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Trust me if you can – neurophysiological insights on the influence of consumer impulsiveness on trustworthiness evaluations in online settings

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Abstract

Purpose – The purpose of this study is to examine how consumer personality trait impulsiveness influences trustworthiness evaluations of online-offers with different trust-assuring and trust-reducing elements by measuring the brain activity of consumers. Shoppers with high degrees of impulsiveness are referred to as hedonic shoppers, and those with low degrees are referred to as prudent consumers.

Design/methodology/approach – To investigate the differences between neural processes in the brains of hedonic and prudent shoppers during the trustworthiness evaluation of online-offers, the present study used functional magnetic resonance imaging (fMRI) and region-of-interest analysis to correlate neural activity patterns with behavioral measures of the study participants.

Findings – Drawing upon literature reviews on the neural correlates of both trust in online settings and consumer impulsiveness and using an experimental design that links behavioral and fMRI data, the study shows that consumer impulsiveness can exert a significant influence on the evaluation of online-offers. With regard to brain activation, both groups (hedonic and prudent shoppers) exhibit similar neural activation tendencies, but differences exist in the magnitude of activation patterns in brain regions that are closely related to trust and impulsiveness such as the dorsal striatum, anterior cingulate, the dorsolateral prefrontal cortex and the insula cortex.

Research limitations/implications – The data provide evidence that consumers within the hedonic group evaluate online-offers differently with regard to their trustworthiness compared to the prudent group, and that these differences in evaluation are rooted in neural activation differences in the shoppers' brains.

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Practical implications – Marketers need to be made aware of the fact that neurological insights can be used for market segmentation, because consumers' decision-making processes help explain behavioral outcomes (here, trustworthiness evaluations of online-offers). In addition, consumers can learn from an advanced understanding of their brain functions during decision-making and their relation to personal traits such as impulsiveness.

Originality/value – Considering the importance of trust in online shopping, as well as the fact that personality traits such as impulsiveness influence the purchase process to a high degree, this study is the first to systematically investigate the interplay of online trustworthiness perceptions and differences in consumer impulsiveness with neuroscientific methods.

Keywords Trustworthiness, Trust, Online shopping, Impulsiveness, Consumer neuroscience, Functional magnetic resonance imaging

Paper type Research paper

Introduction

The increasing digitalization of everyday life is accompanied by the rise of radically new shopping possibilities, and consumers are faced with an enormous offer of offline and online shops (Ba and Pavlou, 2002; Verhoef *et al.*, 2015). Therefore, the investigation of consumers' information search and purchase behavior within the multilayered interaction of different online (i.e. Web stores and apps) and offline channels (i.e. regular stores), as well as customer touchpoints (i.e., social media, TV ads), is a very complex undertaking in contemporary marketing research and of large interest for both researchers and practitioners (Becker *et al.*, 2017; Braun and Moe, 2013; Verhoef *et al.*, 2015).

Given these complex, interchangeable and simultaneously usable online and offline channels (Verhoef *et al.*, 2015), consumers' ability to trust specific (product) information and hence to perceive an offer, product, service or cooperation partner as trustworthy represents an important antecedent for interpersonal interactions in offline and online contexts (Kim and Peterson, 2017; Pengnate and Sarathy, 2017). Especially because of its strong influence on purchases or the use of a service, trust is a central research topic in marketing and information systems research (Ba and Pavlou, 2002; Bleier and Eisenbeiss, 2015; Chang *et al.*, 2016; Gefen *et al.*, 2003; Gefen *et al.*, 2008; Kim and Peterson, 2017; McKnight *et al.*, 2004; Pavlou and Gefen, 2004; Pavlou *et al.*, 2007; Riedl *et al.*, 2014a; Wang *et al.*, 2016).

Although trust is very relevant for any purchase decision, it plays an even greater role in online settings (Bart *et al.*, 2005; Heijden *et al.*, 2003; Wang and Emurian, 2005). Compared to offline environment, online purchases differ with regard to mainly anonymous non-personal interaction (i.e. via a Web shop or an app) without typical face-to-face contact between the trustor and trustee (Ba and Pavlou, 2002; Gefen *et al.*, 2003; Riedl *et al.*, 2014b; Wang and Emurian, 2005), the interaction with information technology instead of a human (Hubert *et al.*, 2017; Linzmajer *et al.*, 2015; Lee and Turban, 2001; Moody *et al.*, 2010), the ambiguous security of online transactions (Gefen *et al.*, 2003; Lee and Turban, 2001) and information asymmetries (Ba and Pavlou, 2002; Lee and Turban, 2001). These differences often increase consumers' perceived uncertainty, and it has been shown that online environments require a higher level of trust (Heijden *et al.*, 2003).

Past research has dealt with online trust as one of the key determinants of the success of e-retailers and service providers, on the one hand, and with psychological antecedents of online trust, on the other hand (for a review, see Kim and Peterson, 2017). In particular, the question of what "happens" in the consumer¨s mind before or while a person decides to trust in online offers is still a future research endeavor and remains mainly unsolved to date (Kim and Peterson, 2017). As previous research on online trust has shown, consumer characteristics (i.e. personality traits, socio-demographics, expertise or experiences) are central determinants and/

or moderators for both the trusting process and the online shopping process (Ansari *et al.*, 2008; Bart *et al.*, 2005; Kau *et al.*, 2003; Moe, 2003; Riquelme and Román, 2014; Verhoef *et al.*, 2007). It follows that it is academically and practically stimulating to know if and how these consumer characteristics influence online trust. As e-commerce activity of consumers is an individual decision, it is necessary to understand individual difference variables that drive or moderate online trust (Kim and Peterson, 2017). To do so, this study focuses on consumer impulsiveness as important personality trait and central consumer characteristic that may moderate the online trusting and shopping process.

From a theoretical perspective, trust and trustworthiness evaluations can be evoked by more affect-based (emotionally driven) or more cognition-based (rationally and reasoning-driven) processes stemming from experiences and expectations (Holste and Fields, 2010; Kyriazis *et al.*, 2012; McAllister, 1995). Similar to the affect- and cognition-based differentiation of trust and trustworthiness, scientific literature on impulsiveness also distinguishes between either a stronger affect-based or a stronger cognition-based decision-making process (Samson and Voyer, 2012; Shiv and Fedorikhin, 1999; Vohs and Faber, 2007). Against this background, consumer impulsiveness may significantly affect trustworthiness perceptions in buying situations, and particularly in online buying situations in which trust plays a crucial role. Thus, considering the importance of both trustworthiness perceptions and consumer impulsiveness as important drivers of (impulsive) purchase processes in an offline setting (Amos *et al.*, 2014; Dholakia, 2000; Hubert *et al.*, 2013; Park *et al.*, 2012; Rook and Fisher, 1995; Sharma *et al.*, 2010) might help to better understand buying processes in an online context (Jeffrey and Hodge, 2007; Verhagen and van Dolen, 2011). However, to the best of our knowledge, the interplay of online trustworthiness perceptions and differences in consumer purchase impulsiveness has not been investigated so far.

Importantly, research has already shown that consumers' decision-making processes in general (Plassmann *et al.*, 2015), but also with regard to trust, trustworthiness perceptions (Riedl and Javor, 2012) and consumer impulsiveness (Hubert *et al.*, 2013), are influenced by unconscious and implicit processes, which are, by definition, difficult to measure with conventional methods such as self-reports. Thus, the use of neurophysiological and neuroscientific methods (i.e. functional magnetic resonance imaging [fMRI], electroencephalography [EEG] and functional near-infrared spectroscopy [fNIRS]) in marketing (Hubert and Kenning, 2008; Lee *et al.*, 2007; Plassmann *et al.*, 2015) and in information systems research (Riedl and Léger, 2016) established new research streams (neuromarketing/consumer neuroscience, NeurIS, etc.) to investigate these unconscious processes (Camerer and Yoon, 2015). A major objective is to better understand how the brain operates in different contexts (i.e. brand perception, price perception and purchase behavior) and to identify general and specific neural processes underlying judgement and consumers` decision-making (Plassmann *et al.*, 2015).

Against this background, the aim of the current study was twofold. First, this work builds on the relationship between trustworthiness evaluations of online-offers based on structured product descriptions with different trust-assuring and trust-reducing elements (Kim and Benbasat, 2006; Toulmin, 1958; 2003) and consumers' impulsiveness as a personality trait. Following prior research in this field, in this paper, consumers with high degrees of consumer impulsiveness are referred to as hedonic shoppers and those with low degrees of consumer impulsiveness are referred to as prudent shoppers (Puri, 1996). Second, and based on the evidence of unconscious processes underlying both trustworthiness perceptions (Dimoka, 2010; Riedl and Javor, 2012) and consumer impulsiveness (Hubert *et al.*, 2013; Samson and Voyer, 2012), this work compares neural processes in the brains of hedonic and prudent shoppers during the trustworthiness evaluation of online-offers. We used fMRI to investigate the neural processes.

In general, fMRI is a commonly used technique in neuromarketing and consumer neuroscience with the potential to identify brain mechanisms, dissociate between different psychological processes, understand individual differences and improve the prediction of behavior (Plassmann *et al.*, 2015). In this study, fMRI was applied because of its advantages in whole-brain neuroimaging to simultaneously show cortical and sub-cortical areas (Huettel *et al.*, 2004), which is in contrast to other neurophysiological measures (i.e. EEG, fNIRS, positron-emission tomography [PET]) that exhibit different spatial and timely resolutions. In addition, past researchers have used fMRI to investigate participants` responses during the decision-making process (Craig *et al.*, 2012). This may be particularly important regarding our field of research, as the responses during decision-making may differ from post hoc rationalizations after a decision is made (Reimann *et al.*, 2010).

In the following, we continue with a detailed description of the theoretical background of the present study, which forms the conceptual foundation for the hypotheses that we empirically tested in a laboratory experiment.

Theoretical background and hypotheses development

Trust, perceived trustworthiness and neural correlates

Trust is a very abstract and complex construct, and its definitions vary depending on the context (Rousseau *et al.*, 1998; Wang and Emurian, 2005). In an offline – especially marketing and consumer behavior – context, trust is an important behavioral factor influencing buying decisions (Kenning, 2008) and is often investigated, for example, with regard to customer relationship management (Morgan and Hunt, 1994) or interactions with salespersons (Swan *et al.*, 1999).

Trust in an online setting is composed of different main constructs – such as the disposition to trust, institution-based trust, Web vendor interventions, trusting beliefs and trusting intentions (Lee and Turban, 2001; McKnight and Chervany, 2001). The disposition to trust and institution-based trust can be seen as a prerequisite for a basic willingness to cooperate and to start interactions with others in an online environment. Web vendor interventions are external drivers to influence trust. According to trusting beliefs, perceived trustworthiness is seen as substitutional (Jarvenpaa *et al.*, 1999; Mayer *et al.*, 1995) and is either investigated by its sub-constructs (e.g. ability, integrity and benevolence) or merged into one construct, especially in initial stages of consumers' trust-building processes (Bhattacharya *et al.*, 1998, McKnight and Chervany, 2001). In general, trustworthiness is related to consumers' perceptions and evaluations of different components within an online setting (web page, product description, social media appearance, etc.) (Kim and Benbasat, 2006; McKnight *et al.*, 2002). In consequence, trustworthiness is seen as a main mediator between the other trust constructs (i.e. disposition to trust, institution-based trust) and behavior and plays an active part in positively influencing trusting intentions and, therefore, behavior.

There already exist many fMRI studies that have identified various brain regions associated with (interpersonal) trust and trustworthiness perceptions, but often in an offline context with the use of the trust game or other (social) interaction scenarios (Baumgartner *et al.*, 2008; Delgado *et al.*, 2005; King-Casas *et al.*, 2005; Krueger *et al.*, 2007; Winston *et al.*, 2002; for a review see Riedl and Javor, 2012). With regard to an online context (i.e. online purchases and social media interaction), there exist fewer studies investigating brain regions associated with non-personal trust processes (Dimoka, 2010; Javor *et al.*, 2016; Kopton *et al.*, 2013; Riedl *et al.*, 2010; Riedl *et al.*, 2014b). In general, these studies show that the striatum, cingulate and prefrontal structures, as well as the insular cortex, are crucial for the generation of trust. Based on an extensive literature search [GoogleScholar; neurosynth.org (based on Yarkoni *et al.*, 2011)], Table I gives an overview of relevant studies with regard to the investigation of trust, trustworthiness and associated brain regions in an offline and online context and the number of appearance (Table I).

Consumer impulsiveness and neural correlates

Impulsive buying in an offline context has been studied extensively (Amos *et al.*, 2014; Dholakia, 2000; Kacen and Lee, 2002; Rook, 1987; Sharma *et al.*, 2010). Research findings indicate that consumers' impulsiveness as a personality trait has an important influence on (impulsive buying) decisions (Amos *et al.*, 2014; Hubert *et al.*, 2013; Sharma *et al.*, 2010), in addition to situational factors (i.e. social influence, constraints and retail environment) (Amos *et al.*, 2014). One major characteristic of consumers' impulsiveness is the tendency to seek immediate positive affect, pleasurable feelings and disregard long-term consequences (Peck and Childers, 2006; Vohs and Faber, 2007). A second important component of consumer impulsiveness and corresponding (impulsive) decisions is a low level of cognitive control (Ramanathan and Menon, 2006; Verplanken and Herabadi, 2001; Vohs and Faber, 2007). Against this background, research often distinguishes between consumers with a stronger affect and emotion-based decision-making approach (i.e. impulsive, hedonic shoppers) and consumers with a stronger self-control and stronger rational and reasoning-based decision-making approach (rational, prudent shoppers) (Amos *et al.*, 2014; Hubert *et al.*, 2013; Puri, 1996; Shiv and Fedorikhin, 1999).

Online environments have a high potential to trigger impulsive buying because of several reasons (Park *et al.*, 2012; Zhang *et al.*, 2007), including the possibility to make shopping very fast and convenient (i.e. click and buy) (Jeffrey and Hodge, 2007; Koufaris, 2002), the possibilities of dynamic retargeting (Lambrecht and Tucker, 2013), the absence of money in cash (e.g. PayPal), the possibility to buy anytime and anywhere (Madhavaram and Laverie, 2004) and the anonymity of the Internet (Koufaris, 2002). Against this background, studies on impulsive buying in online environments have mainly focused on aspects of how the structure, design, content and perceived quality of web pages or Web interfaces (Adelaar *et al.*, 2003; LaRose and Eastin, 2002; Madhavaram and Laverie, 2004; Parboteeah *et al.*, 2009; Phau and Lo, 2004; Wells *et al.*, 2011; Zhang *et al.*, 2007), socio-demographics and purchase history (Jeffrey and Hodge, 2007), online store beliefs (Verhagen and van Dolen, 2011) or product attributes and categories (Kim, 2008; Lim and Hong, 2004; Park *et al.*, 2012) foster impulsive buying decisions. However, despite its importance in an offline context, little is known about how personality traits, such as consumer impulsiveness, trigger impulsive buying processes in an online context.

From a neuroscience perspective, and according to a stronger affect- and impulsion-based decision-making process, neuroscientific research showed that pleasurable feelings and approach impulses are processed by brain structures that are part of a system 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), drives goal-directed behavior (McClure *et al.*, 2004; Sanfey, 2007; Walter *et al.*, 2005) and seems to be highly important for the pursuit of hedonic aspects, thereby constituting an essential neurobiological substrate for impulsiveness (Bechara, 2005). Generally, the "reward system" 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 such as faces or money (Bechara, 2005; Büchel *et al.*, 1998). Regions that are associated with both – the "reward system" and affective, impulsive

Article	Sample size (f/m)	Setup	Mental processes/reported brain regions								
			Reward			Uncertainty, risk, ambiguity, memory, learning and cognitive conflict					
			Caudate	Nucleus Acc.	Putamen	Thalamus	Amygdala	Insula	Parahippocampal gyrus	Temporal gyrus	Anterior Cingulate cortex
Aimone *et al.* (2014)	60 (30/30)	Trust game						•			•
Baumgartner *et al.* (2008)	49 (0/49)	Trust game	•		•	•	•	•			•
Bereczkei *et al.* (2013)	27 (14/13)	Trust game			•	•		•	•	•	•
Bos *et al.* (2012)	16 (16/0)	Faces					•	•		•	•
Carter *et al.* (2012)	18 (10/8)	Poker game		•				•			
Chang *et al.* (2011)	30 (10/20)	Trust game		•				•			•
Delgado *et al.* (2005)	12 (5/7)	Trust game	•	•	•			•	•	•	
Dzhelyova *et al.* (2011)	12 (9/3)	Faces								•	
Dimoka (2010)	15 (6/9)	eBay websites	•		•		•	•			•
Emonds *et al.* (2014)	35 (22/13)	Prisoners' dilemma								•	
Fareri *et al.* (2012)	18 (9/9)	Trust game	•		•			•		•	•
Fett *et al.* (2012)	45 (0/45)	Trust game	•			•					•
Fouragnan *et al.* (2013)	18 (0/18)	Trust game	•					•			
Kang *et al.* (2011)	16 (n.a.)	Trust game				•		•			•
Kim and Cabeza (2007)	11 (5/6)	Words					•			•	•
King-Casas *et al.* (2005)	96 (n.a.)	Trust game	•			•					•
Kopton *et al.* (2013)	20 (9/11)	User Profiles								•	•
Krueger *et al.* (2007)	44 (22/22)	Trust game									•
Lauharatanahirun *et al.* (2012)	30 (n.a.)	Trust game							•	•	
Mattavelli *et al.* (2012)	20 (10/10)	Faces					•			•	
Phan *et al.* (2010)	36 (22/14)	Trust game	•								
Platek *et al.* (2009)	11 (7/4)	Faces				•	•	•	•	•	•
Poore *et al.* (2012)	17 (9/8)	Partners		•							
Riedl *et al.* (2010b)	20 (10/10)	eBay websites	•		•	•		•	•		•
Riedl *et al.* (2014a, 2014b)	19 (8/11	Trust game (avatars)									•
Said *et al.* (2009)	32 (15/17)	Faces	•			•	•				
Smith-Collins *et al.* (2013)	24 (24/0)	Trust game	•								•
Sripada *et al.* (2009)	26 (16/10)	Trust game			•					•	
Stanley *et al.* (2012)	40 (22/18)	Trust game	•		•		•	•	•	•	•
Van den Bos *et al.* (2009)	22 (11/11)	Trust game						•			•
Van den Bos *et al.* (2012)	54 (27/27)	Trust game									
Wardle *et al.* (2013)	31 (20/11)	Trust game	•							•	
Watabe *et al.* (2011)	21 (0/21)	Statement	•		•						•
No. of appearance			Caudate	Nucleus Acc.	Putamen	Thalamus	Amygdala	Insula	Parahippocampal gyrus	Temporal gyrus	Anterior Cingu-late cortex
			14	4	9	8	8	15	6	14	20

(continued)

Table I.
Literature review on relevant fMRI studies with regard to trust/trustworthiness

Table I.

Article	Mentalizing and deliberative thinking: Frontal cortex	vmPFC	DLPFC	OFC	Occipital gyrus	Fusiform	Others: Pre-cuneus	Lingual gyrus	TPJ
	Mental processes/reported brain regions								
Aimone *et al.* (2014)	●		●						
Baumgartner *et al.* (2008)									
Bereczkei *et al.* (2013)	●				●	●	●	●	
Bos *et al.* (2012)	●			●					
Carter *et al.* (2012)	●			●		●	●		●
Chang *et al.* (2011)	●	●	●						
Delgado *et al.* (2005)	●	●		●			●		
Dzhelyova *et al.* (2011)					●				
Dimoka (2010)	●			●	●	●	●		
Emonds *et al.* (2014)	●						●		●
Fareri *et al.* (2012)	●				●	●	●		
Fett *et al.* (2012)	●		●		●		●	●	●
Fouragnan *et al.* (2013)	●	●	●						
Kang *et al.* (2011)	●	●	●	●					
Kim and Cabeza (2007)	●		●				●		
King-Casas *et al.* (2005)	●		●						
Kopton *et al.* (2013)	●				●				
Krueger *et al.* (2007)									
Lauharatanahirun *et al.* (2012)	●					●	●		
Mattavelli *et al.* (2012)					●	●			
Phan *et al.* (2010)				●					
Platek *et al.* (2009)	●				●	●		●	
Poore *et al.* (2012)	●	●							
Riedl *et al.* (2010b)	●	●	●			●	●	●	
Riedl *et al.* (2014a, 2014b)	●	●	●	●	●		●		
Said *et al.* (2009)	●								
Smith-Collins *et al.* (2013)	●		●	●					
Sripada *et al.* (2009)	●				●			●	
Stanley *et al.* (2012)	●						●	●	
Van den Bos *et al.* (2009)	●		●						●
Van den Bos *et al.* (2012)	●		●						●
Wardle *et al.* (2013)	●								
Watabe *et al.* (2011)	●								
No. of appearance	Frontal cortex 28	vmPFC 7	DLPFC 12	OFC 8	Occipital gyrus 10	Fusiform 8	Precuneus 12	Lingual gyrus 6	TPJ 5

decision-making – are often striatal areas (i.e. ventral/dorsal striatum) (Haber and Knutson, 2010; Kennis *et al.*, 2013; Plichta and Scheres, 2014; Tanaka *et al.*, 2007) and the nucleus accumbens (Kennis *et al.*, 2013; Peterson, 2005).

According to stronger cognition- and reasoning-based decision-making processes, cognitive deliberation and the consideration of long-term outcomes are associated with processing in 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 (Boes *et al.*, 2009; Büchel *et al.*, 1998; Chen *et al.*, 2007; Potts *et al.*, 2006). In general, prefrontal structures such as the vmPFC and the dlPFC are frequently associated with reflective processes, deliberate decision-making (Ridderinkhof *et al.*, 2004), cognitive control (Hare *et al.*, 2009; 2011) or impulse control (Whelan *et al.*, 2012). In contrast, dysfunctions of the prefrontal cortex have been associated with disadvantageous decisions and the inability to suppress impulsive behavior, especially with regard to addiction and pathological behavior (Boes *et al.*, 2009; Chen *et al.*, 2007; Dawe *et al.*, 2004; Jentsch and Taylor, 1999; Tanabe *et al.*, 2007). Furthermore, areas of the anterior cingulate gyrus (ACC) are associated with reflective and cognition-based processes (Bechara, 2005), especially with regard to conflict monitoring and adjustment for cognitive control (Botvinick *et al.*, 1999; Kerns *et al.*, 2004).

For affect- and cognition-based processes, the insula could play a special role. On the one hand, 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, fear and attractiveness) (Eisenberger and Lieberman, 2004; Knutson *et al.*, 2007; Krendl *et al.*, 2006; Sanfey *et al.*, 2003; Tsukiura and Cabeza, 2011). On the other hand, activity within the insula is also associated with reflection (Bechara, 2005), risk aversion and contextual appraisal (Singer *et al.*, 2009).

The joint investigation of trustworthiness perceptions and consumer impulsiveness

This study argues that the joint investigation of trustworthiness and consumer impulsiveness traits in online settings is of interest for consumer and marketing research. From a behavioral perspective, perceived trustworthiness of an online offer is an important factor for successful online transactions (Kim and Peterson, 2017; Salo and Karjaluoto, 2007; Wang and Emurian, 2005). In this regard, important components for increasing consumers' perception of trustworthiness are, for example, the availability of information and its implementation in the specific interface design (Bart *et al.*, 2005; Hong *et al.*, 2004; Urban *et al.*, 2009; Wang and Emurian, 2005). Also, the extent and content of the given (textual) information (i.e. via website interfaces, product descriptions and seller information) (Kim and Benbasat, 2006) could play a potential role. Therefore, we assume:

H1. Perceived trustworthiness increases with the implementation of trust-assuring elements (based on textual information) and decreases with the implementation of trust-reducing elements (based on textual information) regarding a given product description.

Furthermore, consumer characteristics significantly influence decisions within an online environment (Ansari *et al.*, 2008; Bart *et al.*, 2005; Moe, 2003). In particular, consumer impulsiveness as a personality trait is an important antecedent of (impulsive) purchase decisions (Amos *et al.*, 2014). Additionally, both consumer impulsiveness and trustworthiness perceptions in decision-making processes are characterized by the interplay of affect- or cognition-based processes (McAllister, 1995; Shiv and Fedorikhin, 1999; Vohs and Faber, 2007). Taking this fact into account and considering the different trust-assuring elements of a product description for consumers' perception of trustworthiness, research has shown that textual information (e.g. words) needs more (cognitive) resources for evaluation (Blanco *et al.*, 2010) and is processed more cognition-based (Xu *et al.*, 2005) than non-textual information (e.g. pictures). Therefore, consumers with higher degrees of consumer impulsiveness (hedonic shoppers) and a stronger affect-based driven decision-making process should positively recognize trust-assuring arguments and follow the assumed evaluation pattern (*H1*). However, it is assumed that hedonic shoppers perceive online offers with textual information as less valuable for their decision process (thus less trustworthy) compared to consumers with lower degrees of consumer impulsiveness (prudent shoppers) and a stronger cognition-based decision-making process. Against this, we assume:

H2a. Consumers higher in consumer impulsiveness (hedonic shoppers) in general evaluate online offers that differ in trust-assuring elements (based on textual information) as less trustworthy compared to consumers lower in consumer impulsiveness (prudent shoppers).

However, the use of different phrases that evoke trust can also be seen as specific signal, which may trigger affect- and emotion-based processes (Bohrn *et al.*, 2013). Therefore, the implementation of trust-assuring elements could also act as a (rewarding) signal. It follows that textual information not only yields cognition-based processes but also increases trust, therefore yielding affect- and emotion-based decision processes in hedonic and prudent shoppers. As hedonic shoppers generally react more emotionally and impulsively to stimuli, it is assumed that they will also evaluate the trustworthiness of different online-offers more extremely compared to prudent shoppers. Thus, more trustworthy product descriptions will be evaluated as very trustworthy, whereas less trustworthy product descriptions will be evaluated very negatively. In contrast, prudent shoppers will perceive the product description more consistently with less extreme differences between the magnitudes of their trustworthiness evaluation.

Therefore, it is assumed, that:

H2b. Consumers higher in consumer impulsiveness (hedonic shoppers) show stronger differences in their trustworthiness evaluations for product descriptions that differ in their textual information compared to consumers lower in consumer impulsiveness (prudent shoppers).

From a neuroscientific perspective, it is important to note that empirical investigations revealed that brain regions associated with trust partly overlap with areas associated with affect-based processes (e.g. caudate nucleus), cognition-based processes (i.e. vmPFC, dlPFC and ACC) or both (i.e. insula). It follows that it is possible that trust and impulsiveness functionally share a common neural basis that might influence the way how people perceive specific online content (website design, product descriptions, etc.). Therefore, it is expected that consumer impulsiveness (Cai *et al.*, 2015; Puri, 1996) moderates the neural activity pattern of consumers during the evaluation of online-offers that differ in their product description. With regard to consumers with higher impulsiveness, it is expected that they generally behave more affect-based and less cognition- and reasoning-based (Puri, 1996; Vohs and Faber, 2007), and therefore, it is assumed, that:

H3a. During the evaluation of the trustworthiness of online-offers, consumers higher in consumer impulsiveness (hedonic shoppers) show overall a higher activity in brain regions associated with affect-based processes (i.e. caudate and striatal areas) and more significant activity changes in these areas between online-offers compared to consumers lower in consumer impulsiveness (prudent shoppers).

H3b. During the evaluation of the trustworthiness of online-offers, consumers higher in consumer impulsiveness (hedonic shoppers) show overall a lower activity of brain regions associated with cognition-based decision-making (i.e. dlPFC, vmPFC, ACC and insula) and less significant activity changes between online-offers compared to consumers lower in consumer impulsiveness (prudent shoppers).

With regard to the specific role of the insula that is often associated with both affect- and cognition-based processes, it is not obvious whether hedonic shoppers will show a stronger activation of this brain region. However, we assume that the task of evaluating the trustworthiness of online-offers based on textual information is a more cognition-based process (Blanco *et al.*, 2010). Therefore, the part of cognition-based decision-making to rationally evaluate the risk and context (Singer *et al.*, 2009) might be more pronounced. Therefore, it is assumed that:

H3c. During the evaluation of the trustworthiness of online-offers, consumers higher in consumer impulsiveness (hedonic shoppers) show a lower activity of the insula and less significant activity changes between online-offers compared to consumers lower in consumer impulsiveness (prudent shoppers).

Method and results

Participants

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, $t(18) = -1.61$, p = 0.125]. All participants provided written informed consent prior to the scanning sessions. The 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. After the fMRI experiment, participants were asked to complete the prudence subscale of the consumer-impulsiveness scale by Puri (1996), which was used as a moderator for the 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 and a planner) described them on a seven-point scale from 1 (*usually would describe me*) to 4 (*sometimes would describe me*) to 7 (*seldom would describe me*).

Following the methodology of Puri (1996), a median split (median = 24.5) of the prudence scale (M = 24.7, SD = 6.913, alpha = 0.740) was applied for all participants (Ramanathan and Menon, 2006). Next, the participants were divided 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 = 4.60; M_{HG} = 30, SD = 4.16, $t(18) = 5.40$, $p < 0.001$; no age differences were found: $t(18) = 0.93$, $p = 0.315$].

Stimulus material and experimental setup

Stimulus material (product description with textual information) was developed based on Toulmin's model of argumentation (Toulmin, 1958, 2003) and was embedded into lifelike eBay offers. The use of Toulmin's model of argumentation is supported by existing studies

(Kim and Benbasat, 2006; Mun *et al.*, 2013; Rubin *et al.*, 2017). eBay was selected as online platform, because it is used in existing research (Dimoka, 2010; Gefen and Pavlou, 2012) and is a well-known established institution, and it can be assumed that there are less confounding effects in institution-based trust (Pavlou and Gefen, 2004).

In essence, Toulmin's (1958, 2003) model proposes a layout containing four interrelated components for analyzing arguments: claim, data, backing and rebuttal. These components were used to manipulate the independent variable in the experiment with regard to five trustworthiness classes (A = *no description*, B = *claim only*, C = *claim* + *data*, D = *claim* + *data* + *backing* and E = *claim* + *data* + *backing* + *rebuttal*). It is intended that by adding trust-assuring components (claim – data – backing), trustworthiness rating will increase (Kim and Benbasat, 2006). By adding the rebuttal based on a more vague description of possible constraints (Verheij, 2005) within the product description, it is intended to counter the positively correlating effect of increasing information and trustworthiness perception to reduce trustworthiness perceptions (Figure 1).

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 s), whether they considered an offer to be trustworthy or untrustworthy. After 12 s, participants saw a fixation cross for 3 s. 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.

The responses were recorded with the use of specific software (COGENT), and the mean evaluation (individual trustworthiness share [$indTS_{class}$]) was calculated of all five trustworthiness classes for each participant. Values ranged from 0 to 1. High values indicate that participants perceived the eBay offer in the respective class to be trustworthy, and low values indicate that the eBay offers are untrustworthy.

Analysis of the present data was conducted with the SPM8/SPM12 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). The results are visualized using xjView toolbox (www.alivelearn.net/xjview).

Functional magnetic resonance imaging experiment – behavioral analysis

First, to control for different confounding effects of trust, experience and attitude, participants had to fill out a questionnaire containing questions on their general trust level (Rotter, 1967): 25 items, range = 25-125; M = 65.6, SD = 8.16), their familiarity with the internet (duration of internet usage per week [in hours], M = 12.55, SD = 7.46; duration of internet usage overall [in months], M = 92.15, SD = 48.49; duration of eBay affinity overall [in months], M = 44.72, SD = 32.3), the average value of successful auctions (in euros, M = 38.11, SD = 60.56) and their attitude and experience towards eBay (five-point Likert scale with 1 = extremely positive to 5 = extremely negative, $M_{attitude}$ = 2.55, SD = 0.07; $M_{experience}$ = 2.45, SD = 0.51).

Second, with regard to behavioral differences in trustworthiness ratings between the selected trustworthiness classes and consumer impulsiveness groups, $indTS_{class}$ and $Group_{PG/HG}$ were entered as between-subject factors into one-way ANOVA (with trustworthiness class: A, B, C, D and E) corrected for repeated measures using the Greenhouse–Geisser correction criterion. A significant main effect for trustworthiness class

Claim	An assertion or conclusion put forward for general acceptance. A claim is always of a potentially controversial nature.
Data	Statements specifying the particular facts or previously established beliefs about a situation, as a basis on which a claim is made
Backing	The general body of information or experience that assures the trustworthiness of a warrant.
Rebuttal	An extraordinary or exceptional circumstance that might defeat the warranted claim.

Stimulus classes	Content
A	No trust-assuring advertisement text
B	Claim only
C	Claim + data
D	Claim + data + backing
E	Claim + data + backing + rebuttal

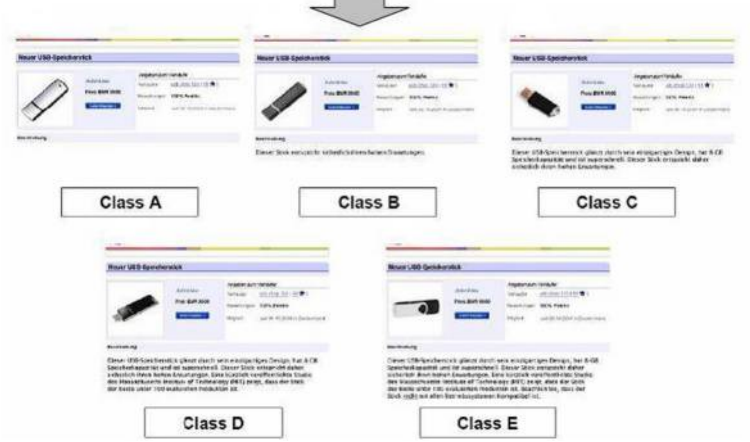


Figure 1.
Components of Toulmin's model of argumentation

was observed; $F(2.63, 47.34) = 21.24$, $p < 0.001$, $\eta_p^2 = 0.54$ [supporting *H1*; Figure 2(a)], and a marginal significant main effect for $\text{Group}_{PG/HG}$ was found; $F(1, 18) = 4.25$, $p = 0.054$, $\eta_p^2 = 0.19$. Overall, the hedonic shoppers marginally significantly evaluated the different online-offers as less trustworthy ($M = 0.36$, SD = 0.05) compared to the prudent group ($M = 0.50$, SD = 0.05), which supports *H2a*. No general interaction effect of trustworthiness class × $\text{Group}_{pg/HG}$; $F(2.63, 47.34) = 0.25$, $p = 0.837$, $\eta_p^2 = 0.01$ was found. Nevertheless, with respect to participants' consumer impulsiveness (CI_{PG}/CI_{HG}) and with the use of paired *t*-tests, partially significant differences in trustworthiness evaluations between each trustworthiness class were found within each group. As assumed, the hedonic group evaluated the trustworthiness of the product descriptions more extremely and exhibited stronger magnitude changes between the groups, except for the change from B to C. In contrast, the prudent group evaluated the different online-offers more moderately with less magnitude changes between the groups [CI_{HG}: A to B: $M = 0.09$; SD = 0.17; B to C: $M = 0.30$, SD = 0.18; C to D: $M = 0.31$, SD = 0.32; D to E: $M = -0.30$; SD = 0.42; CI_{PG}: A to B: $M = 0.06$; SD = 0.30; B to C: $M = 0.38$, SD = 0.28; C to D: $M = 0.17$, SD = 0.29; D to E: $M = -0.28$; SD = 0.52; Figure 2 (b)-(c)]. These results partially support *H2b*.

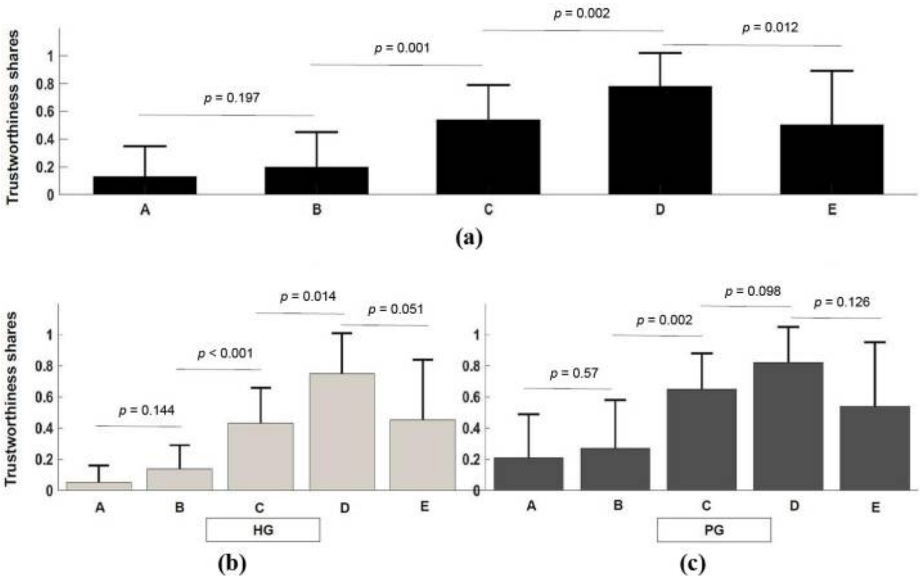


Figure 2.
Mean and SD for each trustworthiness class based on indTS for (a) all classes in general, (b) the hedonic group (HG) and (c) the prudent group (PG) only

Functional magnetic resonance imaging experiment – general group analysis
With regard to the main analysis, for the first-level analysis, we estimated a general linear model for each participant, with robust weighted least squares (Diedrichsen and Shadmehr, 2005) with the following independent variables: (*R*1) an onset regressor for all trustworthiness classes (A, B, C, D and E); (*R*2) a parametric modulator for the averaged trustworthiness share for each stimulus (aTS; equals the averaged sample mean for each stimuli based on indTS); and (R3-R9) movement regressors and session constant. The regressors capturing each trustworthiness class (R1) were modeled using a box car function with the individual response time as duration. Each of the regressors was convolved with a canonical hemodynamic response function (Friston *et al.*, 1994; Huettel *et al.*, 2004). For each participant, we calculated two first-level single-subject contrasts of interest:

(1) activation in brain regions that positively correlates with aTS (R2+); and
(2) activation in brain regions that negatively correlate with aTS (R2−).

On the group level (second level), we computed a one-sample *t*-test over all subjects and generated statistical parametric maps for the given contrasts (R^2+, R^2-) that displayed the *t*-values for each peak voxel that met a significance level of $p < 0.001$ (uncorrected) with an extent threshold voxel of $k = 10$. See Table II for a descriptive overview of all results.

Functional magnetic resonance imaging experiment – region-of-interest analysis
For a brain-behavior-independent region-of-interest (ROI) analysis, the parameter estimates (beta values) for each trustworthiness class (A, B, C, D and E) for an independent ROI were extracted following the procedure given by Litt *et al.* (2011). In particular, for each subject *i*, a peak voxel for the contrast of interest was identified by selecting the voxel within the anatomical area of interest (spherical mask) that exhibited peak activity for that contrast in a mixed-effects analysis that included all

Region	Side	No. of voxels	BA	MNI coordinates (x, y, z)			Peak intensity (*t*-value)
Main results of brain cluster positively correlated with aTS							
Caudate body	R	145		8	16	10	5.28
Middle frontal gyrus	L	15	8	−30	38	48	4.02
Insula	R	20	13	44	−20	12	4.02
Lingual gyrus	L	44	17	−18	−94	−12	4.19
Lingual gyrus	R	42	17	18	−92	−4	4.19
Lingual gyrus	L	14	19	−16	−66	−8	4.02
Middle temporal gyrus	R	47	21	56	−10	−20	4.06
Precentral gyrus	R	11	3/4	50	−14	46	3.79
Postcentral gyrus	R	313	2	44	−38	66	5.58
Postcentral gyrus	R	58	7	22	−52	68	4.83
Main results of brain cluster negatively correlated with aTS							
Cingulate gyrus (vACC)	L	36	24	−2	−10	−50	4.71
Medial frontal gyrus (dACC)	L	37	8/32	−4	24	46	4.73
Inferior frontal gyrus (dLPFC)	R	211	8/9	52	14	40	5.25
Middle frontal gyrus	L	46	46	−44	38	18	4.97
Inferior frontal gyrus	L	97	11/47	−46	42	−12	6.56
Inferior frontal gyrus/*Insula*	L	49	45/13	−44	16	4	4.31
Inferior frontal gyrus	R	98	45	58	20	12	5.05
Postcentral gyrus	L	14		−52	−20	14	4.52
Inferior parietal lobule	L	1887	40	−44	−38	56	7.05
Inferior parietal lobule	R	75		36	−64	42	4.93

Note: Height threshold $T = 3.5794$, $p < 0.001$ [uncorrected], $k = 10$

Table II. Results of the general fMRI analysis

subjects except for i. For each subject, an average parameter estimate over the sessions was computed using a spherical mask centered on the MNI coordinates with a 6-mm 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}).

Four main clusters from the general group analysis were chosen because of their high relevance and general appearance in studies associated with trust-related processes (see Table I with regard to main appearances) and with regard to (consumer) impulsiveness – the caudate nucleus, the ventral ACC (BA24), the dorsal anterior cingulate gyrus (dACC; BA32), the dlPFC (BA9) and the insula (BA13) (Table II).

With regard to the identified main cluster within the caudate nucleus related to increasing aggregated trustworthiness shares (aTS), a 4-mm sphere for a sub-peak – the right dorsal striatum (dStr; $x = 10, y = 22, z = 2$; $T = 4.82$) – was extracted as an ROI. Figure 3 shows the plotted activation for the ROI analysis regarding the dorsal striatum, the given trustworthiness classes (A, B, C, D and E) and each group (hedonic group [HG]/prudent group [PG]) with stronger activity changes between classes for the prudent group (not supporting *H3a*).

With regard to ROIs related to decreasing aTS, the following spheres were extracted:

- a 4-mm sphere for a peak coordinate within the left ventral ACC (BA24; vACC; $x = -2, y = -6, z = 48$; $T = 3.86$);
- a 4-mm sphere for a peak-coordinate within the left dorsal ACC (BA 32; dACC; x = −6, y = 22, z = 46; T = 4.09);

- a 6-mm sphere for a peak-coordinate within the right inferior frontal gyrus (BA9; dlPFC; $x = 48$, $y = 14$, $z = 40$; $T = 4.13$); and
- a 4-mm sphere for a peak-coordinate within the insula (BA13; insula; $x = -42$, $y = 16$, $z = 4$; $T = 4.31$).

Figure 4 shows the plotted activation for the ROI analysis regarding vACC and dACC, as well as dlPFC, the given trustworthiness classes (A, B, C, D and E) and each group (HG/PG) with mostly less activity and less activity changes between classes for the hedonic group (partially supporting *H3b*).

Figure 5 shows the plotted activation for the ROI analysis for the insula, the given trustworthiness classes (A, B, C, D and E) and each group (HG/PG) with mostly less activity and less activity changes between classes for the hedonic group (supporting *H3c*).

Discussion

Aim of the current study was to investigate how the consumer personality trait impulsiveness influences trustworthiness evaluations of online-offers with different trust-assuring and trust-reducing elements (Kim and Benbasat, 2006; Toulmin, 1958; 2003) by measuring the brain activity of consumers. Based on an analysis of an fMRI data set, the present study:

- identified the impact of consumer impulsiveness differentiated into hedonic and prudent shoppers on trustworthiness evaluations within an online environment; and
- revealed differences with regard to the neural correlates of an interaction between consumer's impulsiveness and trustworthiness evaluations.

With regard to the behavioral analysis and *H1-H2b*, this study confirms the positive effect of trust-assuring elements (claim, data and backing) and the negative effect of a trust-reducing element (rebuttal) on trustworthiness evaluations with regard to an online offer (*H1*). This result is in line with current research and is based on the theory of use of structured arguments (Kim and Benbasat, 2006; Toulmin, 1958, 2003). Additionally, while both groups (HG/PG) in general followed the assumed trustworthiness evaluation pattern (supports *H1*), there is a marginal significant difference in the perception of trust-assuring and trust-reducing elements between hedonic and prudent shoppers. Overall, despite

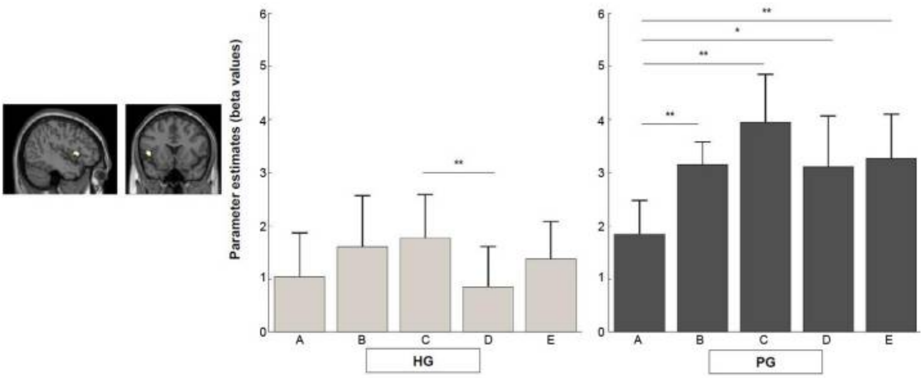
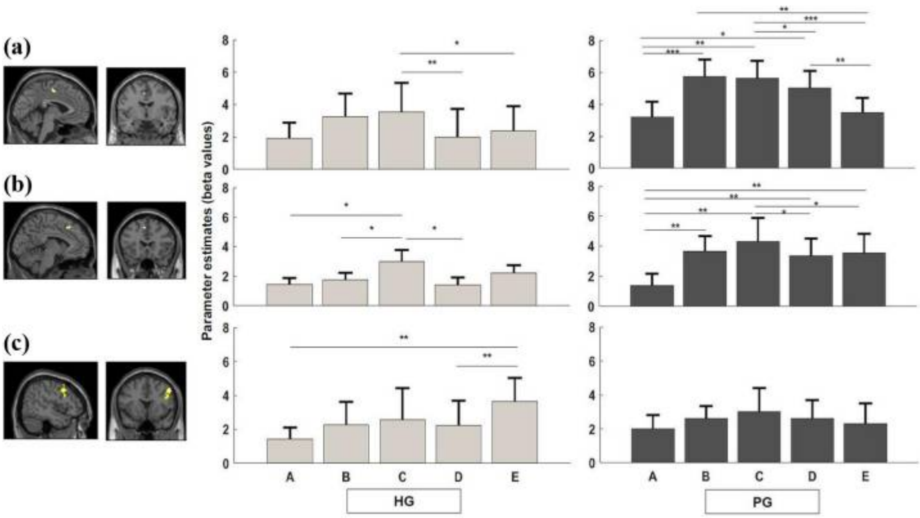


Figure 3. Extracted average of betas (mean and SEM) for each trustworthiness class for selected peak cluster within the dStr from the ROI analysis for the hedonic group (HG) and prudent group (PG)

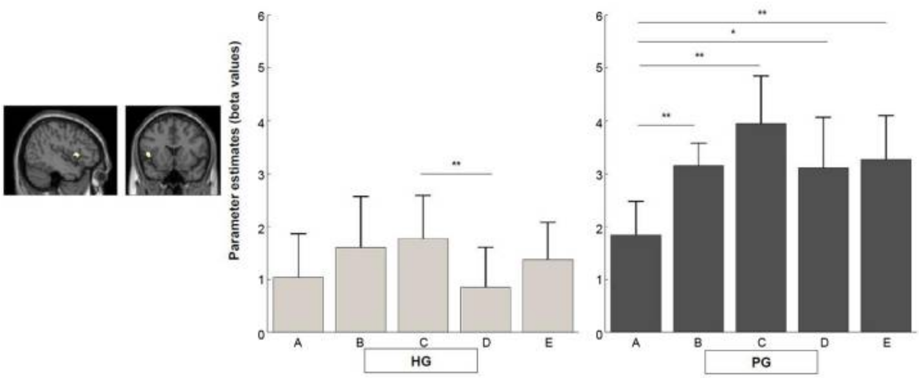
Notes: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$ (based on Wilcoxon signed-rank tests) following the assumed evaluation pattern, the hedonic group evaluated the online-offers as less trustworthy (supports *H2a*). Furthermore, *H2b* was partially confirmed, because the hedonic group mostly exhibited stronger changes in magnitude of their trustworthiness ratings between trustworthiness classes.

While the prudent group evaluated all trustworthiness classes more moderately and only showed a significant increase in trustworthiness ratings between Classes C and B and marginally between Classes C and D, the hedonic group rated the different trustworthiness classes and the underlying information more extremely and revealed significant changes between all trustworthiness classes except for Classes A versus B (Figure 2). This result



Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$ (based on Wilcoxon signed-rank tests)

Figure 4. Extracted average of betas (mean and SEM) for each trustworthiness class for selected peak cluster within the (a) vACC, (b) dACC and (c) dlPFC from the ROI analysis for the hedonic group (HG) and prudent group (PG)



Notes: $^{***}p < 0.01$; $^{**}p < 0.05$; $^{*}p < 0.1$ (based on Wilcoxon signed-rank tests)

Figure 5. Extracted average of betas (mean and SEM) for each trustworthiness class for selected peak cluster within the insula from the ROI analysis for the hedonic group (HG) and prudent group (PG)

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 (Bohrn *et al.*, 2013).

Regarding the general fMRI analysis, this study observed significant activity changes in brain regions associated with both trust and trustworthiness perception and (consumer) impulsiveness/impulsivity (Table I and Theoretical background). While, in general, activity changes within the caudate nucleus are associated with increases in trustworthiness evaluations, activity changes in regions of the vACC, dACC, dlPFC and insula are associated with decreases in trustworthiness evaluations (Table II).

The ROI analysis could not confirm *H3a*. Contrary to the assumption, no stronger activity in brain regions associated with affect-based decisions and impulsivity for the hedonic group were found. In contrast, the results show stronger activity and activity changes between trustworthiness classes within a part of the caudate nucleus – the dorsal striatum – for the prudent group compared to the hedonic group. In general, the caudate nucleus – one of the key structures of the impulsive system (Breiter *et al.*, 2001; Knutson *et al.*, 2000; Lamm *et al.*, 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). 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 revealed 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; Kosfeld *et al.*, 2005).

Compared to the behavioral results (Figure 2), an almost similar effect of blood-oxygen-level dependent contrast imaging (BOLD) activation was observed within the dorsal striatum and the corresponding behavior (trustworthiness rating) for each trustworthiness class (A, B, C, D and E) for the prudent group but not for the hedonic group (Figure 3). The effect for the prudent group is in line with studies showing that striatal areas (i.e. caudate nucleus, ventral and dorsal striatum) are often positively related to the amplitude of trust-related processes (Fareri *et al.*, 2012; King-Casas *et al.*, 2005; Phan *et al.*, 2010). It seems possible that trust-assuring and trust-reducing arguments based on textual information have a greater value for participants within the prudent group with regard to trustworthiness perceptions and therefore lead to the highest activity within the dorsal striatum for Class D. This result might be supported by research on the role of the dorsal striatum, which is associated with memorizing information about the "rewards" (here, textual information) to choose better options in the future (O'Doherty *et al.*, 2004; Tanaka *et al.*, 2007). On the other hand, participants within the hedonic group seem to positively recognize trust-assuring information. However, they might evaluate the amount of information not as positively because of an increase in cognition-based processes (Blanco *et al.*, 2010; Xu *et al.*, 2005).

With regard to the ROI analysis and in line with the assumption of lower activity in regions associated with cognition-based decisions for the hedonic group (*H3b*), lower activity and less significant activity changes between trustworthiness classes within the vACC and dACC were identified. Furthermore, the results revealed lower activity but more significant activity changes between trustworthiness classes within the dlPFC for the hedonic group compared to the prudent group (Figure 4). These results partially support *H3b*.

Regarding the anterior cingulate cortex, this brain region is often associated with trust situations (Baumgartner *et al.*, 2008; King-Casas *et al.*, 2005; Riedl *et al.*, 2014b) and consumer impulsiveness (Bechara, 2005) and might play an important role for processing information during online shopping by being involved in weighing advantages and risks of online offers. Dimoka (2010), Krueger *et al.* (2007) and Riedl *et al.* (2014a, 2014b), among others, identified the anterior paracingulate cortex to be linked to mentalizing and making predictions if other people will behave in a trustworthy way.

Compared to the behavioral results (Figure 2), we did not observe the same pattern of BOLD activation between the chosen regions of interest (vACC and dACC) and the corresponding behavior (Figure 4) for both groups. This indicates that the magnitude of brain activity not always follows corresponding behavior, but that trustworthiness perceptions in the brain are the result of a complex interplay between different regions and relevant processes (i.e. monitoring and evaluation of information) needed in specific situations (Dimoka *et al.*, 2011). Especially, the higher activity and significant changes within the vACC and dACC between trustworthiness classes for the prudent group signal the relevance of cognition-based decision-making and the processes of conflict regulation (vACC; Bush *et al.*, 2000; Etkin *et al.*, 2011) and monitoring and cognitive control (dACC, Botvinick *et al.*, 2004; Etkin *et al.*, 2011; Weber *et al.*, 2009), which might then result in the observed trustworthiness evaluation.

With regard to the dlPFC, this brain region 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 especially, the right part 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) and plays a central role in linking the information about rewards to actual behavior (Heekeren *et al.*, 2006). This process is very important for the evaluation of trustworthiness. During browsing and shopping on the internet, the evaluation of risks and benefits and the anticipation of consequences is important for making an advantageous decision and to build up trust. Similar to the results within regions of the ACC, compared to the behavioral results (Figure 2), we did not observe the same pattern of BOLD activation between the chosen regions of interest (dlPFC) and the corresponding behavior (Figure 4) for both groups. While, overall, a higher activity within the dlPFC for the prudent group was observed, especially, trustworthiness Class E seems to trigger a higher activity within the dlPDC in the hedonic group (significant change from Class D to Class E). Together with the strongly decreased activity within the dorsal striatum, the higher activation within the dlPFC might have led to the significant shift in decreased trustworthiness evaluation from Class D to Class E for the hedonic group.

With regard to the ROI analysis and similar to the assumption of lower activity in the insula regarding the hedonic group (*H3c*), we found lower activity and less significant activity changes between trustworthiness classes within the insula for the hedonic group compared to the prudent group (Figure 4). These results support *H3c*. While the insula is often associated with affect-based decisions (Eisenberger and Lieberman, 2004; Knutson *et al.*, 2007; Krendl *et al.*, 2006; Sanfey *et al.*, 2003; Tsukiura and Cabeza, 2011), the role within this study based on textual information seems to be strongly related to a more cognition-based approach by evaluating the information according to their risk and contextual appraisal (Singer *et al.*, 2009). Therefore, stronger activity was found within the prudent group, which should have a stronger cognition-based decision approach. Nevertheless, the decrease in activation with regard to trustworthiness class D (significant change from Class C to Class D) for the hedonic group could also indicate the role of reduced cognitive processes, which, in consequence, could lead to a significant behavioral shift between Classes C and D.

In summary, although the evaluation pattern of trustworthiness perceptions are similar between hedonic and prudent shoppers [which is in line with the applied theoretical base of structured argumentation (Toulmin, 1958, 2003)], both groups react differentially to the given textual information. This can be seen either in the overall trustworthiness shares or in the magnitude of changes between trustworthiness classes within each group. This behavior corresponds to differences in activity and activity changes in brain regions associated with processing trust and (consumer) impulsiveness. Especially, for the prudent group, textual information is the necessary requirement for evaluating different online-offers that are strongly cognition-based, while the hedonic group seems to react strongly to affective signals within textual information (i.e. the rebuttal) rather than to the rationale behind the concrete content. Furthermore, the behavior of the prudent group seems to be strongly related to activity within the dorsal striatum with a more consistent pattern of activity with cognition-based brain regions (ACC and dlPFC), and the significant changes – especially between trustworthiness Classes C and D and between Classes D and E – within the hedonic group are strongly based on specific lower activity within regions associated with conflict monitoring or risk perception (ACC/insula; from Class C to Class D) or specific higher activity within regions associated with cognitive control (dlPFC; from Class D to Class E). Thus – especially with regard to trust-building elements based on textual information – the results indicate the necessity of research distinguishing between elements influencing both affect- and cognition-based processes in decision-making.

Implications and conclusion

This research links trustworthiness evaluations of online offers, consumer impulsiveness and its neurological foundation. Prior research has used various approaches to measure trust in online settings. However, none of these studies uses the mixture of behavioral and physiologically based methods to test the idea that impulsiveness as a personal trait drives trustworthiness ratings of online offers. Consequently, when trying to understand how consumers who differ in specific characteristics and personality traits perceive online-offers, it is important to consider the underlying neural processes on an individual level that can be connected to consumer self-reports. Along these lines, the present research suggests that the self-report based categorization of consumers as prudent or hedonic as a proxy for impulsiveness helps to determine how consumers perceive online offers.

The findings also suggest that there exists a direct link from impulsiveness as an individual trait to the evaluation of online offers. It was shown that this basic personal trait is likely to influence most purchase decisions in an online context and can be represented by a different neural activation pattern. It is also worthwhile to consider these findings in relation to the literature on neural activation patterns associated with decision-making. The data analysis revealed a lot of similarities between the decision-making processes of the hedonic and prudent shoppers and also important differences. These differences cannot be found in the activation patterns, in general, but in the magnitude of activation patterns, suggesting that marketing actions can modulate these magnitudes.

In this regard, the present findings also have important marketing implications. Considering the trustworthy setup of an online offer as a prerequisite for purchase decisions, marketers may use a trustworthiness rating for their internet offers by assuming that this measure is a good determinant of the quality of the offers. If trustworthiness ratings do indeed always accurately correspond to increased preference or purchasing behavior, this would be a sufficient metric. Following that logic, the present research represents a first step in a framework of neural market segmentation based on a personal trait, namely, impulsiveness that accounts for an additional layer of consumer heterogeneity (Venkatraman *et al.*, 2012).

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