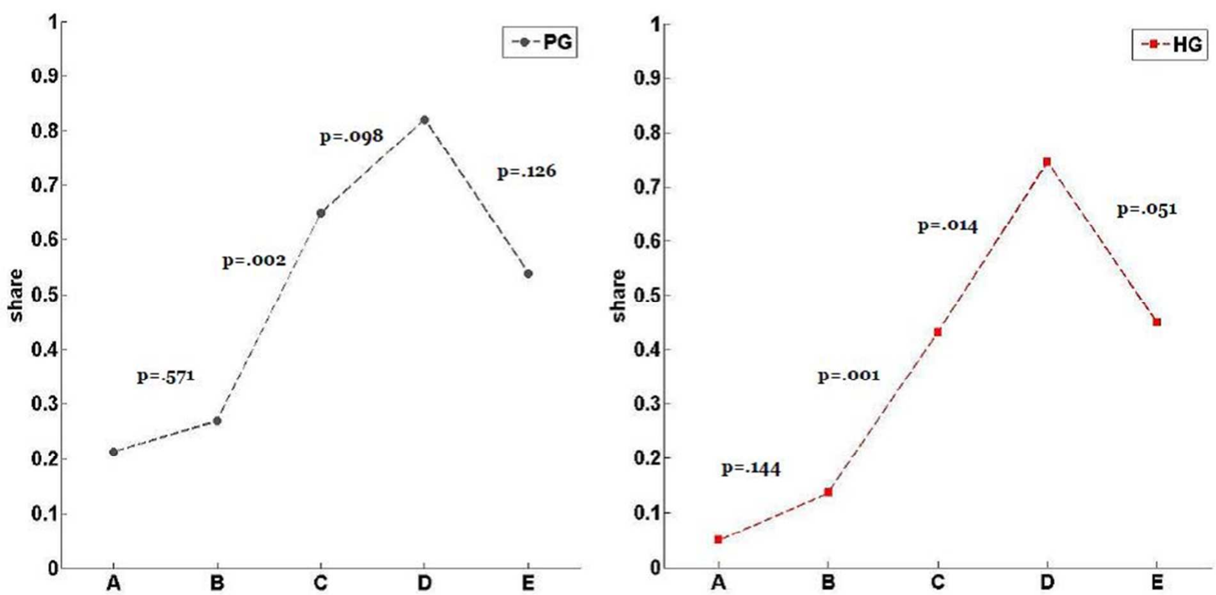

Figure 1. Aggregated Trustworthiness Evaluations for Each Class (A, B, C, D, E) and Group (PG, HG); p-Values Show Significant Differences in Changes of Trustworthiness Shares Between Classes Within Group

Furthermore, we were interested in the investigation of correlations between increasing and decreasing scores of trustworthiness shares, and corresponding activity changes within the brain. In addition to activity changes in regions that have limited relevance in trust situations (e.g., lingual gyrus, parietal lobe), *with increasing values of trustworthiness shares* we identified a main cluster of caudate nucleus ($p_{cluster} = .007$; $q_{FDR(cluster)} = .091$, $k_E=198$) as a region-of-interest with three different sub-peaks: (a) right caudate head, 8, 16, 10, (T=5.59); b) left caudate head, -6, 18, 14 (T=5.14), and c) right dorsal striatum (caudate body), 10, 22, 2 (T=5.13).

In contrast, *with decreasing values of trustworthiness shares* we identified four main clusters as regions-of-interest: the anterior cingulate gyrus (-2,-10, 50, $p_{cluster} = .097$; $k_E=67$), the inferior frontal gyrus (iFG, BA 46) ((a) -44, 38, 18, $p_{cluster} = .069$; $q_{FDR(cluster)} = .165$, $k_E=77$), the dorsolateral prefrontal cortex (dlPFC, BA 9) ((b) 42, 8, 24, $p_{cluster} = .002$; $q_{FDR(cluster)} = .013$, $k_E=271$), and the insula ((c) -42, -2, 4, $p_{cluster} = .018$; $q_{FDR(cluster)} = .086$, $k_E=142$). Second-level comparison of first-level contrast for PG versus HG also showed differences in regions of interest, especially with a higher relevance for the caudate nucleus, the dorsolateral prefrontal cortex (DLPFC), the inferior frontal gyrus (iFG), and the insula (height threshold T = 3.505, $p < .001$ [unc.], $k > 10$) (Figure 2).

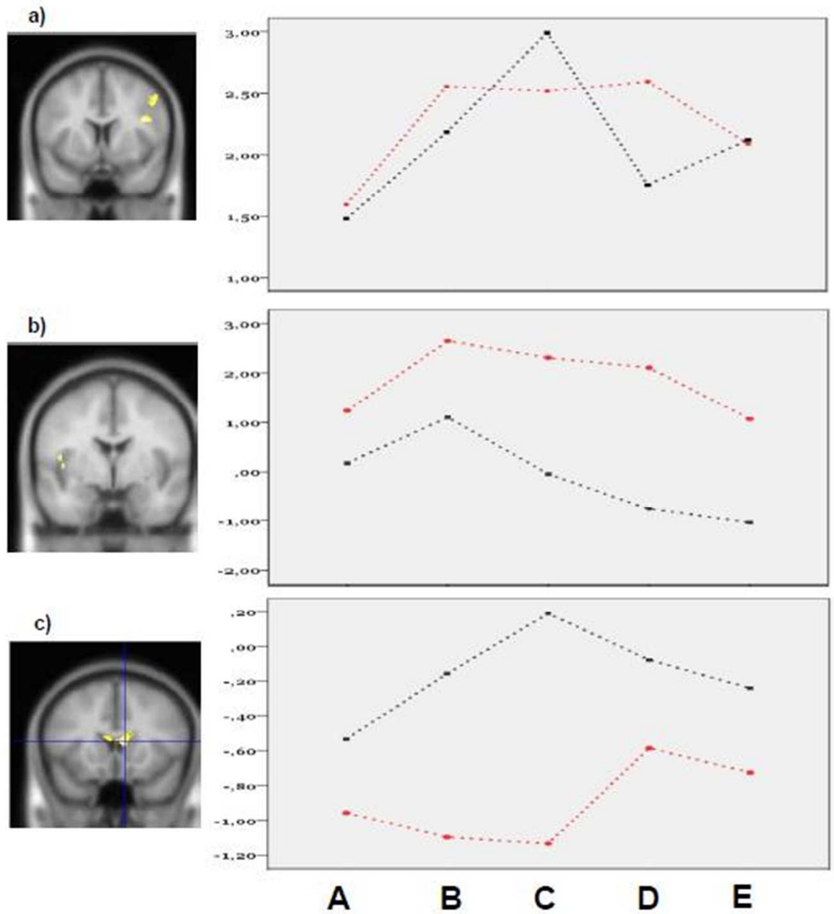

Figure 2. Extracted Parameter Estimates (Beta Values) for Selected Peak Cluster for a) DLPFC, b) Insula, and c) Right Caudate Head from Region-of-Interest Analysis with regard to PG and HG

DISCUSSION

Based on an exploratory analysis of an fMRI dataset, we (i) identified the impact of consumer impulsiveness on trustworthiness evaluations within an online environment, and (ii) revealed the neural correlates of an interaction between consumers' impulsiveness and trustworthiness evaluations. Here, we show that varying levels of trust-assuring arguments in eBay offers result in significant differences in both trustworthiness evaluations and brain activation patterns for participants defined as hedonic and prudent.

The comparison between both groups revealed that there is a significant difference in the process of trustworthiness evaluation of both groups: The prudent group evaluated all trustworthiness classes more moderately and showed a significant increase in trustworthiness ratings only between classes C and B. In contrast, the hedonic group rated the different trustworthiness classes and the underlying information more strongly, and revealed significant changes between all trustworthiness classes except for A versus B (Figure 1). This result may indicate that with a given level of information, the prudent group moderately evaluates any additional information with regard to its trust-value, whereas for the hedonic group any new information seems to have a higher (positive or negative) impact on their perception of trustworthiness.

With regard to our fMRI analysis, we found, among other results, significant differences in the activation of the DLPFC, insular cortex and caudate nucleus. The ***DLPFC*** is an important brain region that seems to "monitor" the assigned values of the VMPFC by exercising self-control (Hare, et al., 2009). Furthermore, the DLPFC is suggested to play a prominent role for cognitive control, working memory, and uncertainty processing, and the right part of the brain, especially, is associated with the perception of fair and unfair offers (Knoch et al. 2006; McClure et al. 2004; Sanfey et al. 2003; Schaefer et al. 2006). Activity changes in the ***insula cortex*** are often linked to the representation of patterns of affective states from prior experiences of reward and punishment (Bechara 2005), and have been associated with uncertainty, pain, and negative emotions (including anger, disgust, and fear) (Eisenberger and Lieberman 2004; Knutson et al. 2007; Sanfey et al. 2003). Studies have also shown the changes to be greater for unattractive stimuli than for attractive stimuli (Krendl et al. 2006; O'Doherty et al. 2003; Tsukiura and Cabeza 2011). The ***caudate nucleus***—a key structure for impulsive decision making (Breiter et al. 2001; Knutson et al. 2000; Lamm 2007; O'Doherty 2004)—is often associated with trust (Baumgartner et al. 2008; King-Casas et al. 2005), emotions, and motivated behavior (Delgado et al. 2003; Haruno and Kawato 2006). Against this background, we can assume that the prudent group applies a different evaluation process in order to decide whether an offer is trustworthy or not.

First, an *untrustworthy offer* is perceived as less trustworthy by impulsive shoppers, as compared to non-impulsive shoppers (Figure 2). This result can also be seen in the lower first-sight volatility of activity changes within the DLPFC, the higher activity changes in the insula cortex, and the lower activity changes in the caudate head in the hedonic group, if compared to the prudent group. Second, a *trustworthy offer* is evaluated more positively (seen in a significant increase in trustworthiness between D and C as well as between D and E) from the impulsive group, if compared to the prudent group (non-significant changes). Thus, a trustworthy offer may specifically trigger impulsive purchases by hedonic shoppers on the Internet. With regard to brain activation, during evaluation of the offer with the highest trustworthiness (D), the hedonic group exhibits the lowest activation of the insula. This result may be seen as a neural explanation for the phenomenon of "blind trust" (Mezias and Boyle 2005) because one of the insula's major functions is to signal risk and uncertainty so that individuals remain observant. Additionally, we found a significant increase in the activation of the caudate nucleus for the highest trustworthiness class in the hedonic group. These findings are in line with studies showing that for impulsive buyers the quality of a webpage is very important for the coherence of impulsive purchases (Wells et al. 2011).

CONCLUSION

With the integration of behavioral and fMRI data, our study shows that impulsiveness can exert significant influence on the evaluation of online offers, and also potentially affects subsequent purchase behavior. Even though there are similarities between the decision making processes of the hedonic and prudent shoppers, we also found significant differences. Our data provide evidence that impulsive consumers evaluate trustworthy and untrustworthy offers differently, if compared to non-impulsive consumers. With regard to brain activation, both groups exhibit similar neural activation tendencies, but differences exist in the magnitude of activation patterns in brain regions that are closely related to trust and decision making, such as the DLPFC, the insula cortex, or the caudate nucleus. The next step in our ongoing research is to run a behavioral study with a larger sample size that draws upon our findings; moreover, we continue our analyses of brain regions and their influence on trustworthiness evaluations and impulsive buying.

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