



# Why and how do founding entrepreneurs bond with their ventures? Neural correlates of entrepreneurial and parental bonding<sup>☆</sup>

Tom Lahti<sup>a,\*</sup>, Marja-Liisa Halko<sup>b,c,d</sup>, Necmi Karagozoglu<sup>e</sup>, Joakim Wincent<sup>f,g,h</sup>

<sup>a</sup> Department of Management and Organisation, Hanken School of Economics, P.O. Box 287, 65101 Vaasa, Finland

<sup>b</sup> Economics, Faculty of Social Sciences, University of Helsinki, Finland

<sup>c</sup> Department of Economics, Aalto University School of Business, Finland

<sup>d</sup> Aalto NeuroImaging, Aalto University School of Science, Finland

<sup>e</sup> College of Business Administration, California State University, Sacramento, United States

<sup>f</sup> Department of Management and Organization, Hanken School of Economics, Helsinki, Finland

<sup>g</sup> Entrepreneurship and Innovation, University of St Gallen, Switzerland

<sup>h</sup> Entrepreneurship and Innovation, Luleå University of Technology, Sweden

## ARTICLE INFO

### Keywords:

Bonding  
fMRI  
Entrepreneurship  
Parenting  
Self-confidence  
Bonding style  
Judgment  
Neuropsychology

## ABSTRACT

This paper investigates why and how founding entrepreneurs bond with their ventures. We develop and test theory about the nature of bonding in a functional magnetic resonance imaging (fMRI) study of 42 subjects (21 entrepreneurs and 21 parents). We find that entrepreneurs and parents show similar signs of affective bonding, that self-confidence plays a role in bonding style, and that the degree to which entrepreneurs include their ventures in the self and to which parents include their child in the self influences their ability to make critical assessments. Our findings suggest that bonding is similar for entrepreneurs and parents and that venture stimuli influence reward systems, self-regulatory functions, and mental factors that are associated with judgment.

## Executive summary

The parent-to-child bond is an affective tie from parent to child. This tie stems from the caregiving system, and its goal is to protect the child (Bowlby, 1969; George and Solomon, 2008). Scholars have argued that this type of bond exists not only between parent and child but also between entrepreneurs and their ventures (Baron and Hannan, 2002; Cardon et al., 2005a; Cardon et al., 2005b). From this perspective, entrepreneurial bonding is an important asset that helps entrepreneurs promote and protect their ventures. By developing strong bonds with their ventures, founding entrepreneurs seem more capable of overcoming threats and challenges that arise during the course of their venturing (Bird, 1995; Baron and Hannan, 2002; Baum and Locke, 2004; Cardon et al., 2005b).

However, we have limited knowledge of how venture bonding manifests itself in entrepreneurs and whether this is a real phenomenon or just an assumption. Entrepreneurship scholars have argued that entrepreneurs relate to their ventures in the same way that parents relate to their children: by developing a powerful bond (Cardon et al., 2005a; Cardon et al., 2005b). But few studies have specifically addressed entrepreneurial bonding, and major doubts remain over the way that activation of different brain areas responds to venture stimuli and whether contact with a child triggers the same responses as contact with a venture. Fortunately,

<sup>☆</sup> Funded by aivoAALTO (Aalto University, Finland), Yrjö Jahnsson Foundation, Research Foundation of Cooperative Banks, Finland and, Finnish Cultural Foundation.

\* Corresponding author at: Department of Management and Organisation, Hanken School of Economics, Vaasa, Finland.

E-mail address: [tom.lahti@hanken.fi](mailto:tom.lahti@hanken.fi) (T. Lahti).

however, this gap in the literature can be addressed, and the essence of bonding can be studied by examining the activation of neural brain correlates.

We conducted an experimental study to determine how bonding manifests itself and how bonding can be traced in entrepreneurs' brain activation. We did so by equating entrepreneurs' attachment and caregiving systems to those of parents. We used functional magnetic resonance imaging (fMRI), which allowed us to capture entrepreneurs' and parents' brain responses to venture and child stimuli. The advantage of fMRI is that it provides an objective measurement for understanding how stimuli affect profound psychological functions such as brain reward systems and judgment. Achieving such an understanding would prove difficult using other techniques such as those traditionally employed in social psychology and organizational research (Becker et al., 2011; de Holan, 2014; Krueger and Welp, 2014; Waldman et al., 2016). Prior research shows the existence of correlations between brain activation data and subjective self-reports and thus implies that bonding could potentially be studied using self-reports (e.g., Davidson and Irwin, 1999; Aron et al., 2005; Acevedo et al., 2012). However, prominent work suggests that self-reported data fail to consider important influences by being unable to capture implicit, automatic processes in the brain that operate at a below consciousness level, but impact on how we think, feel and behave (Nisbett and Wilson, 1977; Russell, 2003, 2005; Camerer et al., 2005; Kahneman, 2011). Neuroscience methods do not suffer from such a shortcoming, as they enable direct measurement of thoughts and feelings.

We observed that when exposed to venture stimuli, entrepreneurs exhibit similar signs of affective bonding to those that parents exhibit when exposed to child stimuli. Evidence of these similarities lies in the activation of the reward system of the brain. We found that self-confidence is associated with activation in brain regions that determine the parent's style of bonding with their children and entrepreneur's style of bonding with their ventures (e.g., stronger activation in brain regions related to anxiety and fear). We also found that inclusion of the child or the venture in the self influences the ability to make critical assessments.

The strong similarities in the neural responses associated with parental and entrepreneurial bonding indicate that founding entrepreneurs can be viewed as caregivers to their businesses. Based on our findings, we argue that emotional rewards justify the efforts and sacrifices that entrepreneurs make on behalf of their ventures, just as these rewards justify the sacrifices parents make on behalf of their children.

We also show that bonding has potentially negative effects. Entrepreneurs that have strong bonds with their ventures may be incapable of critically assessing their ventures, and parents that have strong bonds with their children may be incapable of critically assessing them. This impaired critical assessment may lead to unrealistic expectations of the venture's or the child's qualities. Also, parents and entrepreneurs may exhibit an anxious-ambivalent bonding style. This bonding style is characterized by anxious and fearful responses that are due to low confidence in judgment or decisions.

Overall, our study has important implications, and our findings indicate that we can learn important lessons from examining entrepreneurial bonding. We advocate the need for awareness of similarities between entrepreneurship and parenting in our theories and outline several important areas for future research.

## 1. Introduction

"Upper Street was our baby; our future. We put everything into it, mentally, physically and financially. It was particularly hard when the business fell off a cliff so quickly, when there was still so much potential" (Brown, 2016).

"Jaava was our little baby. It was very hard to let go of its hand when it was taking its first steps. It's almost at the adolescent stage. Maybe we should start letting it walk a bit more on its own" (Shankland, 2002).

Interviews and press statements support the assertion that founding entrepreneurs relate to their ventures as parents relate to their children: through a powerful bond. Prior research has suggested that the experience of bonding is enduring (Cardon et al., 2009; Murnieks et al., 2014). Arguably, it is through this unwavering loyalty that bonding (essentially an entrepreneur's profound connection with the venture) can provide a valuable resource that helps entrepreneurs promote and protect their ventures. By developing strong bonds with their ventures, founding entrepreneurs become motivated to overcome environmental threats and challenges (Beal, 2000; McGee and Sawyerr, 2003; Baum and Locke, 2004), putting themselves in a better position to improve venture creation outcomes, growth, and performance (Baron and Hannan, 2002; Cardon et al., 2005b).

Despite scholars' and founding entrepreneurs' tendency to describe entrepreneurship using parent-child metaphors, few studies have examined entrepreneurial bonding, and we do not know whether the entrepreneur-to-venture bond actually resembles the parent-to-child bond. When focusing on bonding, prior research has largely theorized that entrepreneurial bonding is an important asset, affecting outcomes in the venture development and establishment stages (e.g., Cardon et al., 2005b). The experience of bonding has almost been treated as exogenous. Moreover, limited scholarly attention has been paid to the origins of bonding, despite studies that have emphasized bonding as a key phenomenon in entrepreneurship (e.g., Cardon et al., 2005a; Cardon et al., 2005b). Against this backdrop, we shed light on why and how founding entrepreneurs bond with their ventures.

Our approach was built on attachment theory, which has primarily been used to analyze the propensity of human beings to develop strong affective bonds with others close to them (Bowlby, 1969, 1977). We extended this theory to consider the bond from founding entrepreneurs to their ventures. By drawing on insights from research on the affective influences of ownership (Nuttin, 1987; Belk, 1988; Pierce et al., 2001), we argue that some of the essential tenets of attachment theory also apply to the context of founding entrepreneurs and ventures. Consistent with attachment theory (Bowlby, 1969; Ainsworth, 1979; Mikulincer et al., 2003), entrepreneurial bonding is associated with positive and pleasurable feelings, different bonding styles, and individual differences in attachment intimacy.

From such a perspective, ownership evokes feelings of responsibility and stewardship toward the venture. These feelings manifest themselves in caregiving behaviors to protect the venture (Belk, 1988; Pierce et al., 2001; Townsend et al., 2009). As suggested by

attachment theory (Solomon and George, 1996; George and Solomon, 2008), founding entrepreneurs, like parents, adopt a caregiving system that responds to the venture's needs and ensures the survival and healthy development of the venture. For the founding entrepreneur to make sacrifices on behalf of the venture, emotional rewards that resemble those in parent-child bonds should contribute to sustaining the bond from the entrepreneur to the venture.

However, although entrepreneurial bonding has typically been perceived and discussed in a favorable light (Bird, 1995; Baron and Hannan, 2002; Baum and Locke, 2004; Cardon et al., 2005b), we also explore the likely existence of dysfunctional effects associated with it. There may be entrepreneurs with an anxious-ambivalent bonding style that renders them highly responsive to anxiety and stress because of their lack of confidence in their ability to manage tasks that involve uncertainty (Hayward et al., 2010; Cacciotti et al., 2016). There may also be entrepreneurs who are unable to critically evaluate their venture because of their close relation to the venture and its importance to their sense of self (Cardon et al., 2005b).

Our theory development and empirical analysis show that venture bonding is real and can be traced in entrepreneurs' brain regions. Because the essence of bonding can be studied by examining the neural correlates and neuropsychological pathways that shape behaviors and decisions (Russell, 2003; Rilling and Young, 2014; Nicolaou and Shane, 2014), we conducted a functional magnetic resonance imaging (fMRI) study. This approach allowed us to capture entrepreneurs' brain responses to venture stimuli and parents' brain responses to child stimuli.

The advantage of fMRI is that it provides an objective measurement for understanding the way that different stimuli affect profound psychological functions such as brain reward systems and judgment. Developing such an understanding would prove difficult using traditional methods of social psychology and organizational research (Becker et al., 2011; de Holan, 2014; Krueger and Welp, 2014; Waldman et al., 2016). Prior research shows the existence of correlations between brain activation data and subjective self-reports and thus implies that bonding could potentially be studied using self-reports (e.g., Davidson and Irwin, 1999; Aron et al., 2005; Acevedo et al., 2012). However, prominent work suggests that self-reported data fail to consider important influences, as they are unable to capture implicit, automatic processes in the brain (Nisbett and Wilson, 1977; Russell, 2003, 2005; Camerer et al., 2005; Kahneman, 2011). These processes operate at a below-consciousness level, yet still impact how we think, feel and behave. Neuroscience methods, on the other hand, do not suffer from such a shortcoming, as they enable direct measurement of thoughts and feelings.

By presenting this study, we make several contributions. First, we extend the use of attachment theory and demonstrate its capacity to enhance our understanding of the relationship between founding entrepreneurs and their ventures. We posit that the theory is most useful in the domain of entrepreneurship when complemented with insights from research on affective influences of ownership. For example, ownership contributes to bond formation by increasing the attractiveness of the venture and increasing its salience to founding entrepreneurs' self-identity (Kleine et al., 1995; Pierce et al., 2001; Townsend et al., 2009). We examine the effect of ownership by comparing founding entrepreneurs' brain responses to stimuli associated with the entrepreneur's own venture and stimuli associated with a known venture.

Several of our observations contribute to attachment theory (Bowlby, 1969, 1980; Lopez and Gormley, 2002; Mikulincer et al., 2003) and highlight similarities between entrepreneurial and parental bonding. First, activation of the reward system in the brain as well as suppression in regions related to negative emotions shows that founding entrepreneurs and parents exhibit similar neural signs of affective bonding. Second, activation in the brain regions related to anxiety and fear shows that self-confidence in one's judgment or decisions is likewise similar. Finally, suppression of brain activation in regions related to social and moral judgment shows that relationship intimacy is associated with the entrepreneur's perception of the venture, just as with the parent's perception of the child.

The strong similarities in the neural responses associated with parental and entrepreneurial bonding indicate that founding entrepreneurs can be viewed as caregivers to their businesses. Emotional rewards justify entrepreneurs' efforts and sacrifices on behalf of ventures, just as these rewards justify parents' efforts on behalf of children. Furthermore, the nature of bonding helps explain why decisions about the venture are taken and why anxieties are experienced. By considering the motivational effects of bonding and individual differences in bonding styles, we provide implications for educators, encouraging them to raise awareness about similarities between entrepreneurship and parenting.<sup>1</sup>

Second, we show that bonding could have negative effects. Parents or entrepreneurs with an anxious-ambivalent bonding style experience anxiety and fear caused by their lack of confidence in their decisions. Parents or entrepreneurs with strong bonds to their children or ventures may also be incapable of critical assessment, leading to unrealistic expectations. Because bonding determines how the brain is affected by entrepreneurs' judgment, and because of similarities in how entrepreneurs' and parents' caregiving systems work, we contribute by showing the relevance of discussions about overprotecting children or ventures.

Third, we demonstrate the importance of using fMRI and alternative methods to study entrepreneurship. We show that both child and venture stimuli are associated with activation in the brain's reward system and in regions that relate to judgment and assessment. Although these brain regions are fundamental, it is difficult for an individual to know whether and when they are affected (Russell, 2003; Becker et al., 2011; Waldman et al., 2016). Though entrepreneurs themselves do not know when these regions are affected, and others (e.g., venture capitalists) cannot detect when this occurs, we can assume that strong influences arise when entrepreneurs are exposed to venture stimuli and that these influences affect important decisions and actions in the present and future.

<sup>1</sup> The theory and analyses presented in this paper are unique but are partly based upon the same series of experiments and subjects as in the paper "Entrepreneurial and Parental Love: Are They the Same?" (Halko, M.-L., Lahti, T., Hytönen, K. & Jääskeläinen, I.). The results reported in this paper are based on a unique (pooled) dataset and analyses with direct implications for a theory on entrepreneurial bonding.

## 2. Literature background and theory

### 2.1. The entrepreneur-to-venture bond

Entrepreneurship studies have widely acknowledged that venture ownership is associated with formal control rights that enable decision-making rights, access to information, financial returns, and, most importantly, the right to decide how the venture's tangible and intangible assets are used (Hart, 1995; Rousseau and Spherling, 2003; Alvarez and Parker, 2009). In young ventures, ownership is typically still in the hands of the founding entrepreneurs, who make countless venture-related decisions on a daily basis (Baron, 2010; Vanacker and Manigart, 2010). However, venture ownership also determines the nature of the founding entrepreneur's bond with the venture. As a target of ownership, a venture embodies the founding entrepreneur's creations, ideas, goals, unique knowledge, work, invested efforts, and life experiences, all of which are expressive of and salient to the entrepreneur's representation of the self (Belk, 1988; Kleine et al., 1995; Townsend et al., 2009). Besides formal control of the venture, ownership of a venture is associated with the founding entrepreneur's sense of self and a high degree of motivation to act on behalf of the venture (Pierce et al., 2001; Townsend et al., 2009). Hence, ventures are important to founding entrepreneurs' sense of self (Pierce et al., 2001), just as children are important to parents' sense of self (Aron et al., 1991, 1992; Ashforth et al., 2016).

We show that many of the mechanisms that explain how founding entrepreneurs bond with their ventures manifest themselves similarly in the parent-child relationship. We first introduce attachment theory. We then examine some of its tenets: parent's/entrepreneur's caregiving behavior, emotional rewards, bonding styles, and judgments related to the children/venture. This discussion provides the background for the hypotheses we develop in the following sections.

#### 2.1.1. Introduction to attachment theory

Attachment theory proposes that human beings are born with the capacity to develop caregiving behaviors designed to protect others in need (Bowlby, 1969; Collins and Ford, 2010). Dependability and accountability are at the core of this theory. The *parent-to-child bond* is an affective tie from parent to child. It stems from the caregiving system, and its goal is to protect the child (Bowlby, 1969; George and Solomon, 2008). Likewise, the *entrepreneur-to-venture bond* is an affective tie from the entrepreneur to the venture. The parent-to-child bond forms during the early stages of an infant's life (Bowlby, 1969), whereas the entrepreneur-to-venture bond forms when an idea for a new business is conceived (Cardon et al., 2005b). As such, in this study *bonding* reflects the involvement and emotional bonds that parents/entrepreneurs have with their children/ventures (Haapasalo et al., 2012). Bonding with a child relates to a set of altruistic needs, including knowing the child, being with the child, avoiding separation and loss from the child, protecting the child, and gratifying the needs of the child (de Cock et al., 2017). Bonding with a venture likewise relates to altruistic needs involving sacrifices on behalf of the venture despite uncertain payoffs, which are often potentially far off in the future (Cardon et al., 2005b).

#### 2.1.2. Entrepreneurs have a caregiving system

The parent-child attachment relationship is based on a caregiving system (Bowlby, 1969; Ainsworth, 1979; Collins and Ford, 2010; Cassidy, 2000), which is activated when a child is in need of care or protection (Bretherton, 1985; Mikulincer et al., 2003). The parent's sensitivity and responsiveness to the child's needs contribute to the development of a well-functioning bond that fosters the healthy development of the child (Bowlby, 1969; Lamb et al., 1985). Parental bonding is necessary to promote survival. Parents bond with their children by investing time, energy, and resources (Trivers, 1972) to secure the best outcomes for their children (Buss, 1988).

Prior research postulates that people take better care of and strive to maintain and nurture what they own, as well as protecting and improving the object of ownership (Belk, 1988; Pierce et al., 2001; Avey et al., 2009). For founding entrepreneurs, venture ownership creates a feeling of responsibility that involves stewardship and personal sacrifice on behalf of the venture in a bid to sustain the entrepreneur-venture bond (Pierce et al., 2001; Van Dyne and Pierce, 2004). Founding entrepreneurs have a caregiving system that mirrors that of parents and children (Bowlby, 1969; Ainsworth, 1979; George and Solomon, 2008). Thus, an entrepreneur takes responsive action to ensure the healthy development and survival of his or her venture (Wiltbank et al., 2006; Chandler et al., 2011). The entrepreneur acts upon important venture signals such as poor financial performance, which in turn informs the entrepreneur that the current *modus operandi* is inappropriate or that he or she may need to change the business model or product (Boeker and Goodstein, 1991; Delmar and Shane, 2004; Loch et al., 2008). Hence, entrepreneurs' bonding efforts are necessary to respond to the needs of the venture.

Entrepreneurial investments in the bonding process encompass social, financial, and human capital as well as time and energy. These investments help ventures overcome challenges (Bates, 1990; Townsend et al., 2009). These efforts are warranted to gather the necessary resources and overcome the challenges that are inherent to the liability of newness (Freeman et al., 1983; Gimeno et al., 1997; Kor and Misangyi, 2008; Wiklund et al., 2010).

#### 2.1.3. Entrepreneurial bonding is emotionally rewarding

Parents experience intense feelings of pleasure and satisfaction when they are able to protect and comfort their children (Solomon and George, 1996; George and Solomon, 2008). The sacrifices they make for their children are rationalized by these emotional rewards (Eibach and Mock, 2011; Ashton-James et al., 2013), which help sustain the parent-child bond (Bretherton, 1992). Bonding with a child is an uplifting experience, providing a sense of meaning that can assuage feelings of sadness, worry, and depression (Bretherton, 1992; Nelson et al., 2014).

Prior research indicates that a target of ownership must be attractive to the owner to enhance satisfaction (Nuttin, 1987; Belk, 1988; Pierce et al., 2001). Two antecedents, control over the target object and invested efforts, increase the emotional rewards derived from ownership (Nuttin, 1987; Van Dyne and Pierce, 2004), causing the target object to become a positive expression of the self that contributes to self-enhancement and provides a sense of purpose (Belk, 1988; Van Dyne and Pierce, 2004). Consistent with these antecedents of the attractiveness of one's own objects, founding entrepreneurs control their ventures through the legal/residual rights of ownership (Baron, 2010; Vanacker and Manigart, 2010) and, as highlighted earlier, typically make substantial efforts to ensure their survival and healthy development (Cardon et al., 2005b; Townsend et al., 2009; Cardon et al., 2009). Thus, for entrepreneurs, a venture is a highly attractive target object. Their bonding efforts increase their satisfaction, which keeps them motivated to make sacrifices on behalf of the venture, in order to preserve the bond.

#### 2.1.4. *Entrepreneurs have different bonding styles*

Attachment theory identifies individual differences in bonding style. These differences influence the nature and quality of the parent-child relationship (Ainsworth, 1979). A distinction is made between secure and insecure bonding styles (Hazan and Shaver, 1994; Collins and Ford, 2010). Individuals that have a secure style are self-reliant, confident in their abilities, and able to cope with problems (Bowlby, 1988; Lopez and Gormley, 2002). In contrast, individuals with an anxious-ambivalent bonding style, which represents an insecure bonding style, express more self-related doubts and have difficulties in managing their fears and anxieties (McFarlin and Blascovich, 1981; Lopez and Gormley, 2002; Crocker and Park, 2004). The adaptive coping strategies of individuals with a secure style are positively associated with decision-making self-efficacy, which makes it easier for such individuals to navigate uncertain situations (Wolfe and Betz, 2004; Vignoli et al., 2005). For parents with an anxious-ambivalent bonding style, parenthood involves more stressful situations and fearful experiences than for parents with a secure bonding style (Bartholomew and Shaver, 1998; Mikulincer et al., 2003; Crocker and Park, 2004).

Like parents, founding entrepreneurs can have either secure or insecure bonding styles. As a target of ownership, a venture is part of a founding entrepreneur's identity, thereby reflecting an extension of the self. Accordingly, the venture's failure may severely reduce the entrepreneur's self-worth, causing the entrepreneur to experience shame and embarrassment (Mitchell and Shepherd, 2010; Cacciotti and Hayton, 2015; Cacciotti et al., 2016). In this respect, the confidence that the founding entrepreneur has in his or her ability to make correct decisions throughout the entrepreneurial process influences the bonding style with the venture. Founding entrepreneurs that have low self-confidence in their decisions adopt an anxious-ambivalent bonding style, which entails fearful and anxious reactions to uncertain circumstances. Conversely, self-confident entrepreneurs are less affected by such circumstances because they are less likely to acknowledge that this uncertainty exists (Busenitz and Barney, 1997; Forbes, 2005; Hayward et al., 2010). This approach is characteristic of a more secure bonding style.

#### 2.1.5. *Intimacy may influence judgment*

A cognitive consequence of a close relationship between two people is that each person includes the other's characteristics and needs in his or her own self-concept (Aron et al., 1991; Mikulincer et al., 2003). Parents who are closer to their children tend to feel a greater sense of responsibility for their children's well-being and tend to be more motivated to provide help when needed (Aron et al., 1991; Collins and Feeney, 2000). Thus, intimacy, which influences a parent's inclusion of the child in the self, provides an effective proxy of the strength of the affective bond. Although intimacy may motivate a parent's bonding efforts, it may potentially impair the parent's judgment of the child, causing the parent to overlook the child's faults (Bartels and Zeki, 2004; Zeki, 2007).

The objects that we own become a part of the self as our knowledge of them grows (Belk, 1988). The better a person's knowledge of an object, the more intimate that person's bond with that object will be (Nuttin, 1987; Belk, 1988; Pierce et al., 2001). Accordingly, the relationship between a founding entrepreneur and his or her own venture should be considerably stronger than any relationship with known ventures or brands.

Intense, regular involvement with their ventures implies that founding entrepreneurs have insider knowledge about many aspects of the business such as technology and business procedures (Pierce et al., 2001; Cardon et al., 2005b; Townsend et al., 2009). Thus, for founding entrepreneurs, intimacy with their own ventures influences the extent to which they internalize their ventures in their sense of self (Belk, 1988; Pierce et al., 2001). Although intimacy may increase the perceived attractiveness of a venture (Nuttin, 1987; Beggan and Brown, 1994), it may positively bias founding entrepreneurs' judgments about its qualities (Troye and Supphellen, 2012; Atakan et al., 2014).

In the following section, we develop hypotheses based on the tenets of attachment theory. These hypotheses were tested using fMRI data.

## 2.2. *Hypothesis development*

This section has three parts. First, we hypothesize that, like parental bonding, entrepreneurial bonding is associated with emotional rewards that rationalize bonding efforts. We suggest that founding entrepreneurs experience strong emotions toward their own ventures that are analogous to the bond a parent feels toward his or her own child. Next, we predict that self-confidence influences how entrepreneurship and parenthood are experienced. Founding entrepreneurs with an anxious-ambivalent bonding style lack confidence in their ability to cope with uncertainty. We expect this lack of confidence to manifest itself in the form of anxious, fear of failure responses to venture stimuli. Finally, we hypothesize that the extent to which entrepreneurs/parents include their ventures/children in the self influences their ability to critically assess their ventures/children.



### 2.2.1. Neural signs of affective bonding in entrepreneurship and parenting

Parental and entrepreneurial bonding reflects altruistic and sacrificial behavior that manifests itself as a willingness on the part of parents/entrepreneurs to put the needs of their children/ventures ahead of their own (Beyers and Reber, 1998; Cardon et al., 2005b). Parents find it rewarding when their children successfully progress through childhood into adulthood (Trivers, 1972; Schaller et al., 2010; Nelson et al., 2014). Many parents justify the high investments associated with raising children by rating the time spent with children as more enjoyable than time spent on other activities (Gilbert, 2006; Eibach and Mock, 2011; Ashton-James et al., 2013).

As suggested earlier, for founding entrepreneurs, ownership of a venture is associated with stewardship and feelings of responsibility (Pierce et al., 2001; Van Dyne and Pierce, 2004). In addition to the opportunity for an entrepreneur to exercise control over the venture through legal ownership rights, the bonding efforts that help bring a venture to fruition contribute to the perceived attractiveness of the venture (Belk, 1988; Bird, 1989; Pierce et al., 2001). Hence, similar to parents, entrepreneurs' protective and supportive measures to ensure the survival of their venture can be satisfying. These emotional rewards rationalize the efforts that are expended on the child/venture and help sustain the bond (Cardon et al., 2005a; Cardon et al., 2005b; Cardon et al., 2009). Consequently, parents'/entrepreneurs' own well-being improves when these efforts enhance the well-being of the children/ventures (Brockner et al., 2004; Shepherd and Haynie, 2009a; Ashton-James et al., 2013; Nelson et al., 2014).

Even as parental and entrepreneurial bonding is driven by a conscious or unconscious pursuit of emotional rewards, it can also lead to the suppression of aversive emotions. Given the altruistic quality of bonding efforts, parents'/entrepreneurs' well-being may also improve through the relief of feelings such as sadness, anxiety, disgust, and depression. Caring for a child/venture often gives people a sense of purpose (Brockner et al., 2004; Shepherd and Haynie, 2009a; Nelson et al., 2013, 2014; Meier et al., 2016) and may therefore be motivated by a desire to alleviate one's own sadness and distress (Gross, 1998). Thus, as suggested earlier, the efforts of an entrepreneur to nurture his or her own venture, which is often salient to the entrepreneur's self-identity, can help the venture become a positive expression of the self, enhancing life satisfaction (Belk, 1988; Van Dyne and Pierce, 2004).

We have argued that a parent's/entrepreneur's affective bond with the child/venture develops through activities and efforts that induce emotional rewards and suppress negative emotions. Given our conjectures, we expect that when parents/entrepreneurs view a picture of their own child/venture and think about their experiences with the child/venture, the reward system of the brain will be activated, and neural regions associated with the processing of negative emotions will be deactivated. Activation implies that activity in neural regions is stronger when the parent/entrepreneur sees images of his or her own child/venture than when the parent/entrepreneur sees images of a known child/venture. Deactivation implies that activity in the neural regions is stronger when the parent/entrepreneur sees images of a known child/venture than when the parent/entrepreneur sees images of his or her own child/venture.

If the first prediction holds, activation will be detected in the *striatum*, a brain area that comprises three subregions—the nucleus accumbens, caudate nucleus, and putamen—associated with mammalian rewards (Bartels and Zeki, 2004; Aron et al., 2005; Zeki, 2007; Acevedo et al., 2012). If the latter prediction holds, deactivation will be detected in the *insula*, which is activated by a wide range of *subjective* negative emotional experiences such as sadness (Liotti et al., 2000; Farb et al., 2010), anxiety (Liotti et al., 2000; Paulus and Stein, 2006), disgust (Lane et al., 1997; Wicker et al., 2003), depression (Wiebking et al., 2010; Mutschler et al., 2012), and pain (Mutschler et al., 2012; Strigo et al., 2013). We expect to observe the following:

**Hypothesis 1.** Parents and entrepreneurs will exhibit similar signs of affective bonding. Stimuli of a parent's own child or an entrepreneur's own venture will elicit stronger activation in the reward-related brain regions and weaker activation in the brain regions that are related to negative affect than stimuli of a known child or venture.

### 2.2.2. Bonding styles and regulation of anxiety and fear

As mentioned earlier, parents and entrepreneurs have different bonding styles that influence their cognitive appraisals of emotional objects and situations (Lazarus, 1991; Hazan and Shaver, 1994; Collins and Ford, 2010). People with an anxious-ambivalent bonding style have self-related doubts and react anxiously to stressful events (Bartholomew and Shaver, 1998; Mikulincer et al., 2003). In contrast, people with a secure bonding style are self-reliant, confident in their ability to cope with new situations, and have low levels of anxiety and vulnerability in stressful situations (Bowlby, 1988; Lopez and Gormley, 2002).

For parents and entrepreneurs, self-confidence is an important psychological resource for regulating anxiety and coping with stressful and uncertain situations (Carver et al., 1989; Scheier and Carver, 2003; Hanton et al., 2004). Parents who are confident in their decisions are able to cope better with uncertainties such as child illnesses or perceived threats (Maltby et al., 2003; George and Solomon, 2008; Meyer and Pilkonis, 2005). Therefore, their confidence in their ability to deal with uncertainty is indicative of their bonding style and experience of parenthood. For unconfident parents, the bonding style is anxious-ambivalent because situations that are perceived as stressful and fearful occur more frequently (Bartholomew and Shaver, 1998; Mikulincer et al., 2003; Crocker and Park, 2004). Conversely, for highly confident parents, who exhibit a secure bonding style, parenthood is a more harmonious emotional experience that is characterized by less frequent and less intense reactions of anxiety and fear (Bartholomew and Shaver, 1998; Mikulincer et al., 2003; Brumariu and Kerns, 2010).

As discussed earlier, for founding entrepreneurs, their own ventures tend to represent an extension of their sense of self (Cardon et al., 2005b; Townsend et al., 2009). Accordingly, a venture's failure may have severe consequences on the perception of the self, undermining the entrepreneur's self-esteem and well-being (Singh et al., 2007; Shepherd et al., 2009) by evoking feelings of shame and embarrassment (Conroy et al., 2003; Mitchell and Shepherd, 2011; Cacciotti et al., 2016). Mirroring the situation for parents and children, the confidence that entrepreneurs have in their ability to make correct decisions when faced with uncertainty influences their bonding style and thereby the way that they experience entrepreneurship (Busenitz and Barney, 1997; Hayward et al., 2010).

Because uncertainty is associated with tasks and activities in the domain of new ventures, the difficulty that anxious-ambivalent entrepreneurs face in coping with uncertainty makes them susceptible to anxiety because of their fear of failure, loss, and disappointment (Sarasvathy, 2001; Read et al., 2009; Crandall et al., 2015). Entrepreneurs with a secure bonding style are in contrast less likely to acknowledge that such uncertainty exists, which makes them less prone to experience anxiety (Busenitz and Barney, 1997; Forbes, 2005; Hayward et al., 2010). As Hayward et al. (2010, p. 572) note, “greater confidence can increase one's feelings of safety and security.”

Given this background, we anticipate that entrepreneurs/parents with low self-confidence will react more anxiously or fearfully to stimuli and recollections of events that are retrieved from long-term memory regarding their own ventures/children. For our conjectures to hold, parents'/entrepreneurs' self-confidence should be negatively associated with activation in the *amygdala*, which is the brain region that mediates anxiety and fear (Davis, 1992; Janak and Tye, 2015). We expect to observe the following:

**Hypothesis 2.** Parents' and entrepreneurs' self-confidence is associated with their bonding style. The higher a subject's self-confidence, the weaker the activation in brain regions related to anxiety and fear.

### 2.2.3. Intimacy of bonding and critical assessment

As mentioned earlier, founding entrepreneurs or parents tend to include their own ventures/children in their self-identity (Aron et al., 1991, 1992; Cardon et al., 2005b; Townsend et al., 2009). Intimacy (or closeness) with the venture/child influences the extent to which the venture/child is included in the entrepreneur's/parent's sense of self (Aron et al., 1991, 1992; Smith et al., 1999). For parents, this strengthens the affective bond because in intimate relationships, they internalize the child's needs and desires (Aron et al., 1991, 1992; Mikulincer et al., 2003). Similarly, intimacy in the relationship between an entrepreneur and his or her venture commonly strengthens the entrepreneur's affective bond with the venture. When intimacy is substantial, founding entrepreneurs have extensive inside knowledge about many aspects of the business (Pierce et al., 2001; Cardon et al., 2005b; Townsend et al., 2009). This intimate knowledge helps them internalize their ventures' needs such that these needs become part of the entrepreneur's sense of self (Ashforth and Mael, 1989; Ashforth et al., 2016). Accordingly, particularly in intimate relationships, parents/entrepreneurs put extra effort into nurturing their children/ventures as if they were doing so to meet their own needs. Although intimacy develops a deep connection of identity with the child/venture (Cardon et al., 2005b), which gives the parent/entrepreneur a sense of responsibility and a strong incentive to invest in the relationship (Aron et al., 1991, 1992, 2013; Collins and Feeney, 2000), intimacy may also lead to some less commonly acknowledged negative effects.

Two organizational behavior studies have highlighted a dark side to the strong inclusion of one's work in the self. These studies have shown that while strong organizational identification motivates employees to work hard, it may compromise their well-being by causing stress and workaholism (Avanzi et al., 2012) and may result in an inability to question the ethicality of the organization's behavior and practices (Dukerich et al., 1998).

By building on the parent-child attachment research, we suggest that intimacy between parent and child or between an entrepreneur and a venture makes parents and entrepreneurs less prone to engage in critical assessment (Bartels and Zeki, 2004; Zeki, 2007; Song et al., 2015; Halko et al., 2017). The strong bond might render parents/entrepreneurs blind to faults in their children/ventures because they may have an overly idealized image of them (Cardon et al., 2005b). Because the mental images of the self and this close other (i.e., child or venture) overlap, the suppression of critical assessment may also indicate a lack of self-criticism by the parent/entrepreneur.

For our conjectures to hold, intimacy—reflected by the inclusion of the child/venture in the parent's/entrepreneur's self (see Aron et al., 1991, 1992, 2013)—should be associated with brain activation in regions that relate to social and moral judgment. The temporo-parietal junction (TPJ) region has been shown to reflect the ability to understand others' emotions and intentions (Van Overwalle, 2009; McMullen et al., 2014). It has also been shown to be associated with evaluations of fairness, morality, and empathy toward others (Cropanzano et al., 2017). Because of the TPJ's aforementioned role in social and moral judgment, suppressed activity within the TPJ suggests a reduced ability to assess others' social trustworthiness (Saxe and Kanwisher, 2003; Young et al., 2007; Young et al., 2010a; Koster-Hale et al., 2013; Cropanzano et al., 2017). Thus, we anticipate that intimacy, which is represented by the degree of inclusion of a child/venture in the parent's/entrepreneur's self and which is indicative of the strength of the parent-to-child or entrepreneur-to-venture bond, is negatively associated with activation in the TPJ when parents/entrepreneurs are exposed to stimuli of their children/venture and think about experiences with them (Fig. 1).

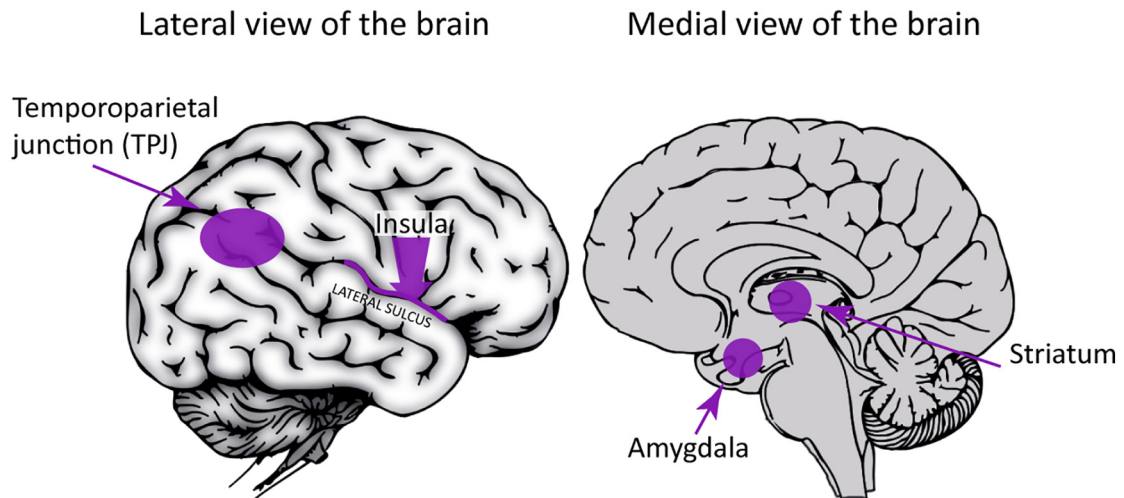
We formalize this prediction as follows:

**Hypothesis 3.** The degree to which a parent includes his or her child in the self and the degree to which an entrepreneur includes his or her venture in the self will influence the parent's or entrepreneur's ability to make critical assessments. The higher a subject's score on the Inclusion of Other in the Self (IOS) scale, the weaker the activation in brain regions related to social and moral judgment.

## 3. Methods

### 3.1. Sample

The sample comprised 42 subjects (21 entrepreneurs and 21 parents). Our group size ( $N = 21$ ) was similar to the group sizes in previous fMRI studies of parental attachment (e.g., Bartels and Zeki, 2004; Abraham et al., 2014). In fMRI studies sample sizes tend to be small as there are typically copious amounts of data gathered from each subject (Huettel et al., 2014).



**Fig. 1.** Lateral and medial view of the brain and the locations of the brain areas that are pertinent to [Hypotheses 1, 2, and 3](#). The insular cortex is folded deep within the lateral sulcus.

We recruited the entrepreneurs by disseminating information about the research project to members of the Finnish Federation of Entrepreneurs, which represents > 115,000 entrepreneurial ventures of all sizes (<https://www.yrittajat.fi/en>). These members received an email in which we indicated that subjects should be founders of ventures and should be involved in their ventures' business operations. We included a sign-up link in the email. We verified compliance with the two criteria before inviting interested individuals to participate.

On the recruitment webpage, we asked the entrepreneurs to list the age of their ventures and estimate their ventures' probable annual growth in the next three years. In this study, we focused on ventures that were younger than 12 years old and entrepreneurs who expected the annual growth of their ventures to exceed 20% in the three years following the experiment. By using growth intention and venture age as selection criteria, we targeted entrepreneurs who are most likely to have placed their ventures' needs ahead of their own and therein have experience with venture bonding.

In total, 71 entrepreneurs volunteered for our study. We invited 21 to participate. We welcomed female entrepreneurs in our study, but very few eligible women volunteered. Of the 21 female entrepreneurs who volunteered, only five (23.8%) met the selection criteria. Of the 50 male entrepreneurs who volunteered, 27 (54%) met these criteria. We therefore ended up studying only male entrepreneurs and fathers. We constructed our interpretations and conclusions with this limitation in mind, although recent studies comparing mothering and fathering have found a similar neural basis and synchronous brain activation for both groups ([Abraham et al., 2014](#)).

To recruit fathers, we posted advertisements in the City of Helsinki's daycare centers, with the city's permission. As in the case of the entrepreneurs, interested individuals signed up online. On the webpage, we requested the age of the child/children. To ensure that the fathers were involved in the daily life and caregiving activities of their child/children, we also asked them to estimate how much time per day they spent with their child/children. Mirroring the selection process for entrepreneurs, we selected fathers with children who were < 12 years old. We excluded fathers who had limited involvement with their children (< 3 h a day). In total, 160 fathers volunteered for the study, of which 111 (69.4%) met the first two selection criteria.

Our primary goal was not to study how age or education affects entrepreneurs'/parents' bonds with ventures/children, so we homogenized the groups with respect to age and education ([Table 1](#)). We also ensured that the average age of the entrepreneurs and the average length of their education did not significantly differ from those of parents, and homogenized the groups in terms of the length of the subjects' relationships with the venture/child. On average, the parents' experience in parenting was as long as the entrepreneurs' experience in entrepreneurship. [Table 1](#) presents the results of two-sided *t*-tests comparing the averages for the two groups with respect to the three measures.

[Table 2](#) shows the characteristics of the ventures with respect to industry, turnover, and number of employees. The biggest

**Table 1**

Age, education, and the duration of the parent-child and entrepreneur-venture relationships.

Variable	Entrepreneurs			Fathers			Two-sided <i>t</i> -test	
	Mean	SD	Range	Mean	SD	Range	<i>t</i> -statistics	<i>p</i> -value
Age	33	5.82	24–45	35	4.31	27–43	1.446	0.155
Length of education (years)	14.8	2.43	9–17	15.4	2.46	9–17	0.827	0.413
Duration of the relationship (years)	4.5	2.94	0–11	5.6	2.42	1–10	1.317	0.195



**Table 2**  
Characteristics of the ventures.

Industry	%	Turnover	%	Personnel	%
Communications	14.30	< €1 M	76.20	< 6 employees	66.70
Information technology	19.00	€1–2 M	23.80	6–10 employees	14.30
Consumer goods	4.80			11–49 employees	14.30
Construction	9.50			50–250 employees	0.00
Industrial manufacturing and services	4.80			> 250 employees	4.80
Consultancy services	28.60				
Other services	9.50				
Other	9.50				

industry was “consultancy services,” which accounted for 28.6% of the ventures. The vast majority of ventures still had turnovers of less than €1 M. The ventures were also small in terms of personnel: Most had fewer than six employees.

### 3.2. Task

In accordance with previous fMRI studies, our experiment consisted of two separate sessions (Bartels and Zeki, 2004; Aron et al., 2005; Acevedo et al., 2012). The first session was arranged before the fMRI experiments. In this session, the entrepreneurs were asked to select and send us two to four pictures related to their own venture and another known to them. Each picture fell into one of four categories: the venture's logo, the venture's product or service, key personnel, and the business idea. To avoid possible negative reactions to a known venture, the entrepreneurs were asked not to choose pictures of direct competitors. Fathers were asked to send pictures of their own children and of another known child (Bartels and Zeki, 2004; Swain, 2008, 2011).

During the first session, the subjects also completed questionnaires: the 40-item Affect Intensity Measure (AIM) questionnaire (Larsen, 1984), a confidence measure (Fischhoff et al., 1977), and a questionnaire on socioeconomic and entrepreneurship/parenthood background. We asked subjects to evaluate several impressions: their sense of closeness/intimacy with their child/venture using the Inclusion of Other in the Self (IOS) scale (Aron et al., 1992), love (Aron and Westbay, 1996; Sternberg, 1997), the chances of success of their child/venture compared to other children of the same age or ventures in the same industry, and the frequency with which they place the needs of their child/venture ahead of their own needs. The purpose of the last four questions was to collect behavioral data on entrepreneurs' attachment to their ventures and parents' attachment to their children.

The three most relevant measures for testing our hypotheses were the AIM, the IOS scale, and confidence scores. As explained later, the confidence and IOS scores for the two groups were correlated with the brain regions of interest (amygdala and TPJ). The AIM was used as a control in the analysis. Because significant differences between the groups were found for AIM but not for the other behavioral measures (IOS, love, success beliefs, and own needs versus others' needs), only the AIM was used as a control in our study. Descriptive statistics and *t*-statistics for all behavioral measures are reported in Table S1 of the Supplementary Figures and Tables.

The 40 items of the AIM describe emotional reactions to typical life situations. Example items include “When I am excited over something, I want to share my feelings with everyone” and “When I do something wrong, I have strong feelings of shame and guilt.” Subjects rated whether they react to these situations as described on a scale from 1 to 6 (1 = *Never*, 3 = *Sometimes*, and 6 = *Always*). The final AIM score was the average of the results.

The IOS scale is a graphical measure that consists of seven pairs of differently overlapping circles (Fig. S1, Supplementary Figures and Tables). Fathers/entrepreneurs were asked to circle the alternative that best described their relationship with their child/ventures. The IOS scale has been widely used to measure individuals' sense of closeness/intimacy, interconnectedness, and identification with others (e.g., Aron and McLaughlin-Volpe, 2001; Ashforth et al., 2016). The IOS score is higher when the selected circles have a higher degree of overlap.

We measured subjects' confidence using a judgment task. Subjects received seven general knowledge statements and were then asked to choose between two mutually exclusive answers. Subjects also had to evaluate their confidence that the answer was correct on a scale ranging from 50% (*I am not at all sure*) to 100% (*I am completely sure*). The final confidence score was defined as the difference between the mean confidence score and the mean proportion of correct answers.

In the fMRI experiment (second session), we used a task that has been used in several neuroimaging studies of parental and romantic attachment (e.g., see Bartels and Zeki, 2004; Swain, 2011). From the pictures supplied, we selected two pictures of the subject's own venture/child and two pictures of the known venture/child. The two pictures of the entrepreneur's own venture and the two pictures of the known venture were selected from the same subject category (e.g., logos of the entrepreneurs' own and a known venture). The vast majority of the pictures selected depicted either the venture's logo or the venture's product or service. Only 20% of the pictures included people, and only 5% included team members.

During the fMRI session, the entrepreneurs were shown the two pictures of their own venture and the two pictures of the other known venture in alternating order on a dark background. The fathers were likewise shown pictures of their own child and a known child. The pictures were presented for 30 s at a time, and each was repeated six times. To reduce possible carry-over effects, the subjects performed a count-back task for 30 s between pictures (Aron et al., 2005; Acevedo et al., 2012). They were shown a four-digit number on the screen, such as 8421, and they were asked to count back from the number in decrements of seven as long as the number remained on the screen. The total duration of the task was approximately 13 min. Fig. 2 illustrates the fMRI trial structure.

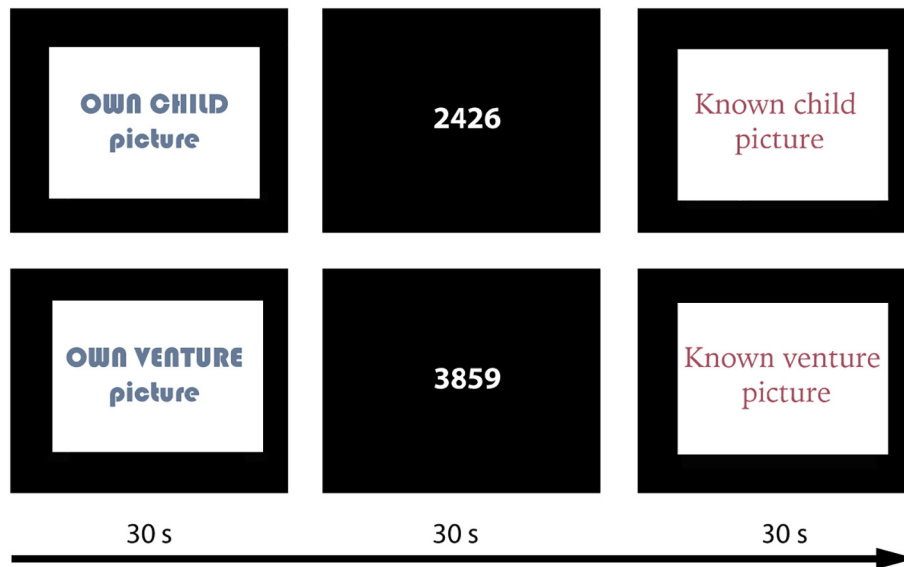


Fig. 2. The fMRI trial structure.

### 3.3. Experimental procedure

All subjects were studied individually. The first session was conducted by one member of the research team in a meeting room at Aalto University. After welcoming the subject and explaining the structure of the study, the member of the research team gave general introductions, and the subject signed an informed consent form. After the subject had completed the questionnaire privately, a second session was scheduled. As a reward, subjects received one movie ticket, the value of which was approximately €10. The first session lasted approximately 30 min.

The second session was conducted by three of the six members of the research team at the Aalto NeuroImaging Centre ([http://ani.aalto.fi/en/ami\\_centre/](http://ani.aalto.fi/en/ami_centre/)). After welcoming the subject and explaining the course of the study, the members of the research team again gave a general introduction. The subjects were instructed to focus on the pictures they would see on the screen and think about things and events related to these pictures. The fMRI safety instructions were reviewed with the subject, and the subject signed an informed consent form. When the subject was lying inside the scanner, visual stimuli were back-projected on a semitransparent screen and, from there, via a mirror to the subject.

### 3.4. fMRI data analysis

The trial structure did not differ between the two groups. Therefore, we were able to pool the data for the two groups when analyzing the difference between brain activation in response to a picture of the subject's own venture/child and a picture of a known venture/child. The data gathered from our experiments were also used in Halko et al. (2017). In that study, the data were analyzed separately for founding entrepreneurs and fathers. In our study, each of the fMRI analyses at the whole-group level were unique. Through performing analysis at this level we were able to statistically test for similarities and differences between groups. In this instance, we compared the neural signs of bonding between entrepreneurs/parents and venture/child.

The fMRI data analysis had two levels. At the single-subject (within-subject) level, the fMRI data were analyzed using the general linear model (GLM).<sup>2</sup> Our model included one independent variable for pictures of the parent's/entrepreneur's own child/venture and

<sup>2</sup> In the GLM, the dependent variable consists of a vector of values showing blood-oxygen-level dependent (BOLD) signal strength in a single voxel in successive scans (a voxel time series) (Laureiro-Martínez et al., 2015). The voxel, a three-dimensional volume element, is the basic sampling unit in MRI. In this study, the voxel size was  $3 \times 3 \times 3$  mm. Before applying the general linear model and as a standard procedure, our hypothesized model—that is, the time course for predictors (independent variables)—was convolved with a canonical hemodynamic response function that models the basic brain response to a stimulus. This enabled us to compare BOLD signals received in our model. In accordance with the GLM approach, the model was fitted for each voxel to obtain the parameter values/beta estimates that explain how much each independent variable contributes to the BOLD signal strength at each voxel. The GLM model can be expressed as the following function:  $y = Xb + e$ . In the aggregated GLM model represented by the function,  $y$  is the fMRI data,  $X$  is a time course that reflects a matrix containing the predictor time courses (independent variables) as column vectors,  $b$  denotes the beta values for the predictor time courses that suggest the extent to which the stimuli influence the BOLD signals and hence contribute to neural activation, and  $e$  is a vector of residuals (error values) in the prediction. The independent variables represent the modeled time course of the stimulus—here, the two types of pictures: pictures of one's own child/venture and a known child/venture. Our model included one independent variable for pictures of one's own child/venture and another independent variable for pictures of a known child/venture. In the experiment, we used a block design—that is, the trials were arranged to alternate between the experimental conditions (pictures of one's own child/venture or a known child/venture) and the control conditions (no pictures), as shown in Fig. 2. The two types of image blocks were modeled using boxcar functions. In accordance with our experimental design, a boxcar function (time course) received a value of 1 when, for example, a picture of one's own child/venture was presented to the subject and 0 otherwise (see, e.g., Friston et al., 2007;

another independent variable for pictures of a known child/venture. The model was fitted for each voxel to obtain the parameter values ( $\beta$ ) for all independent variables (i.e., for one's own and known pictures,  $\beta_{\text{own}}$  and  $\beta_{\text{known}}$ , respectively). The parameter values represent how much each independent variable contributes to the overall data. After fitting the model for each subject and for each voxel independently, we defined the effect of interest for each subject with a contrast vector. For example, with a contrast vector [1–1], researchers can study which brain regions respond more to pictures of one's own child/venture than to pictures of a known child/venture (i.e., in which regions  $\beta_{\text{own}} > \beta_{\text{known}}$ ) (Hypothesis 1). The contrast vector produces a contrast image containing the contrast of the parameter estimates (e.g.,  $\beta_{\text{own}} - \beta_{\text{known}}$ ) for the single-subject-level model at each voxel. These contrast images form the data for the group-level analysis.

The second-level analysis was used to study activations at the group (between-subject) level. For example, for Hypothesis 1, the analysis gave us all brain regions where  $\beta_{\text{own}} - \beta_{\text{known}}$  was significantly positive at the group level. To account for the possible confounding effect of group differences in affect intensity, our simple second-level model also included an individual-level covariate (the AIM score). Thus, we tested the significance of  $\alpha$  in the following regression model:

$$y = \alpha + \beta x + e,$$

where  $y$  is the vector of contrast values,  $\alpha$  is the constant,  $\beta$  is the coefficient of  $x$ , and  $x$  is the vector of AIM scores. At the second level, one-sample or two-sample  $t$ -tests were used as statistical methods. Compared to a “standard” behavioral data analysis, the first-level analysis offered an extra step to model the brain response of one subject.

To compare the groups, we used region of interest (ROI) analysis, where statistical tests are performed on a certain predetermined area of the brain. The ROIs were defined based on our analysis or based on the anatomy of the human brain. For each “analysis-based” ROI, we located a sphere-shaped volume (two voxel radius or 6 mm) around the peak activation (obtained from the second-level analysis) and extracted mean parameter values (betas) from each region.<sup>3</sup> For the amygdala, we used the bilateral amygdala ROI, with coordinates from Abraham et al. (2014), and the anatomical ROI (i.e., the ROI included the entire anatomically defined amygdala). Lastly, we assessed associations (Pearson correlation) between ROI activation and subjects' individual IOS and confidence scores.

## 4. Results

This section has four subsections. The first subsection introduces the behavioral results related to the bonding of subjects with their own child or venture. The second subsection presents the results for the test of Hypothesis 1, which predicts that parents and entrepreneurs exhibit similar neural signs of affective bonding when exposed to child and venture stimuli, respectively. The third section presents the results for the test of Hypothesis 2, which predicts that the self-confidence of parents and entrepreneurs is associated with their bonding style. The fourth subsection presents the results for the test of Hypothesis 3, which predicts that intimacy, in terms of the extent to which the entrepreneur/parent includes the venture/child in the self, is associated with suppressed activation in neural regions that are responsible for critical assessment.

### 4.1. Behavioral signs of affective bonding in entrepreneurship and parenting

According to the behavioral results, affective bonds from founding entrepreneurs toward their ventures are strikingly similar to affective bonds from parents toward their children (see Fig. 3 and Table S1 of the Supplementary Figures and Tables). Entrepreneurs rated their relationship with their venture to be as close or interconnected as fathers rated their relationship with their child (IOS score, two-sided  $t$ -test,  $p = 0.13$ ). Fathers scored slightly lower than entrepreneurs on the amount of love, in terms of the average measure that was derived from the values of the three love components. However, the difference between groups was not significant (two-sided  $t$ -test,  $p = 0.45$ ). Entrepreneurs rated their venture and fathers rated their child significantly better than average in terms of chances of success. There were no significant differences between the groups (two-sided  $t$ -test,  $p = 0.26$ ). Both entrepreneurs and fathers reported that they placed the needs of their venture/child ahead of their own needs more frequently than “often” (two-sided  $t$ -test,  $p = 0.26$ ).

### 4.2. Neural signs of affective bonding in entrepreneurship and parenting

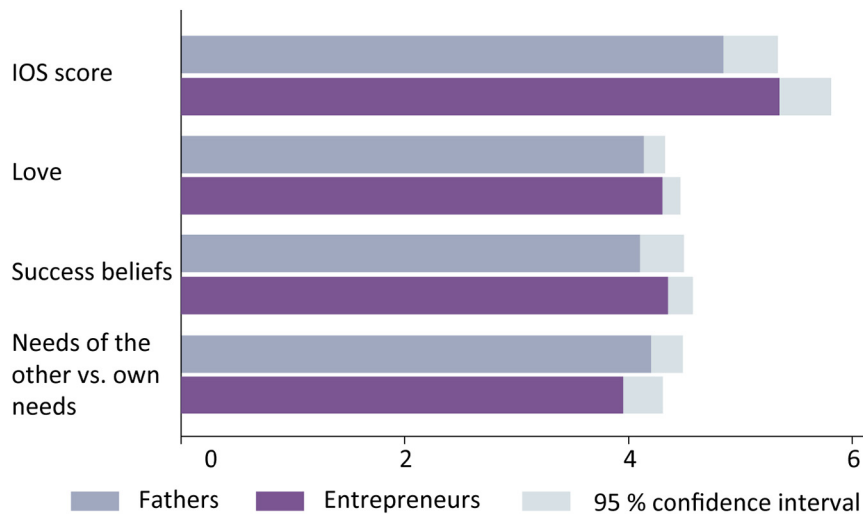
As predicted by Hypothesis 1, the brain regions that were activated when entrepreneurs were exposed to stimuli related to their own ventures vs. stimuli related to a known venture are similar to the brain regions that were activated when fathers were exposed to stimuli related to their own children vs. stimuli related to a known child. Fig. 4A shows the brain areas that were more active when the subjects viewed pictures of their own venture/child than when they viewed pictures of another known venture/child (contrast own > known).<sup>4</sup> The cluster that was identified is the striatum, which is the reward system of the brain. Specifically, the identified

(footnote continued)

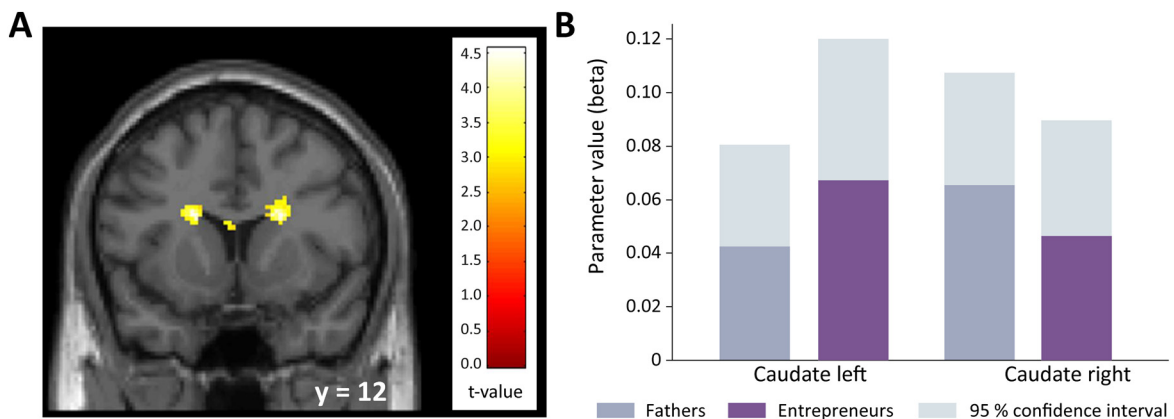
Huettel et al., 2014). To improve the statistical sensitivity, the single-subject model also included vectors of six motion (head motion) parameters as covariates of no interest—that is, covariates associated with known sources of variability.

<sup>3</sup> ROIs were defined, and mean parameter values across voxels in the ROIs were calculated for each subject and each ROI using the MarsBaR software package (Brett et al., 2002; <http://marsbar.sourceforge.net>).

<sup>4</sup> In the whole-brain analysis, statistical maps were created using the thresholds  $p < 0.005$  (uncorrected) at the voxel level and  $p < 0.05$  (with family-wise error



**Fig. 3.** Behavioral signs of affective bonding. Means and 95% confidence intervals for the behavioral measures. The IOS score (max value = 7) measured subjects' sense of closeness/intimacy and interconnectedness with the child/venture. Love score (max value = 5) was the average of three components of love: emotional bond, passion, and commitment. The love score characterized subjects' affective relationship with the child/venture. Success beliefs (max value = 5) measured the beliefs of subjects about their child's/venture's chances of success. Needs (max value = 5) measured how often subjects place the needs of their child/venture ahead of their own needs.



**Fig. 4.** Neural signs of affective bonding. Panel A. Brain regions that were more strongly activated by pictures of subjects' own child/venture than by pictures of a known child/venture (contrast own > known). The distance (in mm) of a section from the origin of the stereotaxic space (anterior commissure) is displayed below the slice. All displayed activations have survived a statistical threshold of  $p < 0.05$  corrected for multiple comparisons. Panel B. Mean parameter values and 95% confidence intervals for the left and right caudate nucleus. All means were significantly larger than zero for a level of significance of at least 5% (one-sided  $t$ -tests).

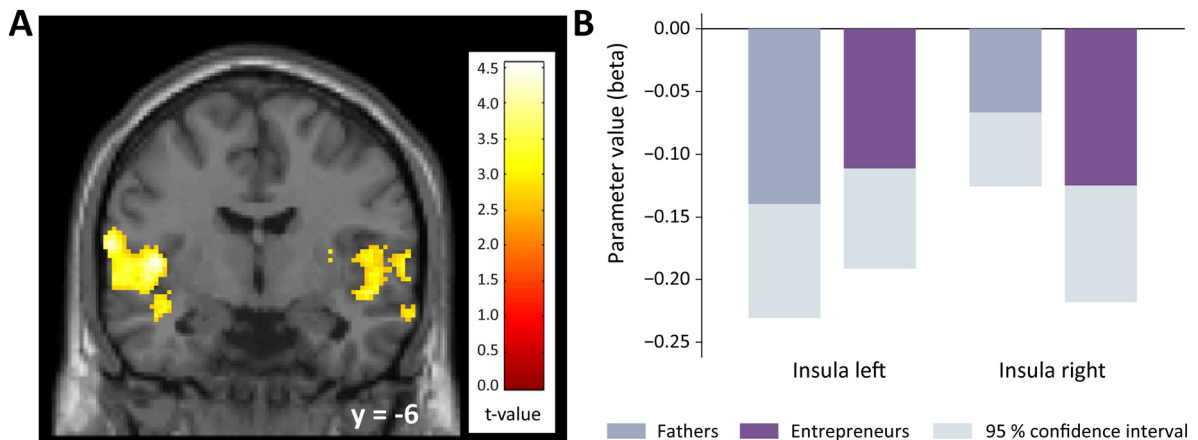
region is the caudate nucleus, which is one of the three regions that form the striatum. The two other regions that make up the striatum are the nucleus accumbens and the putamen. Activation in the caudate nucleus is associated with a variety of rewards, including food and drink (Kelley, 2004) and money (Knutson et al., 2001). Similarly, expectations of rewards have been found to trigger caudate nucleus activation (Onoda et al., 2011). Prior research into parental bonding has also identified activity in the caudate nucleus (e.g., Bartels and Zeki, 2004; Zeki, 2007).

To compare the groups, we calculated the mean parameter values across voxels around the activation peaks. Fig. 4B shows the average parameter values (betas) from the left and the right caudate nucleus.<sup>5</sup> The significant positive parameter values indicate that the area in question was more strongly activated during the own venture/child trials than during the known venture/child trials. There were no significant differences in beta values between fathers and entrepreneurs (two-sided  $t$ -tests: left caudate,  $p = 0.41$ ; right caudate,  $p = 0.55$ ).

(footnote continued)

correction) at the cluster level, unless otherwise stated. The locations of supra-threshold clusters are reported in MNI coordinates (the Montreal Neurological Institute and Hospital).

<sup>5</sup> Betas were calculated from 6 mm radius spheres, centers at  $-20\ 12\ 22$  (left caudate) and  $22\ 14\ 24$  (right caudate).



**Fig. 5.** Neural signs of affective bonding. Panel A. Brain regions that were more strongly activated by pictures of a known child/venture than by pictures of subjects' own child/venture (contrast known > own). The distance (in mm) of a section from the origin of the stereotaxic space (anterior commissure) is displayed below the slice. All displayed activations have survived a statistical threshold of  $p < 0.05$  corrected for multiple comparisons. Panel B. Mean parameter values and 95% confidence intervals for the left and right insula. All means were significantly smaller than zero at a level of significance of at least 5% (one-sided  $t$ -tests).

Fig. 5 shows that the opposite test of known venture/child versus own venture/child (contrast known > own) revealed a significant deactivation in the bilateral insula. This brain region is associated with negative emotional experiences such as sadness (Liotti et al., 2000; Farb et al., 2010), anxiety (Liotti et al., 2000; Paulus and Stein, 2006), disgust (Lane et al., 1997; Wicker et al., 2003), depression (Wiebking et al., 2010; Mutschler et al., 2012), and pain (Mutschler et al., 2012; Strigo et al., 2013). As mentioned earlier, a situation where a brain region is activated significantly more by stimuli of a known venture/child than by stimuli of one's own venture/child is referred to as deactivation. Our results support Hypothesis 1, which predicts that stimuli associated with one's own child/venture suppress neural regions associated with processing negative emotions.

To compare the groups, we again calculated the mean parameter values across voxels around the activation peaks in the left and right insula. Fig. 5B shows the average parameter values (betas) for the left and right insula.<sup>6</sup> The significant negative parameter values indicate that the area in question was more strongly activated during the known venture/child trials than during the trials with material from their own venture/child. There were no significant differences in the beta values between fathers and entrepreneurs (two-sided  $t$ -tests: left insula,  $p = 0.63$ ; right insula,  $p = 0.28$ ).

Entrepreneurs'/parents' affective bonds with ventures/children are reflected by activation in neural regions of the brain related to rewards or pleasure and suppression in regions associated with negative affect. These results support Hypothesis 1, which predicts that when exposed to child/venture stimuli, parents and entrepreneurs exhibit similar signs of affective bonding.

#### 4.3. Bonding styles and regulation of anxiety and fear

Consistent with Hypothesis 2, our results suggest that different parents/entrepreneurs have different bonding styles. Parents/entrepreneurs with low self-confidence show signs of an anxious-ambivalent bonding style reflected by strong activations in the amygdala region, which is known to mediate anxiety and fear. The amygdala is a key component of the human parental brain that heightens parental vigilance and anxiety for a child's safety (Feldman, 2015). While amygdala activation has been associated particularly with primary caregiving mothers (Toscano et al., 2009; Kim et al., 2010), recent studies have localized activation in fathers (Abraham et al., 2014) and have suggested that this activation may relate to their self-confidence (Halko et al., 2017).

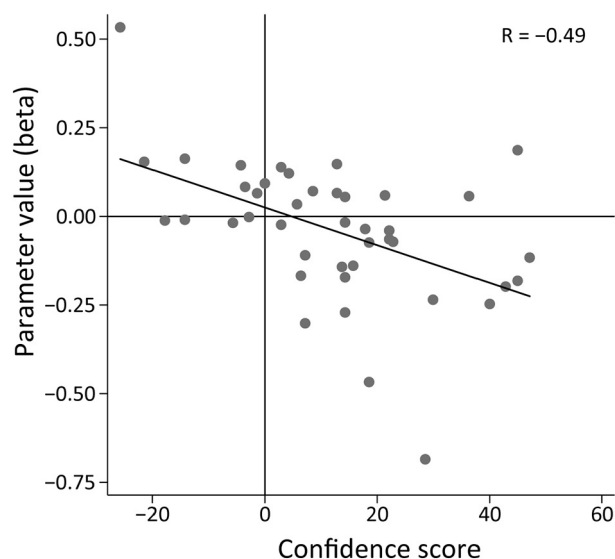
Here, we show that amygdala activation is *more generally* associated with subjects' confidence. In pooled data, the correlation between brain activation around the activation peak localized in Abraham et al. (2014) and subjects' confidence scores was strong and highly significant (Fig. 6;  $r = -0.49$ ,  $p = 0.001$ ). When we extracted the data from a larger area (i.e., the bilateral anatomically defined amygdala), we also detected a significant negative correlation between subjects' confidence scores and the average betas for the bilateral amygdala (pairwise correlation:  $r = -0.31$ ,  $p = 0.047$ ). Our results support Hypothesis 2, which posits that the self-confidence of parents and entrepreneurs is associated with their bonding style because this self-confidence is negatively associated with activation in brain regions that are related to anxiety and fear.

#### 4.4. Intimacy of bonding and critical assessment

As predicted by Hypothesis 3, intimacy, in terms of the entrepreneur's/father's inclusion of the venture/child in the self, was associated with a suppression in brain regions associated with social and moral judgment. As explained earlier, the TPJ region is

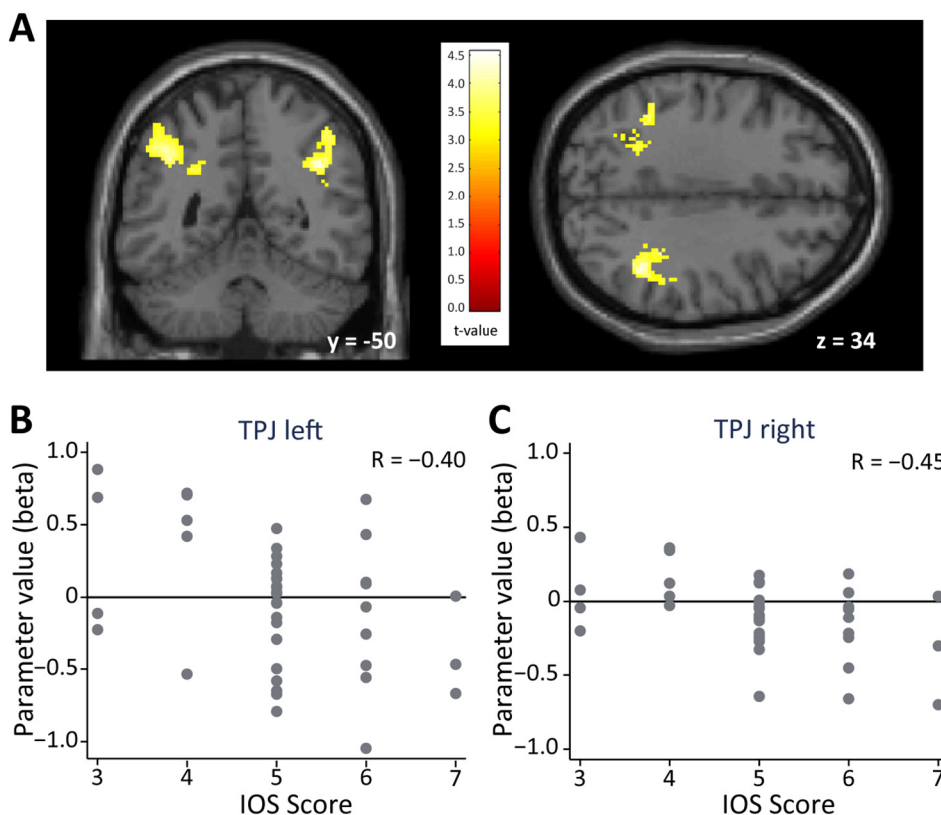
<sup>6</sup> Betas were calculated from 6 mm radius spheres, centers at  $-44 -6 6$  (left insula) and  $44 -16 0$  (right insula).





**Fig. 6.** Bonding styles and regulation of anxiety and fear. Pairwise correlation between left and right amygdala activation and subjects' confidence scores.

activated when individuals make social and moral judgments (Saxe and Kanwisher, 2003; Young et al., 2010a; Young and Saxe, 2011; Koster-Hale et al., 2013). To test *Hypothesis 3*, we used IOS scores as an additional individual-level covariate in the second-level analysis.



**Fig. 7.** Intimacy of bonding and critical assessment. Panel A. Brain areas where activation (own-known contrast) was associated with subjects' individual IOS scores. The distance (in mm) of a section from the origin of the stereotaxic space (anterior commissure) is displayed below the slices. All displayed activations have survived a statistical threshold of  $p < 0.05$  corrected for multiple comparisons. Panels B and C. Pairwise correlations between left and right TPJ activation and subjects' IOS scores.

Fig. 7 shows that, for the pooled data, a significant negative correlation was detected between subjects' IOS scores and the average betas for the bilateral TPJ.<sup>7</sup> Fig. 7B–C show the negative correlations between the IOS scores and the left and right TPJ (pairwise correlations: left TPJ,  $r = -0.40$ ,  $p = 0.01$ ; right TPJ,  $r = -0.45$ ,  $p = 0.003$ ). The results reveal that for entrepreneurs and fathers with high IOS scores, the image of their ventures/children tended to elicit lower activation in the bilateral TPJ than the image of a known venture/child. These results support Hypothesis 3, which suggests that intimacy, in terms of the extent to which an entrepreneur/parent includes a venture/child in the self, is associated with suppression in neural regions that are responsible for critical assessment.

## 5. Discussion

Our goal was to investigate why and how founding entrepreneurs bond with their ventures. We suggested that venture ownership is essential for the formation of an affective bond from the founding entrepreneur toward the venture. Ownership helps the venture become an extension of the entrepreneur's self and heightens the entrepreneur's sense of responsibility for the venture, which encourages the entrepreneur to make sacrifices on the venture's behalf (Pierce et al., 2001; Cardon et al., 2005b; Townsend et al., 2009). These effects of ownership strengthen the parallels between entrepreneurship and parenting. Building on tenets from attachment theory, we argue that, like parents, founding entrepreneurs have a caregiving system, obtain emotional rewards by making sacrifices for their ventures, exhibit different bonding styles, and have varying degrees of intimacy with their ventures (Bowlby, 1969; Mikulincer et al., 2003; George and Solomon, 2008).

We gathered behavioral data from founding entrepreneurs and parents to examine the behavioral signs of bonding. The behavioral results support the assertion that entrepreneurial bonding is akin to parental bonding. No significant differences were observed between the groups in terms of the tendency to place the venture's/child's needs ahead of one's own needs, the perceived love for the venture/child, beliefs regarding the success of the venture/child, and the inclusion of the venture/child in the self.

We used fMRI to examine the neural underpinnings of affective bonds and the extent to which entrepreneurs' bonding with ventures activates the same brain regions as parents' bonding with children. Specifically, we developed and tested three hypotheses regarding entrepreneurs'/parents' brain activations to venture/child stimuli. These hypotheses provide insights into three areas: the potential of parent-to-child bonding and entrepreneur-to-venture bonding to activate positive or rewarding emotions and deactivate negative feelings; the negative and potentially dysfunctional aspects of bonding such as impairing judgment; and the way that self-confidence is associated with brain areas that enable different bonding styles in parenting and venturing.

The significant activation of entrepreneurs' reward systems, specifically in the caudate nucleus, implies that entrepreneurial bonding offers emotional rewards (Bartels and Zeki, 2004; Atzil et al., 2012). Entrepreneurial bonding, encompassing caregiving activities, appears to elicit pleasurable and satisfying emotions. Given these emotional rewards, the well-being of entrepreneurs appears to increase when their bonding efforts help ensure the survival of their ventures (Eibach and Mock, 2011; Nelson et al., 2014). Further, the significant deactivation in the entrepreneurs' insula region shows that entrepreneurship also suppresses negative emotions (Liotti et al., 2000; Farb et al., 2010; Strigo et al., 2013). Our results help explain the strong entrepreneur-to-venture bond and provide an explanation for the entrepreneur's unwavering commitment to the venture in the face of considerable obstacles and impediments (Cardon et al., 2005b; Cardon et al., 2009).

Our results show that the entrepreneur's intimacy with the venture, reflected by the inclusion of the venture in the self, is negatively associated with activity in the TPJ. Consistent with prior research, suppression in this neural region indicates an impaired ability to critically assess the venture (Saxe and Kanwisher, 2003; Young et al., 2010a). In relationships where the bonds are extremely strong, the affection that the entrepreneur has for his or her venture may lead to an overly optimistic view of the venture. This view makes the entrepreneur prone to ignore the venture's faults (Cardon et al., 2005b; Swami et al., 2009; Fletcher and Kerr, 2010).

The possible consequences of these results are twofold. First, viewing the venture in a very positive light contributes to strengthening the entrepreneur's bond with and commitment to the venture. Sacrifices on behalf of one's own venture seem worthwhile because the venture's qualities, reflecting future expectations are assessed favorably. Because these ventures are salient to the entrepreneurs' mental representation of the self, the experienced identity connection may make the entrepreneur less inclined to develop negative beliefs about the venture because its qualities are seen to mirror the entrepreneur's own qualities (Aron et al., 1991, 1992). Strong identification with the venture may generate trust (Rousseau et al., 1998; Hsu et al., 2007; Sundaramurthy, 2008) and thereby contribute to the impairment of critical assessment.

Additionally, given the overlap in the mental representation of the self and the venture, results may indicate a lack of self-criticism by these entrepreneurs. Second, disappointment may arise if an entrepreneur's inability to critically assess the venture results in unrealistic expectations (Cardon et al., 2005b). Disappointments may have adverse effects on the entrepreneur's well-being because of the venture's importance to the entrepreneur's sense of self. Perceived failures might have harsh effects on perceived self-worth. Thus, we predict situations where intense positive, sometimes euphoric, emotions may shift to feelings of grief and sadness.

Our results also suggest that the entrepreneur's relationship with the venture can be understood in terms of psychological characteristics that lay the foundations for the bonding style. Stronger activation of the amygdala shows that entrepreneurs with lower self-confidence react with greater anxiety and fear when exposed to stimuli of their own ventures and when prompted to think about experiences with their ventures. An anxious-ambivalent bonding style may slow the entrepreneurial process if concerns over

<sup>7</sup> Left TPJ: peak at  $-46 -48 42$ , cluster size = 551,  $Z_{\max} = 3.65$ ; right TPJ: peak at  $40 -50 34$ , cluster size 379,  $Z_{\max} = 3.51$ .

venture survival and the corresponding effects on the self prevent these less confident individuals from engaging in risky activities (Cacciotti and Hayton, 2015; Cacciotti et al., 2016). Conversely, highly confident entrepreneurs with a secure bonding style may be overly aggressive in their entrepreneurial actions because of lower anxiety about their ventures (Mitchell and Shepherd, 2010, 2011).

### 5.1. Implications

Our study has important implications, which indicate that we can learn a great deal from examining entrepreneurial bonding. Studies of entrepreneurial cognition, particularly decision making, have demonstrated that entrepreneurs engage in risky actions because of cognitive biases such as over-optimism (Hmieleski and Baron, 2009; Ucbasaran et al., 2010), over-confidence (Busenitz and Barney, 1997; Hayward et al., 2006), and illusion of control (Simon et al., 2000; Keh et al., 2002). Prior research indicates that the beliefs and decisions of entrepreneurs are distorted by wishful thinking that clouds their judgment and makes them prone to errors. Our findings support this stream of research on a neural level by showing how the interplay between three neural regions may shed light on the biological mechanisms associated with cognitive bias.

As previously suggested, caudate nucleus activation and insula deactivation provide a motivational drive that is essential for forming affective bonds with a venture. In an analogy to parents with children, entrepreneurs allocate resources to their ventures to increase their venture's chances of survival and positive development (Trivers, 1972; Wright, 1994; Cassar and Friedman, 2009). Unlike parents, however, entrepreneurs would be well advised to terminate their bond with their ventures if they risk investing more than they can afford, which would have severe consequences in the case of failure (Sarasvathy, 2001; Dew et al., 2009). Based on our results, this risk is particularly pronounced when entrepreneurs include their venture in their sense of self. As mentioned earlier, the suppression of activity in the TPJ can indicate an entrepreneur's inability to accurately assess the qualities of the venture.

Our study's findings appear to provide neuropsychological support for other potential implications that result from a high degree of inclusion of the venture in the self. Because the extent to which a venture is internalized in the entrepreneur's self appears to explain the entrepreneur's tendency to overlook the venture's faults when making judgments, our results support previous discussions suggesting that entrepreneurs may struggle to maintain a healthy work-life balance. When the mental representations of the entrepreneur and the venture overlap, the venture may have a disproportionately large place in the individual's identity and daily life (Forest et al., 2011; Murnieks et al., 2014). Accordingly, our results suggest that educators in entrepreneurship programs should highlight the risks of becoming overly absorbed in one's work and should stress the importance of having a broad set of priorities in life. Hence, our study provides fresh empirical evidence of the potential negative effects of high inclusion of work in the self by demonstrating that doing so not only results in workaholism and stress (Avanzi et al., 2012; Ashforth et al., 2016) but also impairs the ability to exercise social and moral judgment.

Recently, entrepreneurship research has shifted its focus from examining fear of failure as an individual trait to examining fear and anxiety as emotional episodes in the entrepreneurial process (Cacciotti and Hayton, 2015; Cacciotti et al., 2016). Our results contribute to the latter stream of research by indicating that the bonding style of less self-confident entrepreneurs reflects more anxious reactions to events in the entrepreneurial process.

Based on our findings, task-related self-confidence in entrepreneurs can be considered a double-edged sword. Entrepreneurs with high self-confidence appear to be more capable of regulating anxiety and stress. This ability has positive consequences for their well-being and mental health. In contrast, entrepreneurs with an anxious-ambivalent bonding style are more likely to suffer from panic attacks, causing frustration (Singh et al., 2007; Cacciotti et al., 2016). Accordingly, self-confidence is an important psychological resource for managing fears and anxieties (Carver et al., 1989; Hanton et al., 2004; Crocker and Park, 2004). However, an entrepreneur's affective bond to the venture is characterized by emotional rewards and the suppression of negative emotions, motivating the entrepreneur to carry out activities on behalf of the venture. Anxious responses to events in the entrepreneurial process that are caused by moderate or low self-confidence may help entrepreneurs avoid rushing into poor decisions. Hence, concerns about the consequences for the self, as reflected by anxious reactions, can be beneficial as long as the reactions are not extreme or unwarranted.

To conclude, we recommend that entrepreneurship education should raise awareness about similarities between entrepreneurship and parenting. Our study reveals major advantages and disadvantages of entrepreneurial bonding that reflect those of parental bonding. For example, emphasis should be placed on addressing the motivational effects, cognitive biases, and potential consequences for well-being that we report herein. Furthermore, like parents, entrepreneurs appear to adopt different working models that influence perceived anxiety and fear during the entrepreneurial process.

### 5.2. Pros and cons of the neuroscience method

The neuroscience method offers a more objective measurement of affective bonding than traditional methods in entrepreneurship research, such as surveys and interviews (Waldman et al., 2016). Surveys and interviews are unable to capture implicit, automatic processes in the brain that lie beyond our consciousness yet influence how we feel, think, and behave (Becker and Menges, 2013; de Holan, 2014). Individuals have very little or no introspective access to these processes, nor do they have volitional control over them (Krueger and Welp, 2014).

Therefore, respondents' self-reports may fail to provide an accurate and complete account of the emotions and thoughts that are associated with a child/venture. The neuroscience methods of fMRI, positron emission tomography (PET), and electroencephalography (EEG) provide techniques to capture implicit influences. Of these neuroscience methods, fMRI has the greatest accuracy in locating specific areas of the brain. Neural activity is detected by mapping the regions where changes in cerebral blood

flow occur (Massaro, 2015, 2017). The fMRI technique provides the most effective method for tracing implicit processes in response to stimuli (Becker and Menges, 2013; Massaro, 2017). It is thus the most precise and advanced tool for understanding how stimuli affect profound psychological functions such as brain reward systems and judgment.

A second related advantage of the neuroscience method is that it allows researchers to obtain more truthful data. Not only may the quality of self-reported data suffer from cognitive limitations, but also biases in reporting may occur because of respondents' intentions to hide or mask emotions (Russell, 2003; Waldman et al., 2016). In fMRI experiments, respondents cannot lie or fake emotions. Therefore, subjects' brain responses from viewing pictures and recalling experiences provide valid data on the subjects' emotional states.

However, fMRI studies also have certain drawbacks. First, sample sizes tend to be smaller than in studies using empirical or experimental methods. However, it is important to keep in mind that the basic sample unit in an fMRI study is a voxel, a small, three-dimensional brain volume element (here  $3 \times 3 \times 3$  mm), and that fMRI data are collected as voxel-wise time series (Huettel et al., 2014). Our single subject fMRI data contains approximately 150,000 time series, each including 345 data points. In fMRI studies, overly large sample sizes can become problematic if they overpower hypothesis tests, implying that unimportant, trivial findings obtain statistical significance (Quinlan, 2013; Nord et al., 2017). Our sample group size ( $N = 21$ ) corresponds to the sample group sizes in previous fMRI studies of parental attachment (e.g., Bartels and Zeki, 2004; Abraham et al., 2014).

Second, many fMRI studies apply “reverse inference” (Poldrack, 2006; McMullen et al., 2014; Plassmann et al., 2015; Massaro, 2017). Reverse inference means that scholars reason backwards from an observed brain activation to a specific mental process. This is problematic because activation in a certain brain area can be associated with many different mental processes. For example, activation in the TPJ is associated with both ascribing moral beliefs to others and higher-order cognitive functions such as direction or reorientation of attention (Young et al., 2007; Young et al., 2010b; Mars et al., 2011). We took four measures to mitigate this potential problem.

First, we relied largely on previous research into attachment relationships at the start, to determine the design, experiment task, and variables of our study (e.g., Bartels and Zeki, 2004; Swain, 2011). Our results and interpretations of the results are consistent with prior studies that have used similar research designs and tasks (e.g., Bartels and Zeki, 2000; Song et al., 2015), particularly those described by Bartels and Zeki (2004). Second, our study was guided by theory. We extrapolated from theoretical arguments in similar existing studies on parental bonding (Waldman et al., 2016). Third, our interpretations of the results are supported by meta-analysis of earlier studies, which strengthens their validity (e.g., striatum and emotional rewards in Buhle et al., 2014; insula and negative emotions in Peyron et al., 2000, and Murphy et al., 2003; amygdala and fear in Murphy et al., 2003; TPJ and social judgment in Van Overwalle, 2009; and morality in Bzdok et al., 2012). Finally, we combined fMRI data with behavioral data to use the strengths of both methods when drawing conclusions about founding entrepreneurs and parents.

### 5.3. Limitations and future research

Like all studies, the present study has limitations. The first limitation is that all the parents and entrepreneurs in our sample were men. Although we drew on the parental and entrepreneurial bonding literature, our inferences are primarily about male entrepreneurs' bonds with ventures based on paternal bonds with children. As discussed later in this section, future research should address this limitation by studying a sample of both men and women.

While we argue here that entrepreneurial and parental bonding have many similarities, we also acknowledge their differences. For example, entrepreneurs can, and sometimes should, terminate bonds with their ventures to avoid over-investing in a venture that is destined to fail. Abandoning a child, however, is typically not an option or an ethically justifiable action, even when the parent is not satisfied with the child's development.

Moreover, the relationship between a parent and a child is one-sided when the child is a baby. A parent responds to the baby's needs by scanning for cues related to the environment or the baby's distress (Bretherton, 1985; Solomon and George, 1996; Meyer and Pilkonis, 2005). This relationship strongly resembles the relationship between an entrepreneur and a venture. However, the relationship between a parent and a child becomes increasingly reciprocal as the child matures. In contrast, the relationship between an entrepreneur and a venture remains one-sided. Consequently, although parental bonding is a good proxy for entrepreneurial bonding, a notable difference between the two is that parental bonding involves an attachment process in which the child forms an emotional bond with the parent, signifying mutual commitment.

A further difference between the two forms of bonding relates to the rewards from the activities of parenting and venturing. A parent's rewards from nurturing and supporting a child are primarily altruistic and intrinsic. In contrast, for entrepreneurs, these types of rewards are complemented by monetary/financial rewards.

This is a pioneering study because it advances entrepreneurship research using neuroscientific methods. There is therefore plenty of scope for future research. First, because all parents and entrepreneurs in this study were men, future research should study a sample of both men and women. A gender comparison may show meaningful differences between men and women entrepreneurs. Such a study could examine the extent to which parents/entrepreneurs engage in caregiving versus play and the influence of this balance on their emotional experience, as reflected in the neural underpinnings of their affective bond. Fathers tend to have somewhat higher involvement in play than mothers, whereas mothers have somewhat higher involvement in caregiving than fathers (Lamb, 1977; Lamb et al., 1985; Bretherton, 1985; Roggman, 2004). Similarly, the theory suggests that women entrepreneurs may be more prone to ensuring the safety and survival of their ventures than men are. In contrast, male entrepreneurs may focus more on playful activities involving exploration, learning, and other venture-development capabilities.

Entrepreneur-venture play might be linked to growth seeking, whereas caregiving may aim to attain performance stability and

limit risks (He and Wong, 2004; Raisch and Birkinshaw, 2008; Parida et al., 2016). Because the aforementioned gender differences in caregiving and play have been verified, studying entrepreneurship as a bonding process may enrich our understanding of why women entrepreneurs are less inclined to grow their businesses (Orser and Hogarth-Scott, 2002; Fairlie and Robb, 2009; Autio and Pathak, 2010). Although recent research has argued that gender differences in motives for entrepreneurship is a myth and that the basis for expecting psychological differences in attachment is limited (Malmström et al., 2017), this could start a new dialogue and lead to new types of empirical findings in entrepreneurship research into gender, regardless of what subsequent studies find.

Second, it would be worthwhile to gather performance data on ventures to examine whether activations in neural regions during fMRI scans help predict venture success. For example, in settings such as that of the current study, data could be gathered to explore the impact of the significant activations associated with the affective bond, intimacy, and self-confidence on venture performance in terms of survival, profitability, and growth. A follow-up period of five years or more would reveal whether our assumptions regarding the implications of our results are empirically supported.

Finally, future research could compare affective bonds in varying segments of the entrepreneur population, including entrepreneurs in family businesses, opportunity-driven entrepreneurs, and necessity-driven entrepreneurs (Baptista et al., 2014). The bond to the venture might be even stronger for family business entrepreneurs than for other groups because the values and traditions of their ventures are even more congruent with and salient to their self-identities (Shepherd and Haynie, 2009b).

## Acknowledgments

The authors wish to thank Principal Lecturer Kaisa Hytönen from Laurea University of Applied Sciences, Associate Professor Iiro Jääskeläinen from Aalto University and Professor Martin Lindell from Hanken School of Economics for their valuable help. We are grateful for the feedback and comments from the participants at the Society for Neuroeconomics Annual Meeting 2013, in particular Ale Smidts, and the aivoAALTO seminars. Also, we would like to thank Jan Nikander and Marita Kattelus for technical assistance.

## Appendix A. Supplementary Figures and Tables

Supplementary Figures and Tables to this article can be found online at <https://doi.org/10.1016/j.jbusvent.2018.05.001>.

## References

- Abraham, E., Hendler, T., Shapira-Lichter, I., Kanat-Maymon, Y., Zagoory-Sharon, O., Feldman, R., 2014. Father's brain is sensitive to childcare experiences. *Proc. Natl. Acad. Sci.* 111 (27), 9792–9797.
- Acevedo, B.P., Aron, A., Fisher, H., Brown, L.L., 2012. Neural correlates of long-term intense romantic love. *Soc. Cogn. Affect. Neurosci.* 7 (2), 145–159.
- Ainsworth, M.S., 1979. Infant–mother attachment. *Am. Psychol.* 34 (10), 932–937.
- Alvarez, S.A., Parker, S.C., 2009. Emerging firms and the allocation of control rights: a Bayesian approach. *Acad. Manag. Rev.* 34 (2), 209–227.
- Aron, A., McLaughlin-Volpe, T., 2001. Including others in the self: extensions to own and partner's group membership. In: Sedikides, C., Brewer, M.B. (Eds.), *Individual Self, Relational Self, Collective Self*. Psychology Press, Philadelphia, pp. 89–108.
- Aron, A., Westbay, L., 1996. Dimensions of the prototype of love. *J. Pers. Soc. Psychol.* 70 (3), 535–551.
- Aron, A., Aron, E.N., Tudor, M., Nelson, G., 1991. Close relationships as including other in the self. *J. Pers. Soc. Psychol.* 60 (2), 241–253.
- Aron, A., Aron, E.N., Smollan, D., 1992. Inclusion of other in the self scale and the structure of interpersonal closeness. *J. Pers. Soc. Psychol.* 63, 596–612.
- Aron, A., Fisher, H., Mashek, D., Strong, G., Li, H., Brown, L., 2005. Reward, motivation and emotion systems associated with early-stage intense romantic love. *J. Neurophysiol.* 93, 327–337.
- Aron, A., Lewandowski Jr., G.W., Mashek, D., Aron, E.N., 2013. The self-expansion model of motivation and cognition in close relationships. In: Simpson, J.A., Campbell, L. (Eds.), *The Oxford Handbook of Close Relationships*. Oxford University Press, New York, pp. 90–115.
- Ashforth, B.E., Mael, F., 1989. Social identity theory and the organization. *Acad. Manag. Rev.* 14 (1), 20–39.
- Ashforth, B.E., Schinoff, B.S., Rogers, K.M., 2016. “I identify with her,” “I identify with him”: unpacking the dynamics of personal identification in organizations. *Acad. Manag. Rev.* 41 (1), 28–60.
- Ashton-James, C.E., Kushlev, K., Dunn, E.W., 2013. Parents reap what they sow: child-centrism and parental well-being. *Soc. Psychol. Personal. Sci.* 4 (6), 635–642.
- Atakan, S.S., Bagozzi, R.P., Yoon, C., 2014. Consumer participation in the design and realization stages of production: how self-production shapes consumer evaluations and relationships to products. *Int. J. Res. Mark.* 31 (4), 395–408.
- Atzil, S., Hendler, T., Zagoory-Sharon, O., Winetraub, Y., Feldman, R., 2012. Synchrony and specificity in the maternal and the paternal brain: relations to oxytocin and vasopressin. *J. Am. Acad. Child Adolesc. Psychiatry* 51 (8), 798–811.
- Autio, E., Pathak, S., 2010. Entrepreneur's exit experience and growth aspirations. *Front. Entrep. Res.* 30 (5), 1–16.
- Avanzi, L., van Dick, R., Fraccaroli, F., Sarchielli, G., 2012. The downside of organizational identification: relations between identification, workaholicism and well-being. *Work Stress* 26 (3), 289–307.
- Avey, J.B., Avolio, B.J., Crossley, C.D., Luthans, F., 2009. Psychological ownership: theoretical extensions, measurement and relation to work outcomes. *J. Organ. Behav.* 30 (2), 173–191.
- Baptista, R., Karaöz, M., Mendonça, J., 2014. The impact of human capital on the early success of necessity versus opportunity-based entrepreneurs. *Small Bus. Econ.* 42 (4), 831–847.
- Baron, R.A., 2010. Job design and entrepreneurship: why closer connections = mutual gains. *J. Organ. Behav.* 31 (2–3), 370–378.
- Baron, J.N., Hannan, M.T., 2002. Organizational blueprints for success in high-tech start-ups: lessons from the Stanford project on emerging companies. *Calif. Manag. Rev.* 44 (3), 8–36.
- Bartels, A., Zeki, S., 2000. The neural basis of romantic love. *Neuroreport* 11 (17), 3829–3834.
- Bartels, A., Zeki, S., 2004. The neural correlates of maternal and romantic love. *NeuroImage* 21 (3), 1155–1166.
- Bartholomew, K., Shaver, P.R., Simpson, J.A., 1998. Methods of assessing adult attachment: do they converge? In: Rholes, W.S. (Ed.), *Attachment Theory and Close Relationships*. Guilford Press, New York, pp. 25–45.
- Bates, T., 1990. Entrepreneur human capital inputs and small business longevity. *Rev. Econ. Stat.* 72 (4), 551–559.
- Baum, J.R., Locke, E.A., 2004. The relationship of entrepreneurial traits, skill, and motivation to subsequent venture growth. *J. Appl. Psychol.* 89 (4), 587.
- Beal, R.M., 2000. Competing effectively: environmental scanning, competitive strategy, and organizational performance in small manufacturing firms. *J. Small Bus. Manag.* 38 (1), 27–47.
- Becker, W.J., Menges, J.I., 2013. Biological implicit measures in HRM and OB: a question of how not if. *Hum. Resour. Manag. Rev.* 23 (3), 219–228.
- Becker, W.J., Cropanzano, R., Sanfey, A.G., 2011. Organizational neuroscience: taking organizational theory inside the neural black box. *J. Manag.* 37 (4), 933–961.
- Beggs, J.K., Brown, E.M., 1994. Association as a psychological justification for ownership. *J. Psychol.* 128 (4), 365–380.



- Belk, R.W., 1988. Possessions and the extended self. *J. Consum. Res.* 15 (2), 139–168.
- Beyers, M.S., Reber, J.S., 1998. The illusion of intimacy: a Levinasian critique of evolutionary psychology. *J. Theor. Philos. Psychol.* 18 (2), 176–192.
- Bird, B., 1989. *Entrepreneurial Behavior*. Scott Foresman & Company, Glenview, IL.
- Bird, B., 1995. Toward a theory of entrepreneurial competency. In: Katz, J.A., Brockhaus, R.H. (Eds.), *Advances in Entrepreneurship, Firm Emergence, and Growth*. Vol. 2. JAI Press, Greenwich, CT, pp. 51–72.
- Boeker, W., Goodstein, J., 1991. Organizational performance and adaptation: effects of environment and performance on changes in board composition. *Acad. Manag. J.* 34 (4), 805–826.
- Bowlby, J., 1969. *Attachment and Loss*. Vol. 1 Basic Books, New York.
- Bowlby, J., 1977. The making and breaking of affectional bonds. I. Aetiology and psychopathology in the light of attachment theory. An expanded version of the Fiftieth Maudsley Lecture, delivered before the Royal College of Psychiatrists, 19 November 1976. *Br. J. Psychiatry* 130 (3), 201–210.
- Bowlby, J., 1980. *Loss: Sadness and Depression*. Vol. 3 Basic Books, New York.
- Bowlby, J., 1988. *A Secure Base: Parent-Child Attachments and Healthy Human Relationships*. Basic Books, New York.
- Bretherton, I., 1985. Attachment theory: Retrospect and prospect. In: Bretherton, I., Waters, E. (Eds.), *Growing points in attachment theory and research*. Monographs of the Society for Research in Child Development. 50. pp. 3–35 (1–2, Serial No. 209).
- Bretherton, I., 1992. The origins of attachment theory: John Bowlby and Mary Ainsworth. *Dev. Psychol.* 28 (5), 759–775.
- Brett, M., Anton, J.L., Valabregue, R., Poline, J.B., 2002. Region of interest analysis using the MarsBar toolbox for SPM 99. *NeuroImage* 16 (2), S497.
- Brockner, J., Higgins, E.T., Low, M.B., 2004. Regulatory focus theory and the entrepreneurial process. *J. Bus. Ventur.* 19 (2), 203–220.
- Brown, J.E., 2016. *My Business Just Collapsed - the Truths that Entrepreneurs Never Tell You About Failure*. Retrieved from. <http://www.telegraph.co.uk/women/work/the-truths-about-failure-that-every-entrepreneur-needs-to-embrace/15.2.2107>.
- Brumariu, L.E., Kerns, K.A., 2010. Mother-child attachment patterns and different types of anxiety symptoms: is there specificity of relations? *Child Psychiatry Hum. Dev.* 41 (6), 663–674.
- Buhle, J.T., Silvers, J.A., Wager, T.D., Lopez, R., Onyemkwo, C., Kober, H., Weber, J., Ochsner, K.N., 2014. Cognitive reappraisal of emotion: a meta-analysis of human neuroimaging studies. *Cereb. Cortex* 24 (11), 2981–2990.
- Busenitz, L.W., Barney, J.B., 1997. Differences between entrepreneurs and managers in large organizations: biases and heuristics in strategic decision-making. *J. Bus. Ventur.* 12 (1), 9–30.
- Buss, D.M., 1988. Love acts. The evolutionary biology of love. In: Sternberg, R.J., Barnes, M.L. (Eds.), *Psychology of Love*. Yale University Press, New Haven, pp. 100–118.
- Bzdok, D., Schilbach, L., Vogeley, K., Schneider, K., Laird, A.R., Langner, R., Eickhoff, S.B., 2012. Parsing the neural correlates of moral cognition: ALE meta-analysis on morality, theory of mind, and empathy. *Brain Struct. Funct.* 217 (4), 783–796.
- Cacciotti, G., Hayton, J.C., 2015. Fear and entrepreneurship: a review and research agenda. *Int. J. Manag. Rev.* 17 (2), 165–190.
- Cacciotti, G., Hayton, J.C., Mitchell, J.R., Giazitzoglou, A., 2016. A reconceptualization of fear of failure in entrepreneurship. *J. Bus. Ventur.* 31 (3), 302–325.
- Camerer, C., Loewenstein, G., Prelec, D., 2005. Neuroeconomics: how neuroscience can inform economics. *J. Econ. Lit.* 43 (1), 9–64.
- Cardon, M.S., Wincent, J., Singh, J., Drnovsek, M., 2005a. Entrepreneurial passion: the nature of emotions in entrepreneurship. *Acad. Manag. Proc.* 2005 (1), G1–G6.
- Cardon, M.S., Zietsma, C., Saparito, P., Matherne, B., Davis, C., 2005b. A tale of passion: new insights into entrepreneurship from a parenthood metaphor. *J. Bus. Ventur.* 20, 23–45.
- Cardon, M.S., Wincent, J., Singh, J., Drnovsek, M., 2009. The nature and experience of entrepreneurial passion. *Acad. Manag. Rev.* 34 (3), 511–532.
- Carver, C.S., Scheier, M.F., Weintraub, J.K., 1989. Assessing coping strategies: a theoretically based approach. *J. Pers. Soc. Psychol.* 56 (2), 267–283.
- Cassar, G., Friedman, H., 2009. Does self-efficacy affect entrepreneurial investment? *Strateg. Entrep. J.* 3 (3), 241–260.
- Cassidy, J., 2000. The complexity of the caregiving system: a perspective from attachment theory. *Psychol. Inq.* 11 (2), 86–91.
- Chandler, G.N., DeTienne, D.R., McKelvie, A., Mumford, T.V., 2011. Causation and effectuation processes: a validation study. *J. Bus. Ventur.* 26 (3), 375–390.
- de Cock, E.S., Henrichs, J., Klimstra, T.A., Maas, A.J.B., Vreeswijk, C.M., Meeus, W.H., van Bakel, H.J., 2017. Longitudinal associations between parental bonding, parenting stress, and executive functioning in toddlerhood. *J. Child Fam. Stud.* 1723–1733.
- Collins, N.L., Feeney, B.C., 2000. A safe haven: an attachment theory perspective on support seeking and caregiving in intimate relationships. *J. Pers. Soc. Psychol.* 78 (6), 1053.
- Collins, N.L., Ford, M.B., 2010. Responding to the needs of others: the caregiving behavioral system in intimate relationships. *J. Soc. Pers. Relat.* 27 (2), 235–244.
- Conroy, D.E., Elliot, A.J., Hofer, S.M., 2003. A 2 × 2 achievement goals questionnaire for sport: evidence for factorial invariance, temporal stability, and external validity. *J. Sport Exerc. Psychol.* 25 (4), 456–476.
- Crandall, A., Deater-Deckard, K., Riley, A.W., 2015. Maternal emotion and cognitive control capacities and parenting: a conceptual framework. *Dev. Rev.* 36, 105–126.
- Crocker, J., Park, L.E., 2004. The costly pursuit of self-esteem. *Psychol. Bull.* 130 (3), 392.
- Cropanzano, R.S., Massaro, S., Becker, W.J., 2017. Deontic justice and organizational neuroscience. *J. Bus. Ethics* 144 (4), 733–754.
- Davidson, R.J., Irwin, W., 1999. The functional neuroanatomy of emotion and affective style. *Trends Cogn. Sci.* 3 (1), 11–21.
- Davis, M., 1992. The role of the amygdala in fear and anxiety. *Annu. Rev. Neurosci.* 15 (1), 353–375.
- Delmar, F., Shane, S., 2004. Legitimizing first: organizing activities and the survival of new ventures. *J. Bus. Ventur.* 19 (3), 385–410.
- Dew, N., Sarasathy, S., Read, S., Wiltbank, R., 2009. Affordable loss: behavioral economic aspects of the plunge decision. *Strateg. Entrep. J.* 3 (2), 105–126.
- Dukerich, J.M., Kramer, R., McLean Parks, J., 1998. The dark side of organizational identification. In: Whetten, D.A., Godfrey, P.C. (Eds.), *Identity in Organizations: Building Theory Through Conversations*. Sage, London, pp. 245–256.
- Eibach, R.P., Mock, S.E., 2011. Idealizing parenthood to rationalize parental investments. *Psychol. Sci.* 22 (2), 203–208.
- Fairlie, R.W., Robb, A.M., 2009. Gender differences in business performance: evidence from the characteristics of business owners survey. *Small Bus. Econ.* 33 (4), 375–395.
- Farb, N.A., Anderson, A.K., Mayberg, H., Bean, J., McKeon, D., Segal, Z.V., 2010. Minding one's emotions: mindfulness training alters the neural expression of sadness. *Emotion* 10 (1), 25.
- Feldman, R., 2015. The adaptive human parental brain: implications for children's social development. *Trends Neurosci.* 38 (6), 387–399.
- Fischhoff, B., Slovic, P., Lichtenstein, S., 1977. Knowing with certainty: the appropriateness of extreme confidence. *J. Exp. Psychol. Hum. Percept. Perform.* 3 (4), 552–564.
- Fletcher, G.J., Kerr, P.S., 2010. Through the eyes of love: reality and illusion in intimate relationships. *Psychol. Bull.* 136 (4), 627–658.
- Forbes, D.P., 2005. Are some entrepreneurs more overconfident than others? *J. Bus. Ventur.* 20 (5), 623–640.
- Forest, J., Mageau, G.A., Sarrazin, C., Morin, E.M., 2011. “Work is my passion”: the different affective, behavioral, and cognitive consequences of harmonious and obsessive passion toward work. *Can. J. Adm. Sci.* 28 (1), 27–40.
- Freeman, J., Carroll, G.R., Hannan, M.T., 1983. The liability of newness: age dependence in organizational death rates. *Am. Sociol. Rev.* 48 (5), 692–710.
- Friston, K., Ashburner, J., Kiebel, S., Nichols, T., Penny, W. (Eds.), 2007. *Statistical Parametric Mapping: The Analysis of Functional Brain Imaging*. Elsevier, Amsterdam.
- George, C., Solomon, J., 2008. The caregiving system: a behavioral systems approach to parenting. In: Cassidy, J., Shaver, P.R. (Eds.), *Handbook of Attachment: Theory, Research, and Clinical Applications*, second ed. Guilford Press, New York, pp. 383–416.
- Gilbert, D.T., 2006. *Stumbling on Happiness*. Alfred A. Knopf, Inc., New York.
- Gimeno, J., Folta, T.B., Cooper, A.C., Woo, C.Y., 1997. Survival of the fittest? Entrepreneurial human capital and the persistence of underperforming firms. *Adm. Sci. Q.* 42, 750–783.
- Gross, J.J., 1998. The emerging field of emotion regulation: an integrative review. *Rev. Gen. Psychol.* 2 (3), 271.
- Haapasalo, I., Välimaa, R., Kannas, L., 2012. Associations between Finnish 9th grade students' school perceptions, health behaviors, and family factors. *Health Educ.* 112 (3), 256–271.
- Halko, M.L., Lahti, T., Hytönen, K., Jääskeläinen, I.P., 2017. Entrepreneurial and parental love—are they the same? *Hum. Brain Mapp.* 38 (6), 2923–2938.
- Hanton, S., Mellalieu, S.D., Hall, R., 2004. Self-confidence and anxiety interpretation: a qualitative investigation. *Psychol. Sport Exerc.* 5 (4), 477–495.
- Hart, O., 1995. *Firms, Contracts, and Financial Structure*. Clarendon Press, Oxford, the UK.
- Hayward, M.L., Shepherd, D.A., Griffin, D., 2006. A hubris theory of entrepreneurship. *Manag. Sci.* 52 (2), 160–172.

- Hayward, M.L., Forster, W.R., Sarasvathy, S.D., Fredrickson, B.L., 2010. Beyond hubris: how highly confident entrepreneurs rebound to venture again. *J. Bus. Ventur.* 25 (6), 569–578.
- Hazan, C., Shaver, P.R., 1994. Attachment as an organizational framework for research on close relationships. *Psychol. Inq.* 5 (1), 1–22.
- He, Z.L., Wong, P.K., 2004. Exploration vs. exploitation: an empirical test of the ambidexterity hypothesis. *Organ. Sci.* 15 (4), 481–494.
- Hmieleski, K.M., Baron, R.A., 2009. Entrepreneurs' optimism and new venture performance: a social cognitive perspective. *Acad. Manag. J.* 52 (3), 473–488.
- de Holan, P.M., 2014. It's all in your head: why we need neuroentrepreneurship. *J. Manag. Inq.* 23 (1), 93–97.
- Hsu, M.H., Ju, T.L., Yen, C.H., Chang, C.M., 2007. Knowledge sharing behavior in virtual communities: the relationship between trust, self-efficacy, and outcome expectations. *Int. J. Hum. Comput. Stud.* 65 (2), 153–169.
- Huettel, S.A., Song, A.W., McCarthy, G., 2014. *Functional Magnetic Resonance Imaging*, third ed. Sinauer, Sunderland, MA.
- Janak, P.H., Tye, K.M., 2015. From circuits to behaviour in the amygdala. *Nature* 517 (7534), 284–292.
- Kahneman, D., 2011. *Thinking, Fast and Slow*. Farrar Straus Giroux, New York.
- Keh, H.T., Foo, M.D., Lim, B.C., 2002. Opportunity evaluation under risky conditions: the cognitive processes of entrepreneurs. *Entrep. Theory Pract.* 27 (2), 125–148.
- Kelley, A.E., 2004. Ventral striatal control of appetitive motivation: role in ingestive behavior and reward-related learning. *Neurosci. Biobehav. Rev.* 27 (8), 765–776.
- Kim, P., Leckman, J.F., Mayes, L.C., Feldman, R., Wang, X., Swain, J.E., 2010. The plasticity of human maternal brain: longitudinal changes in brain anatomy during the early postpartum period. *Behav. Neurosci.* 124 (5), 695–700.
- Kleine, S.S., Kleine III, R.E., Allen, C.T., 1995. How is a possession “me” or “not me”? Characterizing types and an antecedent of material possession attachment. *J. Consum. Res.* 22 (3), 327–343.
- Knutson, B., Adams, C.M., Fong, G.W., Hommer, D., 2001. Anticipation of increasing monetary reward selectively recruits nucleus accumbens. *J. Neurosci.* 21 (16), U1–U5.
- Kor, Y.Y., Misangyi, V.F., 2008. Outside directors' industry-specific experience and firms' liability of newness. *Strateg. Manag. J.* 29 (12), 1345–1355.
- Koster-Hale, J., Saxe, R., Dungan, J., Young, L.L., 2013. Decoding moral judgments from neural representations of intentions. *Proc. Natl. Acad. Sci.* 110 (14), 5648–5653.
- Krueger, N., Welp, L., 2014. Neuroentrepreneurship: what can entrepreneurship learn from neuroscience? In: Morris, M.H. (Ed.), *Annals of Entrepreneurship Education and Pedagogy*. Elgar, Cheltenham, pp. 60–90.
- Lamb, M.E., 1977. Father-infant and mother-infant interaction in the first year of life. *Child Dev.* 48 (1), 167–181.
- Lamb, M.E., Pleck, J.H., Charnov, E.L., Levine, J.A., 1985. Paternal behavior in humans. *Am. Zool.* 25, 883–894.
- Lane, R.D., Reiman, E.M., Ahern, G.L., Schwartz, G.E., Davidson, R.J., 1997. Neuroanatomical correlates of happiness, sadness, and disgust. *Am. J. Psychiatr.* 154 (7), 926–933.
- Larsen, R.J., 1984. Theory and measurement of affect intensity as an individual difference characteristic. In: *Dissertation Abstracts International*. 85. pp. 2297B (University Microfilms No. 84-22112).
- Laureiro-Martínez, D., Brusoni, S., Canessa, N., Zollo, M., 2015. Understanding the exploration–exploitation dilemma: an fMRI study of attention control and decision-making performance. *Strateg. Manag. J.* 36 (3), 319–338.
- Lazarus, R.S., 1991. Cognition and motivation in emotion. *Am. Psychol.* 46 (4), 352.
- Liotti, M., Mayberg, H.S., Brannan, S.K., McGinnis, S., Jerabek, P., Fox, P.T., 2000. Differential limbic–cortical correlates of sadness and anxiety in healthy subjects: implications for affective disorders. *Biol. Psychiatry* 48 (1), 30–42.
- Loch, C.H., Solt, M.E., Bailey, E.M., 2008. Diagnosing unforeseeable uncertainty in a new venture. *J. Prod. Innov. Manag.* 25 (1), 28–46.
- Lopez, F.G., Gormley, B., 2002. Stability and change in adult attachment style over the first-year college transition: relations to self-confidence, coping, and distress patterns. *J. Couns. Psychol.* 49 (3), 355.
- Malmström, M., Johansson, J., Wincent, J., 2017. Gender stereotypes and venture support decisions: how governmental venture capitalists socially construct entrepreneurs' potential. *Entrep. Theory Pract.* 41 (5), 833–860.
- Maltby, H.J., Kristjansson, L., Coleman, M.E., 2003. The parenting competency framework: Learning to be a parent of a child with asthma. *Int. J. Nurs. Pract.* 9 (6), 368–373.
- Mars, R.B., Sallet, J., Schüffegen, U., Jbabdi, S., Toni, I., Rushworth, M.F., 2011. Connectivity-based subdivisions of the human right “temporoparietal junction area”: evidence for different areas participating in different cortical networks. *Cereb. Cortex* 22 (8), 1894–1903.
- Massaro, S., Dagnino, G.B., 2015. *Neuroscientific methods for strategic management*. In: Cincini, M.C. (Ed.), *Research Methods for Strategic Management*. Routledge, New York, pp. 253–282.
- Massaro, S., 2017. Neuroscience methods: a framework for managerial and organizational cognition. In: Galavan, R.J., Sund, K.J., Hodgkinson, G.P. (Eds.), *Methodological Challenges and Advances in Managerial and Organizational Cognition*. Emerald Publishing Limited, West Yorkshire, the UK, pp. 241–278.
- McFarlin, D.B., Blascovich, J., 1981. Effects of self-esteem and performance feedback on future affective preferences and cognitive expectations. *J. Pers. Soc. Psychol.* 40 (3), 521.
- McGee, J.E., Sawyerr, O.O., 2003. Uncertainty and information search activities: a study of owner–managers of small high-technology manufacturing firms. *J. Small Bus. Manag.* 41 (4), 385–401.
- McMullen, J.S., Wood, M.S., Palich, L.E., 2014. Entrepreneurial cognition and social cognitive neuroscience. In: Mitchell, J.R., Randolph-Seng, B., Mitchell, R.K. (Eds.), *Handbook of Entrepreneurial Cognition*. Edward Elgar, Northampton, MA, pp. 316–363.
- Meier, A., Musick, K., Flood, S., Dunifon, R., 2016. Mothering experiences: how single parenthood and employment structure the emotional valence of parenting. *Demography* 53 (3), 649–674.
- Meyer, B., Pilkonis, P.A., 2005. *An attachment model of personality disorders*. Guilford Press, New York.
- Mikulincer, M., Shaver, P.R., Pereg, D., 2003. Attachment theory and affect regulation: the dynamics, development, and cognitive consequences of attachment-related strategies. *Motiv. Emot.* 27 (2), 77–102.
- Mitchell, J.R., Shepherd, D.A., 2010. To thine own self be true: images of self, images of opportunity, and entrepreneurial action. *J. Bus. Ventur.* 25 (1), 138–154.
- Mitchell, J.R., Shepherd, D.A., 2011. Afraid of opportunity: the effects of fear of failure on entrepreneurial decisions. *Front. Entrep. Res.* 31 (6) (Article 1).
- Murnieks, C.Y., Mosakowski, E., Cardon, M.S., 2014. Pathways of passion: identity centrality, passion, and behavior among entrepreneurs. *J. Manag.* 40 (6), 1583–1606.
- Murphy, F.C., Nimmo-Smith, I.A.N., Lawrence, A.D., 2003. Functional neuroanatomy of emotions: a meta-analysis. *Cogn. Affect. Behav. Neurosci.* 3 (3), 207–233.
- Mutschler, I., Ball, T., Wankerl, J., Strigo, I.A., 2012. Pain and emotion in the insular cortex: evidence for functional reorganization in major depression. *Neurosci. Lett.* 520 (2), 204–209.
- Nelson, S.K., Kushlev, K., English, T., Dunn, E.W., Lyubomirsky, S., 2013. In defense of parenthood: children are associated with more joy than misery. *Psychol. Sci.* 24 (1), 3–10.
- Nelson, S.K., Kushlev, K., Lyubomirsky, S., 2014. The pains and pleasures of parenting: when, why, and how is parenthood associated with more or less well-being? *Psychol. Bull.* 140 (3), 846.
- Nicolaou, N., Shane, S., 2014. Biology, neuroscience, and entrepreneurship. *J. Manag. Inq.* 23 (1), 98–100.
- Nisbett, R.E., Wilson, T.D., 1977. Telling more than we can know: verbal reports on mental processes. *Psychol. Rev.* 84 (3), 231–259.
- Nord, C.L., Valtou, V., Wood, J., Roiser, J.P., 2017. Power-up: a reanalysis of ‘Power Failure’ in neuroscience using mixture modeling. *J. Neurosci.* 37 (34), 8051–8061.
- Nuttin, J.M., 1987. Affective consequences of mere ownership: the name letter effect in twelve European languages. *Eur. J. Soc. Psychol.* 17 (4), 381–402.
- Onoda, K., Okamoto, Y., Kunisato, Y., Aoyama, S., Shishida, K., Okada, G., Tanaka, S.C., Schweighofer, N., Yamaguchi, S., Doya, K., Yamawaki, S., 2011. Inter-individual discount factor differences in reward prediction are topographically associated with caudate activation. *Exp. Brain Res.* 212, 593–601.
- Orser, B., Hogarth-Scott, S., 2002. Opting for growth: gender dimensions of choosing enterprise development. *Canad. J. Admin. Sci.* 19 (3), 284–300.
- Parida, V., Lahti, T., Wincent, J., 2016. Exploration and exploitation and firm performance variability: a study of ambidexterity in entrepreneurial firms. *Int. Entrep. Manag. J.* 12 (4), 1147–1164.
- Paulus, M.P., Stein, M.B., 2006. An insular view of anxiety. *Biol. Psychiatry* 60 (4), 383–387.
- Peyron, R., Laurent, B., Garcia-Larrea, L., 2000. Functional imaging of brain responses to pain. A review and meta-analysis (2000). *Neurophysiol. Clin./Clin. Neurophysiol.* 30 (5), 263–288.
- Pierce, J.L., Kostova, T., Dirks, K.T., 2001. Toward a theory of psychological ownership in organizations. *Acad. Manag. Rev.* 26 (2), 298–310.

- Plassmann, H., Venkatraman, V., Huettel, S., Yoon, C., 2015. Consumer neuroscience: applications, challenges, and possible solutions. *J. Mark. Res.* 52 (4), 427–435.
- Poldrack, R.A., 2006. Can cognitive processes be inferred from neuroimaging data? *Trends Cogn. Sci.* 10 (2), 59–63.
- Quinlan, P.T., 2013. Misuse of power: in defense of small-scale science. *Nat. Rev. Neurosci.* 14 (8), 585.
- Raisch, S., Birkinshaw, J., 2008. Organizational ambidexterity: antecedents, outcomes, and moderators. *J. Manag.* 34 (3), 375–409.
- Read, S., Dew, N., Sarasvathy, S.D., Song, M., Wiltbank, R., 2009. Marketing under uncertainty: the logic of an effectual approach. *J. Mark.* 73 (3), 1–18.
- Rilling, J.K., Young, L.J., 2014. The biology of mammalian parenting and its effect on offspring social development. *Science* 345 (6198), 771–776.
- Roggman, L.A., 2004. Do fathers just want to have fun? *Hum. Dev.* 47 (4), 228–236.
- Rousseau, D.M., Shperling, Z., 2003. Pieces of the action: ownership and the changing employment relationship. *Acad. Manag. Rev.* 28 (4), 553–570.
- Rousseau, D.M., Sitkin, S.B., Burt, R.S., Camerer, C., 1998. Not so different after all: a cross-discipline view of trust. *Acad. Manag. Rev.* 23 (3), 393–404.
- Russell, J.A., 2003. Core affect and the psychological construction of emotion. *Psychol. Rev.* 110 (1), 145–177.
- Russell, J.A., 2005. Emotion in human consciousness is built on core affect. *J. Conscious. Stud.* 12, 26–42.
- Sarasvathy, S.D., 2001. Causation and effectuation: toward a theoretical shift from economic inevitability to entrepreneurial contingency. *Acad. Manag. Rev.* 26 (2), 243–288.
- Saxe, R., Kanwisher, N., 2003. People thinking about thinking people: the role of the temporo-parietal junction in “theory of mind”. *NeuroImage* 19 (4), 1835–1842.
- Schaller, M., Neuberg, S.L., Griskevicius, V., Kenrick, D.T., 2010. Pyramid power: a reply to commentaries. *Perspect. Psychol. Sci.* 5 (3), 335–337.
- Scheier, M.F., Carver, C.S., 2003. Goals and confidence as self-regulatory elements underlying health and illness behavior. In: Cameron, L.D., Leventhal, H. (Eds.), *The Self-regulation of Health and Illness Behavior*. Routledge, London, pp. 17–41.
- Shankland, S., 2002. Sun Offers Olive Branch to Java Partners (Retrieved from CNET). News.com (web archive link, 15 February 2017). <https://www.cnet.com/news/sun-offers-olive-branch-to-java-partners/> (15.2.2017).
- Shepherd, D., Haynie, J.M., 2009a. Birds of a feather don't always flock together: identity management in entrepreneurship. *J. Bus. Ventur.* 24 (4), 316–337.
- Shepherd, D., Haynie, J.M., 2009b. Family business, identity conflict, and an expedited entrepreneurial process: a process of resolving identity conflict. *Entrep. Theory Pract.* 33 (6), 1245–1264.
- Shepherd, D.A., Covin, J.G., Kuratko, D.F., 2009. Project failure from corporate entrepreneurship: managing the grief process. *J. Bus. Ventur.* 24 (6), 588–600.
- Simon, M., Houghton, S.M., Aquino, K., 2000. Cognitive biases, risk perception, and venture formation: how individuals decide to start companies. *J. Bus. Ventur.* 15 (2), 113–134.
- Singh, S., Corner, P., Pavlovich, K., 2007. Coping with entrepreneurial failure. *J. Manag. Organ.* 13 (4), 331–344.
- Smith, E.R., Coats, S., Walling, D., 1999. Overlapping mental representations of self, in-group, and partner: further response time evidence and a connectionist model. *Personal. Soc. Psychol. Bull.* 25 (7), 873–882.
- Solomon, J., George, C., 1996. Defining the caregiving system: toward a theory of caregiving. *Infant Mental Health J.* 17 (3), 183–197.
- Song, H., Zou, Z., Kou, J., Liu, Y., Yang, L., Zilverstand, A., Aquillas, F.O., Zhang, X., 2015. Love-related changes in the brain: a resting-state functional magnetic resonance imaging study. *Front. Hum. Neurosci.* 9 (71), 1–13.
- Sternberg, R.J., 1997. Construct validation of a triangular love scale. *Eur. J. Soc. Psychol.* 27, 313–335.
- Strigo, I.A., Matthews, S.C., Simmons, A.N., Oberndorfer, T., Klabunde, M., Reinhardt, L.E., Kaye, W.H., 2013. Altered insula activation during pain anticipation in individuals recovered from anorexia nervosa: evidence of interoceptive dysregulation. *Int. J. Eat. Disord.* 46 (1), 23–33.
- Sundaramurthy, C., 2008. Sustaining trust within family businesses. *Fam. Bus. Rev.* 21 (1), 89–102.
- Swain, J.E., 2008. Baby stimuli and the parent brain: functional neuroimaging of the neural substrates of parent–infant attachment. *Psychiatry* 5, 28–36.
- Swain, J.E., 2011. The human parental brain: in vivo neuroimaging. *Prog. Neuro-Psychopharmacol. Biol. Psychiatry* 35 (5), 1242–1254.
- Swami, V., Stieger, S., Haubner, T., Voracek, M., Furnham, A., 2009. Evaluating the physical attractiveness of oneself and one's romantic partner: Individual and relationship correlates of the love-is-blind bias. *J. Individ. Differ.* 30 (1), 35–43.
- Toscano, J.E., Bauman, M.D., Mason, W.A., Amaral, D.G., 2009. Interest in infants by female rhesus monkeys with neonatal lesions of the amygdala or hippocampus. *Neuroscience* 162 (4), 881–891.
- Townsend, D.M., DeTienne, D., Yitshaki, R., Arthurs, J.D., 2009. The psychological ownership of entrepreneurial organizations: theoretical and model development. *Front. Entrep. Res.* 29 (6) (Article 3).
- Trivers, R.L., 1972. Parental investment and sexual selection. In: Campbell, B. (Ed.), *Sexual Selection and the Descent of Man: The Darwinian Pivot*. Aldine, Chicago, pp. 136–179.
- Troye, S.V., Supphellen, M., 2012. Consumer participation in coproduction: “I made it myself” effects on consumers' sensory perceptions and evaluations of outcome and input product. *J. Mark.* 76 (2), 33–46.
- Ucbasaran, D., Westhead, P., Wright, M., Flores, M., 2010. The nature of entrepreneurial experience, business failure and comparative optimism. *J. Bus. Ventur.* 25 (6), 541–555.
- Van Dyne, L., Pierce, J.L., 2004. Psychological ownership and feelings of possession: three field studies predicting employee attitudes and organizational citizenship behavior. *J. Organ. Behav.* 25 (4), 439–459.
- Van Overwalle, F., 2009. Social cognition and the brain: a meta-analysis. *Hum. Brain Mapp.* 30 (3), 829–858.
- Vanacker, T.R., Manigart, S., 2010. Pecking order and debt capacity considerations for high-growth companies seeking financing. *Small Bus. Econ.* 35 (1), 53–69.
- Vignoli, E., Croity-Belz, S., Chapeland, V., de Fillipis, A., Garcia, M., 2005. Career exploration in adolescents: the role of anxiety, attachment, and parenting style. *J. Vocat. Behav.* 67 (2), 153–168.
- Waldman, D.A., Wang, D., Fenters, V., 2016. The added value of neuroscience methods in organizational research. In: *Organizational Research Methods*, <http://dx.doi.org/10.1177/1094428116642013>.
- Wicker, B., Keysers, C., Plailly, J., Royet, J.P., Gallese, V., Rizzolatti, G., 2003. Both of us disgusted in My insula: the common neural basis of seeing and feeling disgust. *Neuron* 40 (3), 655–664.
- Wiebking, C., Bauer, A., De Greck, M., Duncan, N.W., Tempelmann, C., Northoff, G., 2010. Abnormal body perception and neural activity in the insula in depression: an fMRI study of the depressed “material me”. *World J. Biol. Psychiatry* 11 (3), 538–549.
- Wiklund, J., Baker, T., Shepherd, D., 2010. The age-effect of financial indicators as buffers against the liability of newness. *J. Bus. Ventur.* 25 (4), 423–437.
- Wiltbank, R., Dew, N., Read, S., Sarasvathy, S.D., 2006. What to do next? The case for non-predictive strategy. *Strateg. Manag. J.* 27 (10), 981–998.
- Wolfe, J.B., Betz, N.E., 2004. The relationship of attachment variables to career decision-making self-efficacy and fear of commitment. *Career Dev. Q.* 52 (4), 363–369.
- Wright, R., 1994. *The Moral Animal: Evolutionary Psychology and Everyday Life*. Little Brown, New York.
- Young, L., Saxe, R., 2011. Moral universals and individual differences. *Emot. Rev.* 3 (3), 323–324.
- Young, L., Cushman, F., Hauser, M., Saxe, R., 2007. The neural basis of the interaction between theory of mind and moral judgment. *Proc. Natl. Acad. Sci.* 104 (20), 8235–8240.
- Young, L., Camprodon, J.A., Hauser, M., Pascual-Leone, A., Saxe, R., 2010a. Disruption of the right temporoparietal junction with transcranial magnetic stimulation reduces the role of beliefs in moral judgments. *Proc. Natl. Acad. Sci.* 107 (15), 6753–6758.
- Young, L., Dodel-Feder, D., Saxe, R., 2010b. What gets the attention of the temporo-parietal junction? An fMRI investigation of attention and theory of mind. *Neuropsychologia* 48 (9), 2658–2664.
- Zeki, S., 2007. The neurobiology of love. *FEBS Lett.* 581, 2575–2579.