Dissertation

THE IMPACT OF
INFORMATION PROCESSING DEFICITS ON MORAL COGNITION:
EVIDENCE FROM vmPFC PATIENT AND PSYCHOPATHIC POPULATIONS

by

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DEDICATION

This dissertation is dedicated to

my Mother,

who has always encouraged me to work even when I have not wanted to,

my Father,

who fostered my interest in science when I was a child,

and my Sister,

who inspired me to do my first experiments.

Thank you for supporting me.
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LIST OF ABBREVIATIONS

ACC...............................................................anterior cingulate cortex
ADD..............................................................attention deficit disorder
ADHD............................................................attention deficit hyperactivity disorder
ANS..............................................................autonomic nervous system
BA.................................................................Brodmann’s Area
BDAE............................................................Boston Diagnostic Aphasia Examination
BIS.................................................................Barratt Impulsiveness Scale
BNT.................................................................Boston Naming Test
BSA...............................................................Brixton Spatial Anticipation test
BVRT.............................................................Benton Visual Retention Test
CT.................................................................Category Tests
CF.................................................................Complex Figures tests
CIM...............................................................Complex Ideational Material
COWA/COWAT................................................Controlled Oral Word Association Test
D-II...............................................................D-II Cancellation test
DS...............................................................Digit Symbol
EEG.............................................................electroencephalogram
ERP..............................................................event-related potential
ESI..............................................................Externalizing Spectrum Inventory
fMRI............................................................functional Magnetic Resonance Imaging
FSIQ............................................................Full Scale Intelligence Quotient
FTD............................................................fronto-temporal dementia
GARP.................................................................Generalized Axiom of Revealed Preference
GMI.................................................................General Memory Index
HCT.................................................................Halstead Category Test
HR.................................................................heart rate
IGT.................................................................Iowa Gambling Task
IQ.................................................................Intelligence Quotient
JOL.................................................................Judgment of Line Orientation test
LSRP..............................................................Levenson Self-Report Psychopathy scale
MAE...............................................................Multilingual Aphasia Examination
MDQ...............................................................Moral Dilemma Questionnaire
MFQ...............................................................Moral Foundations Questionnaire
NC.................................................................Necker Cube test
OFC..............................................................orbital frontal cortex
   IOFC...........................................................lateral orbital frontal cortex
   mOFC.........................................................medial orbital frontal cortex
PAL.............................................................Paired Associate Learning test
PCL..............................................................Psychopathy Checklist
   PCL-R.........................................................Psychopathy Checklist-Revised
   PCL-SV.......................................................Psychopathy Checklist – Screening Version
   PCL-YV.......................................................Psychopathy Checklist-Youth Version
PET.............................................................Positron Emission Tomography
PFC..............................................................prefrontal cortex
   aPFC.........................................................anterior prefrontal cortex

dlPFC……………………………………………………..dorsolateral prefrontal cortex
IPFC……………………………………………………lateral prefrontal cortex
mPFC……………………………………………………mediolateral prefrontal cortex
vmPFC………………………………………………ventromedial prefrontal cortex
PPI / PPInv…………………………………………….Psychopathic Personality Inventory
PIQ……………………………………………………..Performance Intelligence Quotient
PMT……………………………………………………..Porteus Maze Test
POI……………………………………………………..Perceptual Organization Index
PR……………………………………………………..Prose Recall test
PSI……………………………………………………..Processing Speed Index
PSD……………………………………………………Psychopathic Personality Inventory
RAVLT……………………………………………….Rey Auditory Verbal Learning Test
ROCF……………………………………………….Rey-Osterrieth Complex Figure test
RT……………………………………………………reaction time
SCT-BF……………………………………………Short Category Test – Booklet Format
SCR…………………………………………………skin conductance response
SD……………………………………………….standard deviation
SMH………………………………………………Somatic Marker Hypothesis
SMMT…………………………………………….Sequential Matching Memory Test
SPSRQ……………………………………Sensitivity to Punishment and Sensitivity to Reward Questionnaire
SRM……………………………………………….Standard Raven Matrices test
SRP………………………………………………Self-Report Psychopathy scale
STS……………………………………………….superior temporal sulcus
TMT……………………………………………………………………………………Trail Making Test
ToH……………………………………………………………………………Tower of Hanoi
ToL……………………………………………………………………………Tower of London
ToM……………………………………………………………………………Theory of Mind
TriPM……………………………………………………………………Triarchic Psychopathy Measure
TT……………………………………………………………………………Token Test
VCI……………………………………………………………………………Verbal Comprehension Index
VIM……………………………………………………………………………Violence Inhibition Model
VIQ……………………………………………………………………………Verbal Intelligence Quotient
VJ……………………………………………………………………………Verbal Judgment
VOT……………………………………………………………………………Visual Organization Test
VVT……………………………………………………………………………Visual-Verbal Test
WAIS……………………………………………………………………………Wechsler Adult Intelligence Scale
  WAIS-R………………………………………………………………………Wechsler Adult Intelligence Scale – Revised edition
  WAIS-III……………………………………………………………………Wechsler Adult Intelligence Scale – third edition
WCST……………………………………………………………………………Wisconsin Card Sorting Test
WMI……………………………………………………………………………Working Memory Index
WMS……………………………………………………………………………Wechsler Memory Scale
WRAT……………………………………………………………………………Wide Range Achievement Test
  WRAT-R……………………………………………………………………Wide Range Achievement – Revised edition
Y-BOCS……………………………………………………………………Yale-Brown Obsessive Compulsive Scale
This dissertation examines whether using data from two populations, patients with ventromedial prefrontal cortex (vmPFC) damage (vmPFC patients) and individuals diagnosed with psychopathy or who score high in having psychopathic characteristics, is appropriate to make assertions regarding the age-old dichotomic Emotion-Reason debate of whether emotion or reason is more influential for moral cognition. Recent work in psychology and neuroscience has largely supported the necessary and/or sufficient roles of emotion, but not reason, in moral cognition, often using data from these populations as evidence that emotion is necessary in order to behave morally. Specifically, both populations characteristically display aberrant social and moral behaviors in the real world and perform abnormally on laboratory tests that measure emotion and moral cognition. From this, both populations are believed to have specific deficits in the capabilities to subjectively experience and objectively identify emotion. However, increasing evidence demonstrates that both populations also have basic information processing deficits in attention and the ability to assess value about the world that could alternatively explain the populations’ abnormalities. Importantly, these information processes are necessary for the higher-order processes of both emotion and reason and are not specific to emotion. Therefore, using the broad terms “emotion” and “reason” may be the wrong level of description when explaining the deficits of the populations. Using data from these populations to support the necessary role of emotion in moral cognition in attempts to adhere to the age-old Emotion-Reason debate is then inappropriate because it inaccurately describes the deficits which the populations actually have.
RÉSUMÉ

Dans cette thèse, nous tenterons de comprendre si l’étude de données concernant deux populations — des patients ayant subi des dommages au cortex préfrontal ventromédián (VM) et des individus diagnostiqués psychopathes ou présentant des caractéristiques de la personnalité psychopathe — permet de déterminer quel élément a une plus grande influence sur la cognition morale, l’émotion ou la raison. De récentes recherches en psychologie et en neurosciences ont mis en évidence le rôle de l’émotion (mais pas celui de la raison) sur la cognition morale en utilisant souvent des données concernant ces populations prouvant ainsi que l’émotion est nécessaire à un comportement moralement sain. En effet, ces deux populations affichent de manière caractéristique des comportements sociaux et moraux aberrants dans la vie de tous les jours et ont obtenu des résultats anormaux sur des tests de laboratoire visant à évaluer l’émotion et la cognition morale, ce qui nous incite à conclure qu’ils présentent des déficits dans leur capacité à ressentir les émotions subjectivement et à les identifier objectivement. Néanmoins, de plus en plus de données suggèrent que ces deux populations auraient également des troubles d’attention, des difficultés à comprendre et à traiter l’information et une capacité réduite à déterminer les valeurs dans le processus de prise de décision, ce qui pourrait expliquer leurs comportements immoraux et leurs résultats anormaux. Il est important de noter que ces processus de traitement de l’information ne sont pas uniquement liés à l’émotion, mais aussi à la raison. Par conséquent, les termes « émotion » et « raison » pourraient s’avérer trop généraux pour décrire les déficits de ces populations. Il serait donc incorrect d’utiliser des données concernant ces populations pour tenter d’élucider le rôle de l’émotion dans la cognition morale au sein de la dichotomie émotion-raison puisque ces données décrivent les déficits de ces populations de façon imprécise et inexacte.
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CONTRIBUTION TO ORIGINAL KNOWLEDGE

This dissertation questions the status-quo of using data from two populations, ventromedial prefrontal cortex (vmPFC) patients (vmPFC patients) and individuals diagnosed with psychopathy or who score high in having psychopathic characteristics, to support the claim that emotion is necessary for moral cognition within the age-old framework of the dichotomic Emotion-Reason debate. This dissertation is the first work to date that thoroughly demonstrates that the aberrant moral behaviors and abnormal performance of these populations on laboratory tests that measure emotion and moral cognition can be explained by other, more basic information processes instead of having broad deficits in emotion. By demonstrating that the populations’ aberrant moral behaviors and abnormal moral cognition could otherwise be explained by information processing deficits, the work in this dissertation challenges the use of data from these population as contributions to the Emotion-Reason debate.
CONTRIBUTION OF AUTHORS

I, Anna Kathleen Garr, am the only author of this dissertation.

I alone have researched, organized, and written all work.
CHAPTER ONE: Introduction

A classic debate regarding moral cognition examines to what extent processes of emotion and reason influence moral behavior. Referred to as the Emotion-Reason debate, this discussion was originally put forth and dichotomized by philosophers David Hume (Hume 1739) and Immanuel Kant (Kant 1785) and has since been adopted in the psychological and neuroscientific sciences. In order to investigate the influences of emotion and reason on moral cognition, most scientific research has focused on the cognitive processes involved in moral judgment and decision-making. Specifically, early work in psychology emphasized the necessary role of reason in moral development (Piaget 1965/1932, Kohlberg 1969); however, recent work in psychology and neuroscience has since emphasized the role of emotion, claiming that emotion plays a causal or constitutive role in moral judgment (Greene, Sommerville et al. 2001, Haidt 2001, Nichols 2004, Wheatley and Haidt 2005, Valdesolo and DeSteno 2006, Schnall, Haidt et al. 2008) that is considered either necessary (Haidt, Rozin et al. 1997, Greene, Sommerville et al. 2001, Haidt 2001, Greene, Nystrom et al. 2004, Schnall, Haidt et al. 2008) or both necessary and sufficient (Haidt 2001, Prinz 2006) conditions for moral cognition. Specifically, research in psychology has focused on how affect influences moral judgment (Haidt, Koller et al. 1993, Wheatley and Haidt 2005, Schnall, Haidt et al. 2008) and research in neuroscience has implicated a particular neuroanatomical structure, the vmPFC, as being selectively active during emotion and moral cognition tasks (Greene, Sommerville et al. 2001, Moll, de Oliveira-Souza et al. 2002, Moll, de Oliveira-Souza et al. 2002, Greene, Nystrom et al. 2004, Greene, Morelli et al. 2008), with emphasis on the vmPFC as being functionally necessary for the processing and/or regulation of emotion (Ochsner and Gross 2005, Urry, van Reekum et al. 2006, Ochsner and Gross 2008, Wager, Barrett et al. 2008, Schiller and Delgado 2010, Diekhof, Geier et al. 2011, Etkin, Egner et al. 2011).
Likewise, neuropsychological and psychopathological investigation of vmPFC patients and individuals with psychopathy, who both have associated vmPFC dysfunction and characteristically display aberrant social and moral behaviors in the real world and perform abnormally on laboratory tests that measure emotion and moral cognition, has largely supported the view that emotion is necessary for normal moral cognition. Both populations are believed to have deficits in the processing and regulating emotion, specifically in the processing capabilities to subjectively experience emotion (i.e., in the ability to actually feel emotion, measured through self-report as well as through physiological and behavioral reactions) and objectively identify the emotional states of others (i.e., through Theory of Mind (ToM) capabilities which are necessary for empathy (Baron-Cohen and Wheelwright 2004, Blair 2005)). These deficits highlight specific emotional disruptions that have been used to explain why the populations’ display the aberrant moral behaviors and abnormal performance on emotion and moral cognition tests that they do.

Fellows and Farah 2003, Fellows and Farah 2005, Fellows and Farah 2005, Budhani, Richell et al. 2006, Fellows 2006, Kiehl 2006, Mitchell, Fine et al. 2006, Fellows 2007, Fellows and Farah 2007, Wheeler and Fellows 2008, Tsuchida, Doll et al. 2010, Camille, Griffiths et al. 2011, Camille, Tsuchida et al. 2011, Fellows 2011, Henri-Bhargava, Simioni et al. 2012, Beszterczey, Nestor et al. 2013, Tsuchida and Fellows 2013, Dargis, Wolf et al. 2017), which can be used to alternatively explain the populations’ aberrant moral behaviors and abnormal performance on emotion and moral cognition tests. Importantly, these basic information processes are necessary for the higher-order processing of both emotion and reason and are not specific to emotion. Because of this, data from these populations should not be used as supporting evidence regarding the role of emotion in moral cognition. Using the terms “emotion” and “reason” in attempts to adhere to the age-old dichotomic Emotion-Reason debate may be the wrong level of description when explaining why the populations display the aberrant moral behaviors and abnormal moral cognition that they do. In other words, the level of description is too broad, inaccurately describing the deficits that the populations actually have.

The following subsections thoroughly introduces the Emotion-Reason debate and how psychological and neuroscientific contributions to this debate have supported the role of emotion in moral cognition. Specific attention is given to the vmPFC as it has been associated with emotion processing, emotion regulation, and moral cognition. The neuropsychological and psychopathological investigation of vmPFC patient and psychopathic populations that have also been used to support this claim is then introduced and challenged. This section concludes by detailing the Rationale and Objectives of this dissertation and how the three independent manuscripts that constitute this dissertation provide evidence that the information processing
deficits of the populations can alternatively explain the populations’ aberrant moral behavior and abnormal moral cognition.

1.1. The Emotion-Reason Debate

The Emotion-Reason debate is an age-old debate that has attempted to explain human behavior in a variety of contexts including, but not limited to, economic, political, and moral domains. The debate, as it relates to moral cognition, was initiated in 1739 when philosopher David Hume proposed that sentiment, here synonymous with the term emotion, motivates moral action (or inaction) by exciting passions. To Hume, sentiment, or how one feels about something, determines what is and is not considered moral and because of this, morality is and can only be motivated by passion. Reason, on the other hand, is void of sentiment and thus incapable of motivating moral behavior. More so, since morality is first and foremost determined by passion, reason only comes into play after a moral intention, determined by one’s sentiment, has been made as a mere means to achieve moral goals (Hume 1739). From this, Hume famously writes that "reason is, and ought to be, the slave of passions" (Hume 1739, pg. T2.3.3.5).

Less than fifty years later, philosopher Immanuel Kant challenged Hume's claim proposing instead that rational deliberation based on moral principles (i.e., reason), is what determines morality. Kant points out that emotion often influences individuals to behave immorally (e.g., crimes of passion) and without rational control over emotions, along with guiding moral principles, human behavior is merely instinctual reaction, akin to animals. More so, feelings based on emotion are incapable of producing moral standards, or norms, across individuals and because of this, emotion cannot be used to determine what should or should not be considered moral. Thus, moral principles are and must be determined by reason alone. To Kant, moral will, or intention, can only be good if it comes from a rational place. Morality, then, is the relationship between good moral
will and corresponding moral action. Moral individuals are those whose will is driven by moral principles and who exhibit rational control over their passions in order to act in morally appropriate ways. Without principles based on reason and without will based on principles, moral action could not exist (Kant 1785).

1.1.1. Psychological Contributions to the Emotion-Reason Debate

In line with traditional assumptions that human judgment and decision-making is based on rational deliberation rather than instinctual emotional reaction (i.e., rational choice theory), early work in psychology emphasized the necessary role of reason, and not emotion, in moral cognition. Specifically, child developmental studies found that moral development corresponds with progressive stages of moral reasoning, highlighting the role of reason in moral cognition (Piaget 1965/1932, Kohlberg 1969). However, recent work in psychology and neuroscience has instead focused on the role of emotion and not reason. Specifically, affect (i.e., the experience of feeling emotion) is believed to have a strong influence on moral judgment (Haidt, Koller et al. 1993, Haidt, Rozin et al. 1997, Haidt 2001, Wheatley and Haidt 2005, Schnall, Haidt et al. 2008). Recent experiments have demonstrated that when participants are asked to judge social violations that evoke feelings of disgust (Haidt, Koller et al. 1993) or when experimenters manipulate the state of the environment (e.g., by making the room dirty or smell foul), the mood of the participants (e.g., by imposing negative affective states of disgust) (Schnall, Haidt et al. 2008), or the association of neutral words with disgust through hypnosis (Wheatley and Haidt 2005), participants are more likely to judge moral transgressions as being wrong. However, it should be noted that not every study has replicated these results (Royzman, Leeman et al. 2009) and the effect size in these studies has been relatively weak (Maibom 2010).
In addition, it has been observed that participants are unable to explain why they make the moral judgments they do (Cushman, Young et al. 2006, Hauser, Cushman et al. 2007), a phenomenon termed "moral dumbfounding" (Haidt, Bjorklund et al. 2000). The observation that individuals cannot pinpoint the reasons for why they make moral judgments supports the position that moral judgments are not based on reason. This, along with the observations that affect can influence moral judgment, led to the development of a social intuitionist model of moral judgment. Specifically, according to this model, moral judgments and decisions are made based on intuitive gut feelings that are fast, automatic, and effortless (as opposed to reason which involves a slow, effortful, step-by-step deliberative process). Both intuition and reason are cognitive processes that can be influenced by emotion; however, unlike reason, emotion drives quick, intuitive judgments (or knee-jerk reactions) that are characteristic of everyday moral judgment (Haidt 2001).

1.1.2. Neuroscientific Contributions to the Emotion-Reason Debate

With the advent of functional imaging technologies of positron emission tomography (PET) and functional magnetic resonance imaging (fMRI), neuroscience has furthered the exploration of the psychological processes involved in moral cognition. Neuroanatomical structures associated with moral cognition include the cortical structures of the dorsolateral prefrontal cortex (dIPFC, primarily Brodmann’s Areas (BA) 9 and 49), anterior prefrontal cortex (aPFC, mainly the frontopolar cortex: BA 10), anterior cingulate cortex (ACC, BA 24 and 32), ventromedial prefrontal cortex (vmPFC, including the medial (BA 10-12) and lateral (BA 11/47) orbitofrontal cortex (OFC) and some portions of the frontopolar cortex (BA 10) and medial prefrontal cortex (mPFC, BA 9, 10, 24, 25, 32, specifically including BA 10 and subgenual (BA 25) and ventral regions of the anterior cingulate cortex (ACC, BA 24/32)), anterior temporal lobes (BA 20, 21, and 38), superior temporal sulcus (STS, with emphasis on the posterior STS: BA 21
and 39), and insula as well as subcortical structures of the amygdala, ventromedial hypothalamus, basal forebrain (specifically the ventral striatum pallidum and extended amygdala), septal areas and associated nuclei, rostral brainstem tegmentum, and walls of the third ventricle. In addition, other cortical areas including the parietal lobe (specifically the precuneus: BA 7 and 31) and occipital lobe as well as subcortical structures including the basal ganglia and brainstem have been implicated in moral cognition, though not as reliably (see Moll, De Oliveira-Souza et al. (2008) for review).

While some of these structures are associated with what has been identified as processes that involve “reason”, such as the dlPFC in cognitive (also referred to as executive) control, including emotion regulation, and working memory (Duncan and Owen 2000, Miller and Cohen 2001, Ochsner and Gross 2005) and the ACC in error monitoring (Nieuwenhuis, Schweizer et al. 2007), conflict detection (Botvinick 2007, Carter and van Veen 2007), attention (Devinsky, Morrell et al. 1995), and impulse and/or other types of cognitive control (Posner, Rothbart et al. 2007) (although see Devinsky, Morrell et al. (1995) and Etkin, Egner et al. (2011) for accounts that the ACC has something to do with emotion), most structures are associated with what has been described as processes involved with “emotion”. These structures include the vmPFC, frontopolar cortex, STS, amygdala, ventromedial hypothalamus, insula, and basal forebrain (Moll, Oliveira-Souza et al. 2008).


The remainder of this section focuses on the vmPFC, thoroughly introducing the structure and how evidence has supported the functional role of the vmPFC in emotion processing, emotion regulation, and moral cognition.

1.1.2.1. The vmPFC: Introduction and Functional Associations with Emotion and Moral Cognition

While the term “vmPFC” is widely used to indicate both the ventral and medial sections of the prefrontal cortex, there are different anatomical definitions regarding which specific structures constitute the vmPFC. Anatomical definitions of the vmPFC include the medial (BA 10-12) and lateral (BA 11/47) OFC, medial regions of the frontopolar cortex (BA 10), as well as portions of the medial prefrontal cortex (mPFC, BA 9, 10, 24, 25, 32, specifically including BA 10 and subgenual (BA 25) and ventral regions of the ACC (BA 24/32) (Anderson, Barrash et al. 2006, Delgado, Beer et al. 2016). For the purpose of this dissertation the term “vmPFC” will primarily
refer to ventral (orbital) and medial surfaces of the prefrontal cortex (PFC) encompassing both the medial and lateral OFC as well BA 10 of the mPFC (see Figure 1 for details).

**Figure 1.** Anatomical locations that constitute the vmPFC are indicated by gray shading and include the medial (BA 10-12) and lateral (BA 11/47) OFC, medial regions of the frontopolar cortex (BA 10), as well as portions of the medial prefrontal cortex (mPFC, BA 9, 10, 24, 25, 32, specifically BA 10 and subgenual (BA 25) and ventral regions of the anterior cingulate cortex (ACC, BA 24/32) (Anderson, Barrash et al. 2006, Delgado, Beer et al. 2016). This figure has been borrowed with permission from Elliott (1969) and modified with gray shading to exhibit this vmPFC anatomical definition. BA 12 is not explicitly represented in this image but is considered to be between BA 10, 32, 11, and 25 in the sagittal representation, arguably with dorsal portions of BA 11 constituting BA 12.

Importantly, the vmPFC has extensive connectivity with many neuroanatomical structures. These structures include the thalamus and brainstem, virtually all sensory areas, and structures associated with both reward and emotion processing, specifically the ventromedial striatum and
most areas within the limbic system (primarily the amygdala and hypothalamus), respectively, as well as a structure associated with reason, the dIPFC (Rolls, Critchley et al. 1999, Ongur and Price 2000, Rolls 2000). Because the vmPFC is extensively connected to these other structures, especially with “emotion” and “reason” areas of the brain, the vmPFC has been implicated in both emotion processing (Wager, Barrett et al. 2008) and emotion regulation (Ochsner and Gross 2005, Urry, van Reekum et al. 2006, Ochsner and Gross 2008, Schiller and Delgado 2010, Diekhof, Geier et al. 2011, Etkin, Egner et al. 2011).

Specifically, single cell and ablation studies with non-human animals have implicated the vmPFC in emotion processing by identifying a structure within the vmPFC, particularly distinct areas within the OFC, as necessary in encoding the reinforcement, or affective information, of sensory stimuli and associated outcomes (e.g., whether something feels good or bad as in rewards and punishments). Importantly, the coding of affective information, even as basic as in the ability to process rewards and punishments, has been theorized as being necessary to subjectively experience emotion (Rolls 2015), particularly regarding appraisal theories of emotion (Phelps 2009). According to this perspective, the OFC assigns affective significance to stimuli and associated outcomes in order for individuals to process information about the world. This basic evaluation, termed affective value, and the association of affective experience with the world (Rolls 2015) requires both basic reinforcement processing and abilities to learn and relearn (flexibly adapt and update) stimulus-outcome associations (Rolls 2015), processes that have been functionally associated with the vmPFC (Rolls, Hornak et al. 1994, Schoenbaum, Chiba et al. 1998, Rolls 2000, O'Doherty, Kringelbach et al. 2001, Gottfried, O'Doherty et al. 2002, Gottfried, O'Doherty et al. 2003, Holland and Gallagher 2004, Hornak, O'Doherty et al. 2004, Ostlund and Balleine 2005, Schoenbaum and Roesch 2005, Salzman, Paton et al. 2007, Tsuchida, Doll et al.
Thus, affective value requires the basic information process of encoding reinforcement value and without this capability, basic computations of “feels good/feels bad” could not be made. It is then theorized that individuals with vmPFC disruption would then have selective difficulty processing affective value regarding any context that involves affective content, thereby disadvantaging them from making sound judgments and decisions (Rolls 2000, Rolls 2015).

In addition, the vmPFC is also associated with emotion processing through the autonomic physiological expression of emotion, referred to as embodied emotion, through its connectivity with the hypothalamus (Critchley, Nagai et al. 2011). Specifically, embodied emotion is when the visceral physiology of an individual changes as a reflection of their emotional state through the autonomic nervous system (ANS). These changes include alterations such as increased heart rate (HR) and sweating (measured in the laboratory through electrodermal activity typically using a test known as skin conductance response (SCR)), indicating that one may be experiencing anxiety or nervousness. Notably, this automatic physiological expression of emotion has been considered necessary in order to subjectively experience emotion. Specifically, while there is no agreed upon definition of emotion (Izard 2010, Mulligan and Scherer 2012, Russell 2012, Scarantino 2012), prevailing theories of emotion suggest that emotion is a mix of the subjective experiences of bodily arousal, expressive behaviors, and higher-order cognitive interpretation of one’s reactive state (Myers and DeWall 2015). However, in order for bodily arousal, behavioral expression, and higher-order processing to occur, affective representation must first be computed – one has to be able to process what feels good and feels bad in order to have a reaction to it. Therefore, if the vmPFC specifically encodes affective value (Rolls 2000), disruption of the affective value
computations of vmPFC would disrupt all further emotion-related processes (Rolls 2015), including subjective emotional experiences of physiological expressions of embodied emotion.

Further, the vmPFC has been associated with emotion regulation (Quirk and Beer 2006, Wager, Barrett et al. 2008, Roelofs, Minelli et al. 2009, Etkin, Egner et al. 2011, Ochsner, Silvers et al. 2012, Hu and Jiang 2014, Motzkin, Philippi et al. 2015). Specifically, the anatomical location and connectivity of the vmPFC between “emotion” (i.e., limbic) and “reason” (e.g., dlPFC) areas of the brain makes the vmPFC an ideal structure to referee between the two cognitive processes. Because of this, the vmPFC is believed to be necessary for the regulation of amygdala emotional reactivity through its intervention with the other frontal structures, particularly portions of the lateral PFC (lPFC) (Ochsner and Gross 2005, Urry, van Reekum et al. 2006, Ochsner and Gross 2008, Schiller and Delgado 2010, Diekhof, Geier et al. 2011, Etkin, Egner et al. 2011). This theory is supported by non-human animal single cell studies in which stimulation of mPFC neurons decreases the responsiveness of neurons in the amygdala (Quirk, Likhtik et al. 2003), especially in relation to affective conditioning (Rosenkranz, Moore et al. 2003). In addition, causal non-human animal studies have demonstrated that the vmPFC is not just necessary for the encoding of conditioned affective associations such as fear but also for the cognitive suppression of it, as in fear extinction (Sierra-Mercado, Corcoran et al. 2006). This suppression or extinction of a previously learned emotional response requires cognitive control in order to regulate (or suppress) the initially learned emotional reaction. This process also requires relearning affective associations, known as reversal learning, which involves basic reinforcement learning of value, also associated with the vmPFC (Rolls, Hornak et al. 1994, O'Doherty, Kringelbach et al. 2001, Kringelbach and Rolls 2003, Hornak, O'Doherty et al. 2004, Ostlund and Balleine 2005, Salzman, Paton et al. 2007, Tsuchida, Doll et al. 2010, McDannald, Lucantonio et al. 2011).
Importantly, functional imaging with humans has supported non-human animal research regarding the role of the vmPFC in both emotion processing and emotion regulation. While functional imaging has identified multiple regions within the vmPFC as being active during emotion regulation, most imaging research has implicated medial portions of the vmPFC (specifically the mPFC, BA 10) during the processing of emotion (Phan, Wager et al. 2002, Sabatinelli, Fortune et al. 2011). Specifically, PET studies have implicated the mPFC in the processing of emotional information in which participants were asked to imagine and plan their behavior in emotional, but not in non-emotional, situations (Partiot, Grafman et al. 1995). The mPFC is also active when participants watch emotionally salient films, recall emotional states, and look at pictures of emotionally salient images (Lane, Reiman et al. 1997, Lane, Reiman et al. 1997, Reiman 1997). More so, mPFC as well as OFC PET activity has been correlated with not only watching emotional films and personally recalling emotional experiences, but also with the physiological visceral expressions of those emotional experiences through embodied emotion (i.e., HR) (Lane, Reiman et al. 2001).

fMRI has confirmed these PET results, demonstrating that the mPFC is active during the judgment of emotionally salient pictures and this activity subsides when the participants are distracted (i.e., not paying attention to the emotional significance due to distractor tasks that increase ‘cognitive load’ or demand) (Northoff, Heinzel et al. 2004). The mPFC is also active when participants view (Mataix-Cols, An et al. 2008, Winecoff, Clithero et al. 2013) and are anticipating the viewing of emotionally salient stimuli (Ueda, Okamoto et al. 2003). In addition, the vmPFC as a whole has been shown to correlate with retaining learned fear (Phelps, Delgado et al. 2004), supporting evidence from non-human animal research, as well as with judgments of valence (i.e., the intrinsic attractiveness or adverseness of something; analogous to like/dislike or
goodness/badness judgments) of emotional images (Grimm, Schmidt et al. 2006). Further, the vmPFC has been implicated in the detection of disgust (Mataix-Cols, An et al. 2008), particularly in a task in which participants are asked to objectively identify facial expressions that display signs of repulsion (Jehna, Neuper et al. 2011).

Functional imaging has also supported vmPFC associations with emotion regulation. Findings from PET and fMRI studies demonstrate that the dlPFC influences amygdala responses through OFC activation (Damasio, Grabowski et al. 2000, Davidson, Putnam et al. 2000, Ochsner, Ray et al. 2004, Blair, Smith et al. 2007, Eippert, Veit et al. 2007). This finding has been supported by fMRI studies with humans in which extinction of learned fear activates the vmPFC as a whole (Phelps, Delgado et al. 2004, Delgado, Nearing et al. 2008), particularly in studies in which participants are instructed to re-adjust previously learned affective associations, as in re-appraisal tasks (which requires updating previously learned stimulus-outcome reinforcement associations, similar to reversal learning) (Ochsner, Bunge et al. 2002, Winecoff, Clithero et al. 2013) or when participants are asked to suppress (i.e., regulate) their emotional responses induced by emotionally evocative images (Mak, Hu et al. 2009). In addition, fMRI of vmPFC patients have shown that vmPFC patients have increased amygdala responses when viewing aversive images, supporting the role of the vmPFC in regulating emotional reactivity (Motzkin, Philippi et al. 2015).

Notably, the vmPFC is also selectively active during moral cognition tasks, especially when participants are exposed to emotionally salient moral content. In a landmark study in the investigation of the neuroanatomical structures associated with moral judgment, the vmPFC was found to be selectively active when participants made moral judgments that were considered “emotional”, especially when these judgments were made in content that was considered highly emotionally salient (Greene, Sommerville et al. 2001). Since this and similar studies (Greene,
Sommerville et al. 2001, Greene, Nystrom et al. 2004, Greene, Morelli et al. 2008), there has been considerable emphasis on the vmPFC as being necessary for emotion processing in moral cognition. Specifically, the vmPFC has been found to be selectively active when participants read emotionally charged moral sentences (Moll, Eslinger et al. 2001, Moll, de Oliveira-Souza et al. 2002), make simple ethical decisions about moral but not non-moral (i.e., semantic) violations (Heekeren, Wartenburger et al. 2003, Prehn, Wartenburger et al. 2008), make judgments about harming others (Schaich Borg, Hynes et al. 2006), moral conflicts (Sommer, Rothmayr et al. 2010), and violating social norms (Schaich Borg, Lieberman et al. 2008), and while making general deliberations (Harenski, Antonenko et al. 2010) or evaluations (Garrigan, Adlam et al. 2016, Garrigan, Adlam et al. 2017) about moral statements. The vmPFC is also selectively active while participants passively look at pictures believed to evoke moral emotions (Moll, de Oliveira-Souza et al. 2002), during an implicit association test in which moral attitudes of interpersonal violence and vandalism are measured (Luo, Nakic et al. 2006), and while participants make inferences about moral beliefs during moral judgments (Young and Saxe 2009). In addition, the vmPFC has also been implicated in emotion regulation during the processing of moral content. Specifically, in a passive viewing task in which participants were asked to internally regulate their emotional reactivity to moral and non-moral images that were matched by social and emotional salience, the vmPFC, specifically portions of the mPFC, was involved during both the processing and the suppression of moral information (Harenski and Hamann 2006).

Taken together, the vmPFC has been widely implicated in emotion processing, emotion regulation, and moral cognition with vmPFC involvement in moral cognition based on the assumption that the vmPFC has something to do with emotion and that moral content is inherently more emotional than non-moral content. However, the evidence that implicates human vmPFC
functionality in emotion and moral cognition primarily stems from non-human animal research and human functional imaging studies that cannot provide the same type of information regarding brain-behavior relationships as data that the neuropsychological and psychopathological investigation of vmPFC patient and psychopathy populations can. Specifically, while research with non-human animals employ electroneurophysiological and/or lesion (also referred to as loss-of-function and ablation) methodology that are classic measurements of causation, the neuroanatomy of non-human animals and humans does not necessarily correspond and measurements of “emotion” in non-human animals are fundamentally nothing more than basic reinforcement processes. Likewise, while functional imaging is widely used to assess the cognitive underpinning of human psychology and is important for inferences regarding brain-behavior relationships, functional imaging is a measurement of correlation and not causation. Therefore, inferences from functional imaging studies are limited, especially regarding the time sequence of brain-behavior relationships (Huebner, Dwyer et al. 2009).

In order to infer causation, vmPFC patients, that is, individuals with focal damage to the vmPFC, have been tested in a variety of tasks that measure judgment and decision-making. The theory is that if an individual has a dysfunction (e.g., loss-of-function) in a particular area of the brain, and their behavior is measurably different from other, healthy and/or brain damaged controls, then researchers can infer that the damaged area in the brain is responsible for the abnormal behavior. Investigations of psychopathy, however, cannot infer causation. Even though psychopathy is associated with vmPFC dysfunction, psychopathy is associated with other neuroanatomical regions as well. More so, not one area associated with psychopathy is focally damaged; therefore, the investigation of psychopathy does not suffice for loss-of-function methodology. However, because psychopathy is largely associated with emotional dysfunction,
this population has been used in comparison with vmPFC patients to support the necessary role of emotion for normal moral cognition.

1.1.3. Population Contributions to the Emotion-Reason Debate

In order to determine the influence of emotion on moral cognition, neuropsychological and psychopathological investigation of vmPFC patients and individuals with psychopathy have been widely explored. Both populations are characteristically described as retaining intact intelligence, memory, and reasoning capabilities while displaying specific deficits in the capability to respond appropriately in social settings, especially in situations that are considered emotionally salient. Specifically, both populations demonstrate emotion processing and emotion regulation deficits in that they display both hypo- and hyper- emotional reactivity by appearing apathetic (i.e., lacking subjective emotion through deficient emotion processing) but sometimes showing bursts of frustration and anger (i.e., displaying poor impulse, or cognitive, control through deficient emotion regulation). In addition, laboratory testing of both populations have found specific deficits in the capabilities to both subjectively experience (specifically in the ability to physiologically and behaviorally respond to emotional states) and objectively identify (specifically in the ability to recognize the emotions of others through ToM) emotion, leading researchers to conclude that the populations have specific deficits in emotion.

The following subsections introduce each population and focuses on how data from each population have been used to support theories regarding the necessary role of emotion in moral cognition. The specific deficits in being able to process emotion through the subjective experience and objective identification of emotion as well as specific deficits in being able to regulate emotion are highlighted.
1.1.3.1. vmPFC Patients

vmPFC damage typically occurs due to developmental, traumatic, vascular, neoplastic, or neurodegenerative disorders which are not uncommon and can happen early or late in life, with early-onset damage characteristically resulting in more extreme cognitive and behavioral deficits (Anderson, Barrash et al. 2006). Across patients, damage to the vmPFC is rarely in the exact same locations within the vmPFC or consisting of the exact same extent of damage. For instance, some patients may have damage focal to the OFC regions while other patients may have damage to more expansive areas within the vmPFC, including the ACC. In addition, vmPFC damage can be unilateral or bilateral, resulting in differing cognitive deficits – while patients with unilateral damage of the vmPFC retain some vmPFC functionality from the undamaged side, bilateral damage is believed to cause more severe cognitive and behavioral dysfunction (Rorden and Karnath 2004).

vmPFC patients are characterized as being incapable of making sound judgments and decisions in both the real-world and in laboratory settings. In addition, vmPFC patients are also characterized as having poor behavioral (e.g., cognitive) control (Bechara and Van Der Linden 2005). For example, vmPFC patients have a difficult time managing everyday tasks, such as not keeping professional and personal appointments and displaying an increased tendency to take risks. Often these deficits appear to be expressed when the demands of the situations become complex and in situations that involve affective content (Anderson, Barrash et al. 2006).

vmPFC patients also fail to respond appropriately in social settings (Eslinger and Damasio 1985, Damasio, Tranel et al. 1990, Eslinger, Grattan et al. 1992, Stuss, Gow et al. 1992, Damasio 1994, Anderson, Bechara et al. 1999, Blair and Cipolotti 2000, Beer, Heerey et al. 2003, Anderson, Barrash et al. 2006), leading many to believe that the vmPFC is responsible for either social...
cognition or emotion or both (but see Delgado, Beer et al. (2016) for a discussion regarding vmPFC functionality). Specifically, vmPFC patients are generally described as having decreased emotional reactivity (hypo-) in that they act callously and apathetically as well as behave as if they have a blatant lack of concern for others, which theoretically is what leads them to behave in socially inappropriate ways (Eslinger and Damasio 1985, Damasio, Tranel et al. 1990, Rolls, Hornak et al. 1994, Beer, Heerey et al. 2003, Anderson, Barrash et al. 2006, Spikman, Timmerman et al. 2012). However, vmPFC patients are also described as having increased emotional reactivity (hyper-) in that when situations become intense or complex, they often display high levels of aggression as in increased behavioral displays of anger and frustration (Eslinger and Damasio 1985, Damasio, Tranel et al. 1990, Eslinger, Grattan et al. 1992, Stuss, Gow et al. 1992, Damasio 1994, Anderson, Bechera et al. 1999, Blair and Cipolotti 2000, Beer, Heerey et al. 2003, Bechera and Van Der Linden 2005, Anderson, Barrash et al. 2006), indicating a deficit in emotion regulation rather than a complete deficit in being able to process and experience emotion per se.

Interestingly, despite vmPFC patient deficits in emotion and real-world behaviors, vmPFC patients are largely believed to have retained intelligence, memory, and reasoning capabilities (Eslinger and Damasio 1985, Bechera, Damasio et al. 1994, Anderson, Bechera et al. 1999, Anderson, Barrash et al. 2006), suggesting that vmPFC patients have specific deficits in processing (and/or regulating) information about emotion. Because vmPFC patients are described as having emotional deficits and are observed as being socially and morally inappropriate (Eslinger and Damasio 1985, Damasio, Tranel et al. 1990, Eslinger, Grattan et al. 1992, Stuss, Gow et al. 1992, Damasio 1994, Anderson, Bechera et al. 1999, Blair and Cipolotti 2000, Beer, Heerey et al. 2003, Anderson, Barrash et al. 2006), it is assumed that the aberrant social and moral behaviors of
vmPFC patients are due to select deficits in emotion, giving credence to the claim that emotion is necessary for normal moral cognition.

1.1.3.1.1. vmPFC Patients: Emotion

Emotion disturbances of vmPFC patients have been widely reported. Self-report from vmPFC patients describe a disruption of the subjective experience of emotion, in that the experience of actually feeling emotion is reported, though often diminished or exaggerated (Damasio, Tranel et al. 1990, Bechara, Damasio et al. 2000). Through clinical observation and care-giver descriptive accounts, vmPFC patients are reported as having both hypo- and hyper-emotional reactivity. vmPFC are described as having hypo-emotional reactivity, specifically for embarrassment, disgust, envy, guilt, regret, shame, compassion, and empathy (Damasio 1994, Eslinger 1998, Beer, Heerey et al. 2003, Camille, Coricelli et al. 2004, Koenigs and Tranel 2007, Krajbich, Adolphs et al. 2009, Koenigs, Kruepke et al. 2010, Ciaramelli, Sperotto et al. 2013). As mentioned, hyper-emotional profiles of vmPFC patients involve increased reaction to negative emotional states (e.g., anger, frustration), suggesting poor cognitive control and regulation over emotional impulses (Grafman, Schwab et al. 1996, Barrash, Tranel et al. 2000, Bechara and Van Der Linden 2005, Anderson, Barrash et al. 2006, Koenigs and Tranel 2007).

vmPFC patients also fail to subjectively experience emotion through the production of physiological expressions of embodied emotion. Specifically, vmPFC patients do not produce normal SCRs in laboratory tasks that involve emotional content, such as when anticipating and experiencing risky or emotionally evocative stimuli or when making risky judgments or decisions (Damasio, Tranel et al. 1990, Bechara, Damasio et al. 1994, Bechara, Tranel et al. 1996, Bechara, Damasio et al. 1997, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011). Interestingly, alongside vmPFC patients’ lack of physiological expressions of embodied emotion, vmPFC
patients also have an increased tendency to take risks. In a famous gambling decision-making task known as the Iowa Gambling Task (IGT) that requires learning and re-learning (as in reversal learning (Fellows and Farah 2005)) reward and punishment contingency outcomes and adjusting behavioral responses in order to gain as much utility (e.g., money) as possible, vmPFC patients persistently chose disadvantageous options with high rewards but even higher losses, supporting Somatic Marker Hypothesis (SMH) explanations for these abnormal judgments and behaviors (Damasio, Tranel et al. 1990, Bechara, Damasio et al. 1994, Damasio 1994, Bechara, Tranel et al. 1996, Damasio 1996, Bechara, Damasio et al. 1997, Bechara, Damasio et al. 2000). Specifically, the SMH posits that subjective experiences of emotion as experienced through physiological expressions of embodied emotion are necessary for the guidance of normal behavior – without physiological cues such as increased HR or sweating that likely indicate nervousness or fear, individuals would be insensitive to risk and negative outcomes, often resulting in hazardous choices and undesirable consequences (Damasio 1994, Bechara, Damasio et al. 2000).

In addition, vmPFC patients have deficits in the objective identification of emotion. In tasks that require individuals to recognize the facial or written expressions or tone of others, vmPFC patients have difficulty, often specific to the recognition of the emotions of fear, disgust, and surprise (Hornak, Rolls et al. 1996, Blair and Cipolotti 2000, Hornak, Bramham et al. 2003, Vandekerckhove, Plessers et al. 2014). Likewise, vmPFC patients have been found to be deficient in empathic processing, specifically in either cognitive (Shamay-Tsoory and Aharon-Peretz 2007, Shamay-Tsoory, Aharon-Peretz et al. 2009) or affective (Shamay-Tsoory, Harari et al. 2010) empathy, or both (Shamay-Tsoory, Tomer et al. 2003, Shamay-Tsoory, Tomer et al. 2004, Shamay-Tsoory, Tomer et al. 2005). Notably, cognitive empathy, also known as “affective ToM” (Shamay-Tsoory, Tomer et al. 2005, Shamay-Tsoory, Harari et al. 2010), is the capacity to
understand another’s mental state, such as being able to objectively perceive and detect (i.e., identify) the emotions of others whereas affective empathy, also known as emotional empathy, is the capability to automatically respond (e.g., through the subjective experiences of embodied emotion and behavioral expressions) to the emotional experiences of others.

1.1.3.1.2. vmPFC Patients: Moral Cognition

vmPFC patients also consistently perform abnormally in moral cognition tasks, especially in tasks that are emotionally salient, further supporting the view that the vmPFC is necessary for emotion processing. Specifically, four studies have claimed that vmPFC patients display aberrant response profiles when making moral judgments in dilemmas that are considered highly emotional (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011). In addition to measuring behavior, one study measured SCR and found that vmPFC patients had diminished SCR leading up to, and following, their abnormal moral judgments (Moretto, Ladavas et al. 2010), supporting SMH explanations of disruption in the subjective experience of emotion. Importantly, because it has been observed that vmPFC patients have response deficits specific to the most emotionally salient dilemmas and not other types of moral dilemmas deemed less emotionally salient, researchers claim that vmPFC patients do not have general decision-making deficits and that the patients’ deficits are specific to emotion (Ciaramelli, Muccioli et al. 2007). Notably, this evidence further implicates functional associations of the vmPFC with emotion processing (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011).

vmPFC patients also perform abnormally in tasks that measure intention and outcome assessments of moral situations. Specifically, two separate studies have found that vmPFC patients judge certain types of harm differently than controls based on abnormal intention and outcome
calculations. For instance, vmPFC patients judge attempted harms (i.e., harm that is intended but never caused; i.e., negative intentions, positive outcomes) as more permissible than accidental harms (i.e., harm that is caused but not intended; i.e., positive (or neutral) intentions, negative outcomes), concluding that vmPFC patients use information about outcomes rather than intentions when making these types of moral judgments (Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012). From this, researchers have posited that the vmPFC plays an integral role in processing the intentions of others (Ciaramelli, Braghittoni et al. 2012), especially when the intentions have negative valence, as in negative affect (Young, Bechara et al. 2010). Notably, this finding implicates the vmPFC in cognitive, rather than affective, empathy.

Lastly, vmPFC patients that have acquired vmPFC damage early in life have been described as having deficits in learning moral rules (referred to as moral knowledge) and in reasoning about moral content (referred to as moral reasoning). Late, or adult, onset vmPFC patients are believed to have intact moral knowledge and intact moral reasoning (Heekeren, Wartenburger et al. 2003, Anderson, Barrash et al. 2006, Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007) due to having had the opportunity to learn moral norms and rules before the damage occurred (Saver and Damasio 1991) whereas early, or adolescent, onset damage to the vmPFC results in a complete lack of moral knowledge and moral reasoning (Ackerly and Benton 1947, Eslinger and Damasio 1985, Anderson, Bechara et al. 1999, Barrash, Tranel et al. 2000, Anderson, Barrash et al. 2006) due to never learning social norms based on having deficits in understanding, and learning, affective value (Saver and Damasio 1991). However, the central evidence used to support this claim comes from two case studies, one that demonstrated that an adult patient passed all of moral cognition measures (Saver and Damasio 1991) with the other that demonstrated that an adolescent patient passed tests that measured moral knowledge and failed a
test that measured moral reasoning (Boes, Grafft et al. 2011). Notably, this latter study with an adolescent patient counters the claim that moral knowledge through affective associations cannot be learned in early-onset vmPFC patients.

1.1.3.2. Psychopathy

Psychopathy is clinically defined as having maladaptive personality characteristics and behaviors divided into four distinct categories which reflect the multidimensional nature of the disorder. These categories are (1) interpersonal (i.e., glibness/superficial charm, grandiose sense of self-worth, pathological lying, conning/manipulative), (2) affective (i.e., lack of remorse/guilt, shallow affect, callous/lack of empathy, failure to accept responsibility for one’s actions), (3) lifestyle (i.e., need for stimulation/proneness to boredom, parasitic lifestyle, lack of realistic long-term goals, impulsivity, irresponsibility), and (4) antisocial (i.e., poor behavioral controls, early behavioral problems, juvenile delinquency, revocation of conditional release, criminal versatility) dimensions (Hare 1991, Hare 2003). Deficits in these dimensions are believed to remain relatively stable throughout one’s lifespan (Hare 1993, Harpur and Hare 1994), often resulting in high recidivism rates compared to non-psychopathic criminal offenders (Hart, Kropp et al. 1988, Harris, Rice et al. 1991, Hemphill, Hare et al. 1998). Importantly, it is believed that it is the interpersonal and affective characteristics of psychopathy which distinguish psychopaths from non-psychopathic offenders who instead primarily have lifestyle and antisocial characteristics (Hart and Hare 1997). Because of this, psychopathy is a relatively selective diagnosis, with estimates of psychopathic individuals comprising approximately 15 – 20% of incarcerated and 1% of the general population (Hare 1998, Neumann and Hare 2008, Koenigs 2012).

Individuals with psychopathy characteristically engage in frequent disruptive, often criminal, social behaviors and display little, if any, sign of remorse. Interestingly, like vmPFC
patients, it is claimed that individuals with psychopathy typically have normal intelligence and do not have general deficits in reasoning (Cleckley 1976/1941, Sutker, Moan et al. 1983, Hare 1984, Sutker and Allain 1987, Hart, Forth et al. 1990), leading many to conclude that psychopaths have specific deficits in emotion, particularly in the subjective experience of emotion (Cleckley 1976/1941, Hare 1998, Habel, Kuhn et al. 2002, Blair, Mitchell et al. 2005, Porter and Woodworth 2006). However, emotion theories of psychopathy are not uniform. Some theories of psychopathy posit that psychopaths are emotionally void and feel no emotion at all (Cleckley 1976/1941, Hare 1993, Hare 1998) while other theories of psychopathy posit that psychopaths have deficits that are specific to only negative emotional states, such as fear and distress (Blair, Mitchell et al. 2005).

This latter theory has contributed to what is known as the Violence Inhibition Model (VIM) of psychopathy which posits that because psychopaths are insensitive to negative emotional states, they develop abnormal social withdrawal mechanisms that are necessary in order to inhibit violent responses. Social disruption of psychopaths is then caused and continued because psychopathic individuals are unable to objectively detect behavioral cues that indicate discomfort because they lack the subjective sensitivity to the negative emotional states of others (Blair 1995, Blair 1999), implicating both subjective experience and objective identification deficits in psychopathy.

Diagnoses of psychopathy have largely relied on the Psychopathy Checklist (PCL (Hare 1980), most currently the revised version, the Psychopathy Checklist – Revised (PCL-R (Hare 1991, Hare 2003)) which is designed for clinical and forensic (i.e., criminal population) settings. The PCL-R has been adapted into the Psychopathy Checklist – Screening Version (PCL-SV (Hart, Cox et al. 2008)) for adult criminal populations and the Psychopathy Checklist – Youth Version (PCL-YV (Forth, Kosson et al. 2003)) and Psychopathy Screening Device (PSD (Frick and Hare in press)) for adolescent delinquent populations. Psychopathy can also be measured in the general
population, primarily using one of three self-reports: the Self-Report Psychopathy Scale (SRP; 4th edition: SRP-4 (Williams and Paulhus 2004, Williams, Paulhus et al. 2007)), the Levenson Self-Report Psychopathy Scale (LSRP (Levenson, Kiehl et al. 1995)), and the Psychopathic Personality Inventory (PPInv or PPI for short (Lilienfeld and Andrews 1996); the revised edition: PPI-R (Lilienfeld and Widows 2005)). Importantly, diagnosing psychopathy involves measuring the multidimensional nature of the disorder, often modeled off of the PCL-R’s four distinct categories of interpersonal, affective, lifestyle, and antisocial dimensions, referred to as facets. Together, the interpersonal and affective facets of psychopathy compose Factor 1 scales of psychopathy, mostly associated with primarily psychopathic tendencies of lacking emotion and instrumental (e.g., for a purpose) aggression. Lifestyle and antisocial facets of psychopathy, on the other hand, compose Factor 2 scales, mostly associated with secondary psychopathic tendencies of being highly reactive, especially in aggressive situations (e.g., known as reactive aggression) often linked to hyper-emotional reactivity and impulse control problems (Levenson, Kiehl et al. 1995, Lykken 1995, Zuckerman 1995, Vassileva, Kosson et al. 2005, Hicks and Patrick 2006).

Psychopathy has also been associated with numerous brain areas primarily including the vmPFC (including frontopolar areas of the vmPFC (de Oliveira-Souza, Hare et al. 2008)), amygdala, anterior and posterior cingulate cortices (Blair 2003, Anderson and Kiehl 2012) as well as parahippocampal and temporal gyri (Kiehl 2006), STS (de Oliveira-Souza, Hare et al. 2008, Sato, de Oliveira-Souza et al. 2011), and the insula (Kiehl 2006, de Oliveira-Souza, Hare et al. 2008). Specifically, structural scans have demonstrated overall reduced gray matter volume in “emotion” areas of the prefrontal cortex (Weber, Habel et al. 2008), specifically portions within the vmPFC including the OFC (Boccardi, Frisoni et al. 2011) and frontopolar cortex (Gregory, Ffytche et al. 2012). In addition, reduced gray matter volume has been found in the temporal lobes
including the STS and associated gyrus (Weber, Habel et al. 2008, Sato, de Oliveira-Souza et al. 2011) as well as the anterior temporal cortices (de Oliveira-Souza, Hare et al. 2008), specifically the temporal poles (Gregory, Ffytche et al. 2012). Reduced gray matter volume has also been found in the emotion areas of medial portions of the temporal lobe including in the amygdala and parahippocampal gyrus (Weber, Habel et al. 2008). Taken together, this reduced structural morphology in areas of the brain deemed responsible for emotion support deficient emotion processing theories of psychopathy. However, two studies have found increased and not decreased morphology, specifically in the amygdala (Boccardi, Frisoni et al. 2011) and corpus callosum (Weber, Habel et al. 2008), suggesting greater emotional reactivity and hemispherical connectivity. Along with these alternative findings, decreased connectivity between the vmPFC and amygdala as well as the vmPFC and medial parietal cortex has also been found (Motzkin, Newman et al. 2011), suggesting a reduced capability to regulate emotional responses.

1.1.3.2.1. Psychopathy: Emotion

Like vmPFC patients, emotion disturbances of psychopaths have been widely reported (Cleckley 1976/1941, Blair 1995, Lykken 1995, Hare 1998). Even though individuals with psychopathy have reported normal subjective experiences of emotion (Cleckley 1976/1941, Patrick, Bradley et al. 1993), some researchers have claimed that these reports are a “mask of sanity”, as psychopaths do not subjectively experience the feeling of emotion but pretend to do so in order to manipulate others (Cleckley 1976/1941). Other self-report accounts of psychopathic individuals indicate that they do have reduced (hypo-) subjective experiences of emotion in that they feel reduced empathy (Glenn, Raine et al. 2009, McIlwain, Evans et al. 2012, Seara-Cardoso, Neumann et al. 2012, Jonason, Lyons et al. 2013, Seara-Cardoso, Dolberg et al. 2013); however, it has also been reported that psychopaths have increased (hyper-) subjective experiences of
emotion in that they feel positively when looking at pictures of negative facial expressions (i.e., sad and fearful faces) and feel negatively when looking at pictures of positive facial expressions (i.e., happy faces) (Ali, Amorim et al. 2009, Wai and Tiliopoulous 2012).

Psychopaths have also been observed making similar behavioral reactions (e.g., facial expressions) as controls when looking at emotional pictures (Cleckley 1976/1941, Patrick, Bradley et al. 1993), which is also a measure of subjective emotional experience. However, even these behaviors can be intentionally controlled, supporting the claim that psychopaths wear “mask[s] of sanity” (Cleckley 1976/1941). More physical manifestations of subjective emotional experience have been measured through startle response experimentation, in which aversive stimuli are unexpectedly administered to individuals and behavioral (e.g., startle blink response) and physiological responses of embodied emotion (i.e., HR, SCR) are measured. Specifically, psychopaths lack startle blink reflexes when looking at pictures of both pleasant and unpleasant images (Patrick, Bradley et al. 1993, Blair, Jones et al. 1997, Levenston, Patrick et al. 2000, Sutton, Vitale et al. 2002, Pastor, Molto et al. 2003) as well as when exposed to aversive noises (Patrick 1994). Psychopaths also display abnormal physiological expressions of HR and SCR when exposed to this type of aversive stimuli (Blair, Jones et al. 1997, Blair 1999, Anastassiou-Hadjicharalambous and Warden 2008, Anastassiou-Hadjicharalambous and Warden 2008, Patrick 2008, Seara-Cardoso, Neumann et al. 2012, Seara-Cardoso, Dolberg et al. 2013). Specifically, it has been found that psychopaths display abnormal changes in HR and reduced SCR when anticipating aversive events (Hare 1965, Hare 1965, Hare 1965, Hare and Quinn 1971, Hare and Craigen 1974, Hare 1978, Hare 1978) and reduced SCR when exposed to unpleasant and pleasant noises (Fung, Raine et al. 2005) and electric shock ((Hare and Craigen 1974, Hare 1978, Hare 1978, Hare, Frazelle et al. 1978, Verona, Patrick et al. 2004), especially in learning paradigms that
measure aversive conditioning (Lykken 1957, Hare 1965, Hare 1965, Hare 1965, Hare and Quinn 1971, Hare 1978, Hare 1978, Hare 1982, Lykken 1995).

Further, psychopathy is associated with reduced expressions of embodied emotion when exposed to content that more directly measures emotion. Specifically, psychopaths display reduced HR and SCR when looking at both pleasant and unpleasant emotional pictures (Cleckley 1976/1941) and reduced SCR while looking at pictures of mutilated faces (Mathis 1970) or reading emotional sentences (Patrick 1994). Further, psychopathy appears to be associated with overall reduced physiological arousal when looking at fearful, but not angry, facial expressions of others (Blair 1995, Marsh and Cardinale 2012). Taken together, this research supports the notion that psychopaths lack the subjective experience of emotion while also supporting SMH (Schmitt, Brinkley et al. 1999, Sobhani and Bechara 2011) and VIM explanations of the disorder (Blair 1995, Blair 1999).

Psychopaths also have specific deficits in objectively identifying the emotional states of others, specifically negative facial expressions of sadness and fear (Blair and Coles 2000, Blair, Colledge et al. 2001, Stevens, Charman et al. 2001, Blair, Mitchell et al. 2004, Dolan and Fullam 2006, Hastings, Tangney et al. 2008) as well as anger and disgust (Blair, Colledge et al. 2001, Kosson, Suchy et al. 2002, Pham and Philippot 2010), further supporting the VIM model of psychopathy (Blair 1995). However, there are some reports that psychopaths have deficits in recognizing the positive emotion of happiness, although these results are not entirely clear (Dolan and Fullam 2006, Hastings, Tangney et al. 2008, Pham and Philippot 2010). Only two studies have found that psychopaths can recognize emotions from faces and that psychopaths do not have deficits in these task (Dolan and Fullam 2004, Book, Quinsey et al. 2007).
In addition, when listening to audio of vocal affect, psychopaths are reported as having objective identification deficits similar to those found in studies that investigate facial affect. Specifically, when listening to sad or fearful vocal expressions, psychopaths do not recognize the emotions associated with the vocal tone (Stevens, Charman et al. 2001, Blair, Mitchell et al. 2002, Blair, Budhani et al. 2005, Bagley, Abramowitz et al. 2009). Psychopaths are also reported as having difficulties in objectively identifying affect from written language (Cleckley 1976/1941, Williamson, Harpur et al. 1991, Kroner, Forth et al. 2005). From this, they are described as having “semantic dementia” (Cleckley 1976/1941) with specific deficits regarding sad, happy, and surprise semantic cues (Bagley, Abramowitz et al. 2009). In addition, psychopaths lack the ability to recognize differences between unpleasant and violent words, such as “ugly” and “kill” (Gray, MacCulloch et al. 2003) and tend to understand the literal, but not connotative or emotional, meanings of language (Hare, Williamson et al. 1988).

Psychopaths are also believed to lack empathy (Marshall, Hudson et al. 1995, Hare 1998, Blair 2005, Young, Bechara et al. 2010). However, once again, results are mixed. Psychopathy has been found to be inversely associated with empathy (Anastassiou-Hadjicharalambous and Warden 2008, Jones, Happe et al. 2010, Shamay-Tsoory, Harari et al. 2010, Brook and Kosson 2013) or not associated with empathy at all (Blair, Sellar et al. 1996, Richell, Mitchell et al. 2003, Dolan and Fullam 2004, Book, Quinsey et al. 2007), although these results depend on which type of empathy is being measured. Specifically, it has been found that psychopaths have deficient affective (Anastassiou-Hadjicharalambous and Warden 2008, Jones, Happe et al. 2010, Shamay-Tsoory, Harari et al. 2010) and cognitive (Shamay-Tsoory, Harari et al. 2010, Brook and Kosson 2013) empathy; however, some studies indicate that the cognitive empathy capability of

1.1.3.2.2. Psychopathy: Moral Cognition


In addition, in the one study that has measured how psychopaths use intention and outcome information during moral judgment, it has been found that psychopaths use intention and outcome information similarly to controls, with the magnitude of judgments being slightly more severe than, but still similar to, control groups. Specifically, psychopaths judged attempted and accidental harm similarly to controls yet judged attempted harm as more permissible than controls but overall not as more permissible than judgments of harm caused by accidents (Young, Koenigs et al. 2012).
This result suggests that psychopaths are able to discern which harm is worse but are not as sensitive to negative intentional states (i.e., cognitive empathy) when compared to controls.

Moral knowledge and moral reasoning capabilities of psychopaths have also been measured, but with mixed results. Despite differing methodology in task type and populations used, most studies have demonstrated that psychopathic individuals overall have intact moral knowledge (Simon, Holzberg et al. 1951, Chandler and Moran 1990, Blair 1995, Blair, Jones et al. 1995, Blair 1997, Dolan and Fullam 2010, Aharoni, Sinnott-Armstrong et al. 2012, Aharoni, Sinnott-Armstrong et al. 2014, Cardinale and Marsh 2015). However, this finding is reversed once additional statistical corrections have been made (Blair, Jones et al. 1995), the psychopathic group is further divided based on how high or low they scored on their psychopathic diagnosis (Dolan and Fullam 2010), or the measurement paradigm is changed from a force choice to free response task (Simon, Holzberg et al. 1951). Meanwhile, other studies have instead found that psychopathic individuals do not have intact moral knowledge (Blair 1995, Blair, Monson et al. 2001, Glenn, Iyer et al. 2009, Aharoni, Antonenko et al. 2011, Djeriouat and Tremoliere 2014, Almeida, Seixas et al. 2015); however, notably, the conclusion from some of these studies (i.e., Blair, Monson et al. (2001) and Blair (1995)) has been based on post-hoc analyses of seemingly null results.

Likewise, measurements of moral reasoning of psychopathy have overall demonstrated that psychopathic individuals have deficient moral reasoning (Fodor 1973, Jurkovic and Prentice 1977, Lee and Prentice 1988, Trevathan and Walker 1989, Chandler and Moran 1990, Campbell, Schermer et al. 2008, Ermer and Kiehl 2010, van Vugt, Asscher et al. 2012), especially when reasoning about real-life victims compared to hypothetical ones (van Vugt, Asscher et al. 2012). However, one study has demonstrated that the moral reasoning of psychopaths is superior to controls (Link, Sherer et al. 1977) and two studies have found that the reasoning of psychopaths
is no different from control groups (OKane, Fawcett et al. 1996, Lose 1997), especially when intelligence levels are controlled (OKane, Fawcett et al. 1996). In addition, psychopaths performed markedly worse than control groups when reasoning about social contract and precautionary, but not descriptive, rules (Ermer and Kiehl 2010), demonstrating that psychopaths have marked deficits when reasoning about social and moral rules as well as when reasoning about scenarios that highlight risk, two areas (i.e., social/moral and impulse control/sensation seeking) in which psychopaths are believed to be deficient (Simon, Holzberg et al. 1951, Blair 1995, Blair, Jones et al. 1995, Blair, Monson et al. 2001, Kiehl 2006, Dolan and Fullam 2010).

1.2. Alternative Claim: An Information Processing Perspective

While the emotion processing, emotion regulation, and moral cognition deficits of both vmPFC patients and psychopaths are widely reported, there is an alternative perspective about the deficits of these two populations. Specifically, there is evidence that both populations have basic information processing deficits in attention and in the capability to assess (i.e., learn, compare and predict) value. Because of this, the observed behavioral deficits of these populations may not be caused by specific deficits in emotion but instead by more basic deficits in being able to input (i.e., detect, attend, process, and assess) information in the first place, whether or not the information contains affective content. Importantly, these information processing deficits can result in the disruption of other, higher-order processes, including more broad processes of both emotion and reason. Therefore, because the populations have basic information processing deficits that are not specific to emotion, this dissertation asserts that the populations should not be used as evidence that emotion is necessary for moral cognition. Using the terms “emotion” and “reason” is the wrong level of description, inaccurately explaining the deficits that the populations actually have.
The information processing perspective of the populations’ dysfunction is not new (Dwyer 2009, Huebner, Dwyer et al. 2009, Guglielmo 2015). It has been proposed regarding vmPFC patient behavior and vmPFC functionality (Huebner, Dwyer et al. 2009, Fellows 2011, Nicolle and Goel 2013, Huebner 2015) as well as regarding explanations of aberrant psychopathic behavior (Newman 1998, Fine and Kennett 2004, Maibom 2005, Kennett 2006, Huebner, Dwyer et al. 2009, Maibom 2010). In fact, some researchers do not believe that these populations definitely demonstrate a lack of emotion (Maibom 2005, Kennett 2006, Huebner, Dwyer et al. 2009, Maibom 2010, Huebner 2015). Instead, information processing deficits can cause disruption of basic information inputs (e.g., picking up, processing, and assessing information about the world) yet resemble gross deficits when measuring behavioral outputs (e.g., appearing like deficits in emotion processing). In other words, minor disruptions in the mental capability to detect and evaluate information about the world can result in tremendous disturbances in the ability to make responses and behave in the world (Dwyer 2009, Huebner, Dwyer et al. 2009).

Specifically, both vmPFC patients and psychopathic individuals have marked deficits in attention. vmPFC patients have difficulty attending to relevant stimuli in social tasks (Vecera and Rizzo 2004) as well as in attending to the eye region of faces when objectively identifying the emotional states of others (Wolf, Philippi et al. 2014). Psychopaths also have notable attentional deficits in the ability to attend to salient features of stimuli (Patterson and Newman 1993, Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011, Newman and Baskin-Sommers 2011, Larson, Baskin-Sommers et al. 2013, Zeier and Newman 2013, Hoppenbrouwers, van der Stigchel et al. 2015). The attentional deficits of psychopaths have been observed in paradigms that measure both attention and response inhibition (i.e., tasks that measure cognitive control) (Munro, Dywan et al. 2007, Munro, Dywan et al. 2007, Zeier and Newman 2013), as well as in tasks that measure
electroencephalogram (EEG) event related potentials (ERP) that index attentional processes during tasks that are composed of both affective (Howard and McCullagh 2007) and non-affective content (Raine and Venables 1988, Kiehl, Hare et al. 1999) (but see (Jutai, Hare et al. 1987, Raine and Venables 1988) for divergent results). Interestingly, the attention deficits of psychopathy seems to be specific when attentional demands increase, as psychopathic individuals have intact early attention but difficulties keeping their attention as time goes on. Because of this, psychopaths are believed to have difficulties in adjusting their behavioral responses once they have decided on a goal, often directed by what grabs their attention first, a theory known as the response modulation theory of psychopathy (Levenston, Patrick et al. 2000, Baskin-Sommers, Curtin et al. 2011, Larson, Baskin-Sommers et al. 2013).

In addition, both vmPFC patients and psychopaths have deficits in the capability to learn, compare, and predict the value of stimuli and outcomes. This deficit is widely reported in vmPFC patients (Fellows and Farah 2003, Fellows and Farah 2005, Fellows and Farah 2005, Fellows 2006, Fellows 2007, Fellows and Farah 2007, Wheeler and Fellows 2008, Tsuchida, Doll et al. 2010, Camille, Griffiths et al. 2011, Camille, Tsuchida et al. 2011, Fellows 2011, Henri-Bhargava, Simioni et al. 2012, Tsuchida and Fellows 2013), preventing vmPFC patients from being able to assess significance in the world around them (Fellows 2011) and is most apparent in complex situations in which multiple value comparisons must be made (Fellows 2006). Notably, this deficit spans across many different types of judgment and decision paradigms, regardless if it is composed of affective content. Specifically, vmPFC patients have marked deficits in the IGT tasks due to reversal learning deficits (Fellows and Farah 2003, Fellows and Farah 2005, Tsuchida, Doll et al. 2010), in simple learning paradigms that require associating value of stimuli, action, and outcomes (Wheeler and Fellows 2008, Camille, Tsuchida et al. 2011), in tasks that measure preference
judgments regarding vegetables, puppies (Fellows and Farah 2007, Camille, Griffiths et al. 2011, Henri-Bhargava, Simioni et al. 2012), and abstract stimuli (Koscik and Tranel 2012), and in a task that explores hypothetical decisions regarding where to live (Fellows 2006).


From these already observed basic information processing deficits across both affective and non-affective content, it is not a stretch to assume that any higher-order processing deficits of the populations would follow. In other words, disruption of basic information inputs would result in deficits in behavioral outputs (Dwyer 2009, Huebner, Dwyer et al. 2009), despite those outputs being in cognitive domains of emotion or reason. Importantly, both higher-order processes of emotion and reason require these basic information processes. If an individual is not attending to relevant stimuli, they would miss pertinent information about the world, especially regarding contextual information that is particularly significant about any given situation or that require ToM through the objective identification of the emotional and cognitive states of others. Likewise,
higher-order emotional experience arguably relies on basic reinforcement processing of what feels
good and bad (i.e., affective value) (Scherer 2001, Scherer 2009, Mulligan and Scherer 2012, Rolls
2015) while higher-order reasoning processes require value calculations and comparison of goal
orientation, motive, agency, and responsibility that are necessary to assess relevance, implication,
and normative significance about the world (Sripada and Stich 2006, Mackie, Moneti et al. 2012).
Therefore, a disruption in either attention or value assessment could result in deficits in both
higher-order processes of emotion and reason.

Importantly, the term “value” is distinct from the term “emotion”, representing two
separate constructs. Specifically, being able to evaluate something does not have to include affect
– one can assess and compare options without emotion being part of it. Likewise, there is mounting
evidence regarding vmPFC functionality that has implicated the vmPFC in value assessment
across a wide range of tasks that are composed of both affective and non-affective content
(Rokeach 1971, Tremblay and Schultz 1999, Rolls 2000, Montague and Berns 2002, Paulus and
and Wallis 2009, Schoenbaum, Roesch et al. 2009, Rangel and Hare 2010, Camille, Griffiths et al.
2011, Camille, Griffiths et al. 2011, Camille, Tsuchida et al. 2011, Cunningham, Johnsen et al.
2011, Fellows 2011, Lim, O'Doherty et al. 2011, Padoa-Schioppa and Cai 2011, Henri-Bhargava,
al. 2016), suggesting a general role of the vmPFC in value assessment that is not specific to
affective processing. Further, even if value does involve affect, there is evidence that suggests that
the neural representations of affective (i.e., reward) processing and emotion are partially distinct,
providing evidence that value and emotion are in fact separate constructs (Murray 2007). In this
sense, while value, especially as it often involves some form of an affective consideration in the sense that affect encompasses valence, motivation, arousal, appraisal, and reinforcement computations, is arguably a necessary component process for emotion (Rolls 2015), it does not wholly constitute emotion. Conceptually, one can hardly say that judging whether an apple tastes better than an orange or if one political candidate is more attractive than another constitutes a complete emotional experience. In addition, something may feel good (i.e., positive affect, positive valence, positive appraisal), as in cracking one’s knuckles, yet not equate to the emotion of happiness. Therefore, value itself, specifically affective evaluation, does not constitute emotion fully.

1.3. Rationale and Objectives

The rationale behind this dissertation is to investigate and reinterpret the populations' aberrant moral behavior and abnormal performance on emotion and moral cognition tasks through the lens of the information processing perspective. While the terms “moral” and “emotion” can encompass multiple definitions, for the purpose of this dissertation, these terms follow definitions put forth by the empirical literature that uses them. Specifically, the terms “moral content” and “moral cognition” embrace definitions used in research studies that have measured the populations’ moral performance, primarily in tasks that have been designed to measure moral judgment and decision-making. Likewise, the term “emotion” follows the definition proposed by Huebner, Dwyer et al. (2009), that being in reference to the vernacular sense of happiness, fear, disgust, guilt etc. To my knowledge, the application of this claim to explain the aberrant moral behaviors and abnormal performance on emotion and moral cognition tests of these populations has simply been suggested and not thoroughly researched nor addressed in the moral literature (Huebner, Dwyer et al. 2009, Fellows 2011, Nicolle and Goel 2013, Huebner 2015). Thus, the
work in this dissertation reflects original scholarship by being the first, to date, to thoroughly apply this alternative claim to the populations' aberrant moral behaviors and abnormal moral cognition.

The primary objective of this dissertation is to suggest that data from the populations should not be applied to age-old Emotion-Reason debate, specifically to support the claim that emotion is necessary for normal moral cognition. Using data from these populations to support this claim is an inaccurate description of the deficits that the populations actually have. Instead, vmPFC patients and individuals with psychopathy have information processing deficits that are more basic and that affect higher-order processes of both emotion and reason. Because of this, insights from these populations cannot shed light on what is required for the moral cognition of normal populations because normal populations typically do not have these types of deficits. Therefore, the application of the data from these populations to the Emotion-Reason debate should not be used to determine whether emotion or reason is necessary for moral cognition.

I meet this objective in three distinct manuscripts. The methodology behind each of the manuscripts is to systematically review the literature and to reanalyze and reinterpret results, highlighting methodological discrepancies and/or population characteristics that further question the validity of using these populations to support the necessary role of emotion in moral cognition. In order to thoroughly assess whether the results from these studies were used by the researchers to support the claim that emotion is necessary for moral judgment, the review criterion was inclusive, examining all empirical studies that have been published on both populations regarding moral cognition in full. Importantly, the moral cognition studies assessed focused on the measurement of moral judgment in a variety of moral psychology tasks, primarily including performance measurements on moral dilemma tasks (e.g., Greene, Sommerville et al. (2001)’s battery of moral dilemmas) and on a task that measures how individuals use intention and outcome
information when judging the permissibility of moral scenarios (Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012). However, other moral cognition studies were also evaluated, including performance on moral knowledge tasks that use either traditional or modified versions of Turiel (1983)'s moral/conventional distinction task (Turiel 1983) or the Moral Foundation Questionnaire (MFQ (Graham, Haidt et al. 2009, Graham, Nosek et al. 2011)), on moral reasoning tasks that measure Kohlberg (1969)’s Moral Dilemma Questionnaire (MDQ (Kohlberg 1969)), as well as any other task that measured moral judgment and decision-making in both populations.

The first manuscript, indexed as Chapter 2, highlights research that associates vmPFC functionality with value assessment and vmPFC patient aberrant behavior and laboratory performance with value deficits, noting functional associations and deficits across scenarios and options that both contain or are void of affective content. I then address the two primary moral cognition studies using vmPFC patients, specifically those that address vmPFC abnormal moral judgments in Greene, Sommerville et al. (2001)’s battery of moral dilemmas (N = 4) and those that address moral judgments manipulated by intention and outcome information (N = 2). I then reinterpret the patient performance both in these tasks and in the real world in terms of having deficits in basic information processing of value assessment rather than deficits in emotion. I suggest that vmPFC patient behavior in these moral judgment tasks could otherwise be explained by having information processing deficits, especially in tasks that are inherently complex, and that vmPFC patients may in fact be using a heuristic in order to minimize task demand.

The second manuscript, indexed as Chapter 3, similarly addresses moral cognition studies using individuals with psychopathy, exploring all published empirical studies using a psychopathic population, including criminal, general, adult, and adolescent demographics (N = 52). This thorough exploration was intended to first review the variance of the findings and second to then
focus on studies that correlate psychopathic behavioral performance on moral cognition tasks with the multidimensional characteristics that are used to diagnose psychopathy ($N = 20$). The moral cognition tasks included in this exploration included moral judgments in moral dilemma tasks (e.g., Greene, Sommerville et al. (2001)’s battery of moral dilemmas), on tasks that manipulated intention and outcome information, on moral knowledge tasks that use either traditional or modified versions of Turiel (1983)’s moral/conventional distinction task (Turiel 1983) or the Moral Foundation Questionnaire (MFQ (Graham, Haidt et al. 2009, Graham, Nosek et al. 2011)), on moral reasoning tasks that measure Kohlberg (1969)’s Moral Dilemma Questionnaire (MDQ (Kohlberg 1969)), the Defining Issues Task (which is based off of Kohlberg’s structured interview and is focused on a component model of moral development (Rest, Cooper et al. 1974)), and the Wason Selectin Task (which measures deductive reasoning about social exchange, precautionary, and descriptive rules (Wason 1966)), as well as on any other task that measured moral judgment and decision-making. The work in this manuscript demonstrates that abnormal moral behavioral performance of psychopaths does not necessarily correlate with having deficits with emotion, as assessed by having a lack of affective characteristics. Instead, abnormal performance is correlated with deficits in interpersonal and lifestyle characteristics of psychopathy, with lifestyle characteristics reflecting deficits in both information processes of attention as well as deficits in impulse control. Notably, impulse control deficits as well as deficits in the other dimensions of psychopathy can be explained by having deficits in attention.

The third manuscript, indexed as Chapter 4, further supports the information processing perspective of the populations’ deficits by exploring whether neuropsychological testing of vmPFC patients and adult criminal psychopathic individuals supports the claim that the populations have select deficits in emotion. This is accomplished by investigating the reported
neuropsychological results of the population samples used in studies that measured the populations’ behavioral performance in the two most prominent moral psychology tasks, specifically Greene, Sommerville et al. (2001)’s battery of moral dilemmas (vmPFC patients, $N = 4$; psychopaths, $N = 3$) and on tasks that measured how intention and outcome information can influence moral judgments (vmPFC patients, $N = 2$; psychopaths, $N = 1$). Importantly, only studies using adult criminal psychopaths were used. Because studies that investigate psychopathic moral psychology rarely include neuropsychological measures besides intelligence (unlike studies that investigate vmPFC patient performance), additional neurocognitive data was collected. Specially, additional studies that measured the neuropsychological capabilities of the adult criminal and/or psychiatric psychopathic population were included in this analyses ($N = 12$). Likewise, two empirical studies that are notorious for measuring vmPFC patient cognitive capability were also included ($N = 2$). From this analyses, this manuscript demonstrates that, as opposed to what is commonly claimed, vmPFC patients and psychopaths actually do have deficits in basic processes of attention, memory, and executive functioning, particularly in reasoning paradigms. Importantly, many of these tasks are not composed of affective content, further supporting the information processing perspective’s claim that these populations have deficits not specific to emotion.

Taken together, these three manuscripts demonstrate that these populations have basic information processing deficits that are not exclusive to emotion and which can be used to alternatively explain the populations’ aberrant moral behaviors and abnormal performance on emotion and moral cognition tests. Therefore, using data from these populations to support the necessary role of emotion in moral cognition in attempts to adhere to the age-old Emotion-Reason debate is inappropriate because it inaccurately describes the deficits in which the populations actually have.
who argued the importance of either emotion or reason, respectively

vmPFC patients have damage focal to the vmPFC whereas individuals with psychopathy have associated vmPFC dysfunction among other areas

e.g., synonymous with the neuroscientific concepts of emotion regulation through cognitive (also known as executive) control

However, each of these areas have also been associated with other psychological processes and cognitive functions outside of emotion (Masserman 1941, Alheid and Heimer 1996, Braver and Bongiolatti 2002, Hein and Knight 2008, Blackford, Buckholtz et al. 2010, Menon and Uddin 2010, Balderston, Schultz et al. 2011, Blackford, Avery et al. 2011, Fellows 2011).

but see different accounts of vmPFC functionality outside of affective associations (Delgado, Beer et al. 2016) as well as different theories as to what constitutes as emotion (Barrett, Mesquita et al. 2007, Izard 2010, Mulligan and Scherer 2012)

but see Barrett (2017) for accounts in which physiology is not necessarily associated with emotional experience

Most theories of morality assume that emotion is key when evaluating moral content (Hume 1739, Eisenberg 2000, Haidt 2001, Nichols 2004, Blair, Mitchell et al. 2005, Moll, Zahn et al. 2007, Prinz 2008); however, not everyone agrees (Huebner, Dwyer et al. 2009, Kennett and Fine 2009, Maibom 2010, Huebner 2015). Specifically, while emotion may be associated with moral evaluations, there is little evidence to suggest that emotion is actually driving moral judgment (Dwyer 2009, Huebner, Dwyer et al. 2009).
However, see Huebner, Dwyer et al. (2009) who highlight that vmPFC patients are able to make some moral judgments in emotionally salient moral dilemmas, suggesting that their capability for moral cognition is not completely deficient.

Refer to Weber, Habel et al. (2008) and de Oliveira-Souza, Hare et al. (2008) for comprehensive reviews.
The first manuscript of this dissertation, indexed as Chapter 2, highlights research that associates vmPFC functionality with value assessment and vmPFC patient aberrant behavior and abnormal performance on emotion and moral laboratory tasks with value deficits, noting functional associations and deficits across tasks that both contain or are void of affective content. In this manuscript, I analyze and address the inherent complexity of moral cognition tasks and suggest that vmPFC patients have difficulty assessing value due to this complexity and rely on using outcome information as a heuristic in order to guide their judgment and decision-making in these tasks. I then reinterpret the vmPFC patient real world behavior and laboratory performance as not deficits in emotion but instead deficits in basic information processing of value assessment.
CHAPTER TWO: Does Data from vmPFC Patients Support Claims that Emotion is Necessary for Moral Cognition? The Answer is ‘No’.

2.1. Abstract

Trends in moral psychology largely support the role that emotion plays in moral judgment. This theory, first popularized by philosopher David Hume, has been supported in the scientific field using both correlational and causal studies, with the latter of the two offering the most compelling evidence to date. Specifically, emotion has been causally linked to moral judgment using experimental designs that have measured the behavior of patient populations who have focal damage to an area of the brain associated with emotion processing and/or regulation in judgment and decision-making, the ventromedial prefrontal cortex (vmPFC). Results from these studies have suggested that the vmPFC is necessary to process emotion during moral cognition tasks. However, patients with vmPFC damage also have deficits in a variety of judgment and decision-making tasks, regardless of whether the tasks are composed of affective content. In this manuscript, I argue for a basic information processing perspective of vmPFC functionality which describes vmPFC functionality, and subsequently vmPFC patient behavior in the real world and performance on both moral and nonmoral tasks, in terms of value assessment rather than emotion. From this alternative perspective, I highlight data from both non-human animal and human studies that support the hypothesis that the vmPFC is necessary for the assessment of value in every judgment and decision, regardless of content. I demonstrate that vmPFC patients have deficits in judgment and decision-making that are not specific to emotionally salient or moral content. I also argue that the studies used to measure vmPFC patient performance in moral judgment tasks inherently disadvantage vmPFC patients from behaving similarly to controls. I point out that when these basic information processing deficits are accounted for in experimental methodology, vmPFC patients
behave similarly to controls and conclude that while the vmPFC, like many frontal structures, is crucial for sound judgment and decision-making, its functionality is not specific to emotion. Instead, vmPFC patient deficits can be more broadly described as general deficits in basic information processing of value and because of this, research using vmPFC patients as evidence that emotion is necessary for normal moral cognition inaccurately describes the deficits of vmPFC patients.

2.2. Introduction

For the past decade, patients with damage to the ventromedial prefrontal cortex (vmPFC) have been a population of interest to support the claim that emotion, and not reason, is cognitively necessary to behave in morally appropriate ways. Known as the Emotion-Reason debate, historically philosophers (Hume 1739, Kant 1785) and, for the past few decades, scientists (Piaget 1965/1932, Kohlberg 1981, Greene, Sommerville et al. 2001, Haidt 2001, Greene and Haidt 2002) have disputed which process is more cognitively necessary to behave in morally appropriate ways. Although many have argued that both processes are necessary for moral cognition (Greene, Nystrom et al. 2004, Moll and de Oliveira-Souza 2007), recent psychological (Haidt 2001, Wheatley and Haidt 2005, Valdesolo and DeSteno 2006) and neuroscientific (Greene, Sommerville et al. 2001, Greene and Haidt 2002, Greene, Nystrom et al. 2004) evidence has highlighted the role that emotion plays in driving moral judgment. For the purpose of this manuscript, emotion here will follow the definition set forth by Huebner, Dwyer et al. (2009) in the vernacular sense of happiness, fear, disgust, guilt etc. Determining whether emotion or reason is cognitively necessary to behave appropriately is an important undertaking in order to explain the reasons behind social and moral conduct as well as for clinicians in diagnosing and treating individuals who display morally aberrant behaviors. In other words, determining the etiology of
moral cognition is crucial for understanding, and adjusting, human behavior. Thus, data from patients with damage to a particular area of the brain that has been associated with emotional, social, or moral disruption have been used to provide insight on whether emotion or reason is cognitively necessary to behave in morally appropriate ways. Known as lesion, or loss-of-function, studies, if an individual has a dysfunction or loss of function in one particular area of the brain and their behavior is markedly different from other healthy and brain damaged individuals, then the lesion location and corresponding behavior can provide direct and causal information about brain-behavior relationships.

The vmPFC is located at the ventral (orbital) and medial surfaces of the prefrontal lobe encompassing both the medial and lateral orbital frontal cortices (OFC; mOFC; IOFC) and medial prefrontal cortex (mPFC). Damage to the vmPFC is usually caused by ischemic or hemorrhagic strokes, resection of low-grade brain tumors, or aneurysm rupture but may also be caused by chronic seizures or neurodegenerative diseases (Anderson, Barrash et al. 2006). The term “vmPFC patient” typically refers to those who do not also suffer from any other comorbidity, such as fronto-temporal dementia (FTD) in which the vmPFC is affected among other regions of the brain with similar behavioral profiles (Rosen, Allison et al. 2005). Importantly, the vmPFC has been a particular area of interest in the study of moral cognition because after vmPFC damaged has occurred, vmPFC patients often retain intelligence, memory, and reasoning capabilities (Eslinger and Damasio 1985, Bechara, Damasio et al. 1994, Anderson, Bechara et al. 1999, Anderson, Barrash et al. 2006) but suddenly behave in seemingly emotionless and callous ways (Blumer and Benson 1975, Damasio, Grabowski et al. 1994, Boes, Grafft et al. 2011), supporting the claim that damage to the vmPFC results in a lack of emotion, and not reason (Eslinger and Damasio 1985, Stuss, Gow et al. 1992, Damasio 1994, Rolls, Hornak et al. 1994, Grafman, Schwab et al. 1996,
Observations of vmPFC patient behavior in the real world describe vmPFC patients as apathetic and impulsive (Eslinger and Damasio 1985, Stuss, Gow et al. 1992, Grafman, Schwab et al. 1996, Cicerone and Tanenbaum 1997, Anderson, Bechara et al. 1999, Barrash, Tranel et al. 2000, Beer, Heerey et al. 2003, Bechara and Van Der Linden 2005, Anderson, Barrash et al. 2006, Spikman, Timmerman et al. 2012), sometimes to such an extreme that vmPFC patients are described as having a complete lack of regard for social and moral norms (Eslinger and Damasio 1985, Saver and Damasio 1991, Cicerone and Tanenbaum 1997, Blair and Cipolotti 2000, Boes, Grafft et al. 2011). Patients as young as six years old who have early-onset vmPFC damage are described as engaging in extremely morally aberrant behaviors similar to psychopaths, such as stealing, lying, aggression, and rage (Boes, Grafft et al. 2011). Clinical observations and laboratory studies of these young patients demonstrate that they fail to learn even the most basic social norms and moral rules (Ackerly and Benton 1947, Anderson, Bechara et al. 1999, Anderson, Barrash et al. 2006, Boes, Grafft et al. 2011). Adult-onset vmPFC patients are more common and display similar, but often less severe, behavioral profiles. Unlike their younger counterparts, these older patients are reported as having the ability to recall previously learned social norms and moral rules but still fail to act in accordance with them (Saver and Damasio 1991, Anderson, Barrash et al. 2006). In fact, the social and behavioral deficits reported after vmPFC damage has occurred, no matter how early or late, are so pronounced that the terms “pseudopsycopathy” (Blumer and
Benson 1975) and “acquired sociopathy” (Eslinger and Damasio 1985, Barrash, Tranel et al. 2000, Blair and Cipolotti 2000) have been used to describe patient behavior.

In the laboratory, vmPFC patients are also described as being impulsive with an increased aptitude for risk and a lack of regard for future consequences (Bechara, Damasio et al. 1994, Bechara and Van Der Linden 2005, Clark, Bechara et al. 2008). Additionally, patients are described as being selfish and non-cooperative, often accompanied by fits of anger (Koenigs and Tranel 2007, Krajbich, Adolphs et al. 2009). During a task that measures risk preference known as the Iowa Gambling Task (IGT), patients, unlike controls, continuously choose risky and disadvantageous options and do not adjust their behavior despite knowing that their choices are overall counterproductive (Bechara, Damasio et al. 1994). In behavioral economic games that measure how individuals cooperate with others, vmPFC patients are described as selfish and without guilt and regret. Specifically, patients are less likely to cooperate with others (Koenigs and Tranel 2007, Krajbich, Adolphs et al. 2009, Moretto, Sellitto et al. 2013) and are seemingly apathetic when outcomes result in gains for themselves but when the outcomes result in gains of their partners, vmPFC patients, unlike controls, often react with frustration and anger (Koenigs and Tranel 2007). vmPFC patients also have a decreased ability to produce physiological anticipatory responses to emotionally salient situations (Bechara, Tranel et al. 1996), such as having an increased heart rate (HR) or perspiratory production measured using skin conductance response (SCR) tests. Patients fail to respond automatically to stimuli when they are in risky gambling situations, such as the IGT (Bechara, Damasio et al. 1994, Bechara, Tranel et al. 1996), as well as when they are viewing emotionally salient images of social and moral violations (Damasio, Tranel et al. 1990). Because vmPFC patients have deficits when making judgments and decisions in emotionally salient situations and lack corresponding visceral responses, the vmPFC
has been hypothesized as being necessary for processing affective information that is cognitively necessary for sound judgment and decision-making (Damasio 1994, Bechara, Damasio et al. 2000). Known as the Somatic Marker Hypothesis (SMH), without a functional vmPFC, individuals are not able to use physiological cues of emotion to guide their decision-making, which explains why vmPFC patients make the aberrant judgments and decisions that they do (Damasio 1994).

In support of the view that the vmPFC actually has a specified functional role in emotion, functional imaging has associated vmPFC activity with emotion processing by revealing that the vmPFC is activated when individuals make assessments of (Partiot, Grafman et al. 1995, Greene, Sommerville et al. 2001, Shenhav and Greene 2010) and react to (Partiot, Grafman et al. 1995, Lane, Reiman et al. 1997, Reiman 1997, Moll, de Oliveira-Souza et al. 2002, Schaich Borg, Hynes et al. 2006) emotionally salient stimuli (but see Moll, de Oliveira-Souza et al. (2002) for an account in which the vmPFC is not activated). In addition, functional work has also supported the role of the vmPFC in the regulation of emotion (Harenski and Hamann 2006, Kanske, Heissler et al. 2011, Vrticka, Sander et al. 2011, Winecoff, Clithero et al. 2013, Motzkin, Philippi et al. 2015). According to the emotion regulation view of the vmPFC, the vmPFC is necessary to properly process and regulate emotional responses from the amygdala using information from the dlPFC in order to enable individuals to make sound, rational judgments and decisions (Damasio 1994, Bechara, Damasio et al. 2000, Greene, Nystrom et al. 2004, Quirk and Beer 2006, Wager, Barrett et al. 2008, Grabenhorst and Rolls 2011, Ochsner, Silvers et al. 2012, Hu and Jiang 2014). Thus, without a functional vmPFC, individuals would lack this regulation capacity resulting in a divergence from normative judgment and decision-making, especially when such judgments and decisions require the processing of emotional content, as judgments of morality are presumed to involve.
Tsoory, Tomer et al. 2003, Shamay-Tsoory, Tomer et al. 2004), especially information that requires affective (i.e., emotional) processing (Shamay-Tsoory, Tomer et al. 2005, Shamay-Tsoory and Aharon-Peretz 2007).

Taken together, this evidence supports the notion that the vmPFC has something to do with emotion. Accordingly, if the vmPFC processes and/or regulates emotion, then vmPFC patients would have marked difficulty making judgments and decisions in any situation that requires emotional processing. Such situations include risky decision-making tasks, economic cooperation games, and moral psychology tasks that measure responses to social and moral conduct. Accordingly, if the vmPFC selectively processes and/or regulates emotional information, then vmPFC patients would have deficits only in situations that contain affective content.

much an option, or particular outcome, is worth, often in relation to economic utility, or how useful, a particular option or outcome is. In addition, the vmPFC has also been hypothesized as an area of the brain necessary for the normalization and comparison of multiple value signals from disparate areas of the brain in order to compute one final value signal that guides judgment and decision-making. According to this hypothesis, the vmPFC takes in all the value signals sent from other areas of the brain and acts as a “common neural currency” by normalizing, weighing, and comparing the signal strength of each individual value signal, a basic information process essential to sound judgment and decision-making. The value signal that is weighted the most wins and the judgment or decision based on that winning value signal is made (Montague and Berns 2002, Grabenhorst and Rolls 2011, O'Doherty 2011, Levy and Glimcher 2012). Notably, evidence of this value-centric hypothesis of the functional role of the vmPFC supports the notion that the vmPFC is critically involved in value assessments across a wide variety of judgment and decision-making tasks that comprise both affective and non-affective content. In other words, the vmPFC is important for the assessment of value of information despite emotion being involved. Thus, it is assumed that disruption of the vmPFC will result in deficits of judgments and decisions irrespective of the presence of affective content.

I introduce recent studies that have used vmPFC patient performance on a moral psychology task as evidence that the vmPFC selectively processes emotional information and that emotion is cognitively necessary to make morally appropriate judgments. I specifically focus on a moral dilemma task designed by Greene, Sommerville et al. (2001). Second, I introduce an alternative description of vmPFC functionally by highlighting research from both non-human animal and human studies that support the hypothesis that the vmPFC is more broadly necessary for the assessment of value, regardless of content. In other words, I introduce research that supports an information processing perspective of vmPFC functionality that is necessary for both affective and non-affective content. I also point out that vmPFC patients have deficits in value judgments that are void of affective content and are often disadvantaged in tasks that require assessing value among multiple options and task complexity. Third, I argue that vmPFC patient performance on Greene, Sommerville et al. (2001)’s moral psychology task can more simply be explained by the patients having these basic information processing deficits in being able to assess what to value due to task complexity. I then reinterpret vmPFC patient performance on this task and as well as vmPFC patient behavior in the real world and other laboratory tests using this alternative description of vmPFC functionality. I propose that data from vmPFC patients should not be used to support the claim that emotion is necessary for moral cognition for the Emotion-Reason debate because it inaccurately describes the deficits that the patients actually have. Instead, the vmPFC is critically involved in every judgment and decision, regardless of content.

2.3. vmPFC Patient Performance in a Moral Psychology Task: Supporting the Functional Role of the vmPFC in Emotion

The primary study that has been used to measure vmPFC patient moral cognition has been a moral dilemma task that has adhered to the traditional dichotomic Emotion-Reason debate and
aimed to distinguish emotional judgments from those of reason (Greene, Sommerville et al. 2001). Specifically, this task exposes participants to a battery of dilemmas similar to the Trolley Problem (Foot 1967, Thomson 1976) in which one has to choose between the acceptability of a utilitarian judgment, in which the end justifies the means (e.g., to kill one in order to save five) and a deontological judgment, in which no matter the ends, the means is never justified (e.g., to let five die) (Greene, Sommerville et al. 2001). This battery in particular compares utilitarian and deontological responses of non-moral dilemmas that do not have social or ethical consequences (e.g., turning a tracker right or left to harvest turnips) to moral dilemmas that are either impersonal or personal. The distinction between impersonal and personal moral dilemmas is based on predetermined emotional saliency ratings, with personal moral dilemmas rated as being more emotionally salient than impersonal moral dilemmas (Greene, Sommerville et al. 2001). Healthy individuals typically choose the utilitarian judgment in impersonal moral dilemmas and spend time deliberating on their judgment, as indicated through reaction time (RT) measurements. Conversely, healthy individuals typically choose the deontological judgments in personal moral dilemmas and often spend less time when making such judgments (Greene, Morelli et al. 2008). Likewise, functional results have implicated the dlPFC as being active during utilitarian judgments and the vmPFC as being active during deontological judgments. Researchers have concluded that when individuals make rational calculations of lives lost versus saved (i.e., choosing the utilitarian option, in impersonal moral dilemmas, such as turning a switch to redirect an out-of-control trolley from hitting five workmen to a sidetrack where the trolley will only hit one person instead, as in the Bystander dilemma), they are using an area of the brain associated with reason and cognitive control, the dlPFC. However, when individuals make emotional choices (i.e., choosing the deontological option, of a seemingly analogous scenario, but more personal in nature, such as
pushing a person to their death in order to save five others, as in the Footbridge dilemma), they are using the vmPFC (Greene, Sommerville et al. 2001) (but see traditional explanations of deontological judgments involving reason rather than emotion (Cushman, Young et al. 2010) and Kahane and Shackel (2008), Kahane and Shackel (2010), Kahane (2012), Kahane, Wiech et al. (2012), Kahane (2015), Kahane, Everett et al. (2015), and McGuire, Langdon et al. (2009) for gross criticism of this task along with an alternative explanation involving the intuitiveness and counter-intuitiveness of judgments in these types of dilemmas).

Four studies using this battery of dilemmas have demonstrated that vmPFC patients display aberrant response profiles. Two of these studies have further divided personal moral dilemmas into low and high conflict dilemmas based on post-hoc analyses of responses and RT. From each of these studies, vmPFC patients judge the moral acceptability of non-moral and impersonal moral dilemmas similarly to controls but endorse the utilitarian option more often than controls in personal, and especially high-conflict, moral dilemmas (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011). Notably, in the one study that actually measured RTs associated with moral judgment, vmPFC patients demonstrated quicker RTs than the control groups (Ciaramelli, Muccioli et al. 2007). In addition to measuring behavior, another study also measured SCR responses while participants made their moral judgments and found that vmPFC patients had diminished SCR responses leading up to, and following, personal moral judgments (Moretto, Ladavas et al. 2010). Further, a third study found that vmPFC patients were more likely to endorse the utilitarian judgment regardless of whether the moral dilemmas entailed indirect or direct personal harm (Thomas, Croft et al. 2011). From these results, researchers claim that since vmPFC patients have response deficits specific to personal moral dilemmas, especially high conflict personal moral dilemmas which are rated as
being the most emotionally salient dilemmas in the battery, then the vmPFC must be necessary for computing emotion during moral judgment and decision-making. Because this deficit is selective to personal moral scenarios, and because the patients overall passed memory control tests, the authors claim this is indicative that vmPFC patients do not have general decision-making deficits but instead have deficits specific to emotion (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011).

2.4. An Alternative Description of vmPFC Functionality: Value Assessment

However, the emotion view of vmPFC functionality may be incorrect. The vmPFC is a large area of the brain encompassing different subregions, including the OFC (Anderson, Barrash et al. 2006), and can be further divided into anterior-posterior, medial-lateral, and ventral-dorsal regions. Importantly, as been exemplified by research from neuroelectrophysiology and lesion studies with non-human animals and supported by functional imaging studies with humans, each of these subdivided regions of the vmPFC, including the subdivisions of the OFC, has been implicated in specified roles of value assessment associated with judgment and decision-making (O'Doherty, Kringelbach et al. 2001, Small, Zatorre et al. 2001, Gottfried, O'Doherty et al. 2002, de Araujo, Rolls et al. 2003, Rolls, Kringelbach et al. 2003, Fujiwara, Tobler et al. 2008, Hare, O'Doherty et al. 2008, Rolls, McCabe et al. 2008, Noonan, Walton et al. 2010, Smith, Hayden et al. 2010, McNamee, Rangel et al. 2013). In other words, an alternative perspective of the vmPFC is that it is responsible for determining and comparing the basic information processing of value of each option or outcome in order to guide and direct decision-making, rather than the specified functionality of processing and/or regulating emotion. A dysfunctional vmPFC would then result in deficits in judgment and decision-making across a wide range of stimuli, regardless of emotional content.
2.4.1. Value: An Introduction

The concept of value is an important topic to understand how individuals make judgments and decisions. Here, value is defined as how much a stimuli, or an option, is worth, and, stemming from experimental economics, is essential in explaining how optimal decisions are made. Specifically, in economics, value is defined by utility, meaning the usefulness of options and outcomes. In describing how value contributes to judgment and decision-making, when an individual is faced with at least two options, they must first comprehend the options available to them and then assign a value to each option. At this point, the value that is assigned to each option is an expected value, described as the value they predict they will receive once they chose either option. Once an expected value has been assigned to each option, individuals must compare the values between the options in order to make a choice. After a choice has been made, individuals must then assess whether the outcome they received was as expected and update their most recent association of that outcome with the option they chose through reinforcement learning, a process which then results in an updated stimulus value association (Rangel, Camerer et al. 2008).

Different descriptions are allocated to the term ‘value’ depending on whether the individual is focused on the stimulus, outcome, action, or goal in regards to the judgment or decision being made. Stimulus value is the initial association of value to a particular stimulus or option. Stimulus value relies on having a reinforcement history in order to immediately assess the value of a stimulus, such as seeing an apple (i.e., stimulus) and assessing immediately that apples are delicious (i.e., stimulus value); however, if an individual does not have a reinforcement history with a particular stimulus, either direct or indirect, their valuation of the stimulus may rely on other assessment mechanisms that to date are not specified (Rangel, Camerer et al. 2008). Outcome value, also known as reward and/or reinforcement value, is the value assessment of the
consequences of choosing a particular option or stimulus that is associated with an outcome. For instance, an individual may be presented with an apple (stimulus) and generally like the taste of apples (stimulus value) but after eating a bad apple, or perhaps an apple of a different variety that they did not enjoy, they compute an outcome value assessment of their most recent experience (e.g., tasted bad = outcome value). Outcome values are used to update stimulus value associations through exposure and reinforcement learning, also known as stimulus-reinforcement, or stimulus-outcome learning. Importantly, the ability to assess stimulus and outcome values aid individuals in projecting action and goal values for judgment and decision-making. Action value requires individuals to be able to project future predictions of the outcomes, or expected values, of options in order to assess which choice will be the most optimal. Goal values are similar to action values but also rely on the abstract concept of what the individual desires as far as the outcome (i.e., goal), which is used to direct decision-making, often through cognitive control (Hare, O'Doherty et al. 2008, Hare, Camerer et al. 2009).

Importantly, value does not have to be an absolute quantity – it can be subjective, that is, based on the influence of something else. That ‘something else’ can be internal preferences, such as likes or dislikes (e.g., apples are tastier than oranges) or motivation (e.g., satiation: being full from a Thanksgiving dinner and not interested in the apple desert). This is known as subjective value. That ‘something else’ can also be relative to external options (e.g., apples are tastier than oranges). This is known as relative value. Subjective and relative values are especially important for forming preferences and, in turn, rational behavior. According to economic choice theory, having consistent preferences (i.e., being able to maintain stable value assessments between options) is crucial for rational behavior – it would not make sense to prefer apples over oranges one minute and oranges over apples the next (Grether and Plott 1979).
2.4.2. The vmPFC and Value

Although there is some research to suggest that the vmPFC is involved in calculating initial stimulus value (O'Doherty, Winston et al. 2003, Lee, Rushworth et al. 2007, Cunningham, Johnsen et al. 2011, Lim, O'Doherty et al. 2013, Wilson, Takahashi et al. 2014), most research suggests that the vmPFC is more critically involved in assessing values related to outcomes (Schoenbaum, Roesch et al. 2009, Rangel and Hare 2010). Specifically, subregions within the vmPFC, such as the medial and lateral OFC, compute basic outcome value (Knutson, Fong et al. 2001, Small, Zatorre et al. 2001, Gottfried, O'Doherty et al. 2002, Gottfried, O'Doherty et al. 2003, Small, Gregory et al. 2003, Padoa-Schioppa and Assad 2006, Noonan, Walton et al. 2010, Howard, Gottfried et al. 2015), regardless whether the outcome is actual, hypothetical (Abe and Lee 2011) or abstract (O'Doherty, Kringelbach et al. 2001). In addition, these areas are also involved in the processing of the expectation of what an outcome may be, i.e., expected value (Tremblay and Schultz 1999, Breiter, Aharon et al. 2001, O'Doherty, Deichmann et al. 2002, Knutson, Taylor et al. 2005, Schoenbaum and Roesch 2005, Tobler, O'Doherty et al. 2007, Rolls, McCabe et al. 2008, Kirk, Skov et al. 2009, Schoenbaum, Roesch et al. 2011), which is crucial for the formation of both action and goal values, as expected value calculations are necessary for the projections of future stimulus-outcome associations. Accordingly, the vmPFC has also been implicated in the processing of action value and goal values guided by these expected outcome value assessments (Tremblay and Schultz 1999, Matsumoto, Suzuki et al. 2003, Plassmann, O'Doherty et al. 2007, Hare, O'Doherty et al. 2008, Hare, Camerer et al. 2009, Noonan, Walton et al. 2010, Plassmann, O'Doherty et al. 2010, Hare, Schultz et al. 2011, Liljeholm, Tricomi et al. 2011, O'Doherty 2011, McNamee, Rangel et al. 2013). What is even more important is the vmPFC involvement, along with its reciprocal connectivity with the amygdala, in learning stimulus-outcome associations and

and Miller 2003, McClure, Li et al. 2004, Padoa-Schioppa and Assad 2008, Padoa-Schioppa 2009, O'Doherty 2011). In addition, when multiple alternatives are present, the vmPFC is also involved in having to calculate both the relative current and future expected value for each of the options (Boorman, Rushworth et al. 2013).

Importantly, recent functional imaging has attempted to incorporate the role of the vmPFC in value assessment in moral cognition (Moretti, Dragone et al. 2009, Shenhav and Greene 2010, Hu and Jiang 2014, Shenhav and Greene 2014, Blair 2015). Specifically, this research has aimed to demonstrate that the vmPFC is necessary for the computation of affective value signals (Moretti, Dragone et al. 2009, Blair 2015), serves as a common valuation center (Shenhav and Greene 2010, Shenhav and Greene 2014), or regulates emotional reactivity from the amygdala in order to maintain goal direction (Hu and Jiang 2014). Regardless of these new interpretations, many of these researchers (i.e., Shenhav and Greene (2010) and Hu and Jiang (2014)) continue to associate vmPFC functionality with value computations specific to emotion.

However, mounting research provides evidence that vmPFC involvement in value assessment is not specific to affective content (Fellows 2006, Chib, Rangel et al. 2009, Kennerley and Wallis 2009, Cunningham, Johnsen et al. 2011, Lim, O'Doherty et al. 2011, Koscik and Tranel 2012, McNamee, Rangel et al. 2013). In other words, the vmPFC calculates value across a wide range of stimuli and outcomes that do not necessarily involve affective content. Because the vmPFC seems to be involved in value assessment no matter what is being valued, it is hypothesized that the vmPFC is crucial for the general processing of value, no matter the type of judgment or decision being made (Montague and Berns 2002, Hsu, Bhatt et al. 2005, Fellows 2006, Chib, Rangel et al. 2009, Kennerley and Wallis 2009, Smith, Hayden et al. 2010, Cunningham, Johnsen

Along the same lines, if the common neural currency view of the vmPFC is correct, in which the vmPFC is responsible for integrating value signals from other specific value areas in the brain in order to normalize and compare value between options (Montague and Berns 2002, Grabenhorst and Rolls 2011, O'Doherty 2011, Levy and Glimcher 2012), then the vmPFC would be especially crucial for value comparison, no matter how simple or complex. Deficits in this area would then produce difficulty when patients assess and compare the value of options in even simple value judgments and decisions. Interestingly, this seems to be the case.

2.4.3. vmPFC Patients and Value Assessments

In trying to understand why vmPFC patients behave the way they do, one line of research set forth by neurologist and neuropsychologist Lesley Fellows has aimed to determine whether vmPFC patient behavior in the real world and performance in judgment and decision-making tasks can be explained by something other than having emotional deficits. Fellows’ work has produced the claim that vmPFC patients have deficits in assessing value in even the simplest judgment and decision-making paradigms. Beginning with a reinterpretation of vmPFC patient performance in the IGT, Fellows and colleagues have demonstrated simple value deficits of patients in tasks that require relearning the value of options in risky decisions (which, in some accounts, can be considered reappraisals in which the vmPFC has been functionally associated with (Harenski and Hamann 2006, Kanske, Heissler et al. 2011, Vrticka, Sander et al. 2011)), maintaining consistency of value assessments for simple preferences, and acquiring information for value comparison when multiple attributes and options are present.
2.4.3.1. vmPFC Patient Performance on the Iowa Gambling Task

In the IGT, participants must choose between advantageous or disadvantageous reward contingencies among four decks of cards, two of which offer high rewards but even higher risks of losing those rewards and the other two of which offer smaller rewards and smaller risks. Compared to control groups, vmPFC patients continuously demonstrated a preference for choosing the decks of cards that offered the higher rewards, regardless of the higher risks, resulting in an overall lower financial gain at the end of the task, making the higher risk decks of cards generally disadvantageous. Moreover, when the SCR of the patients were measured, vmPFC patients, unlike control groups, did not demonstrate attenuation in their SCRs when they chose the high-risk decks. From this, the authors concluded that because vmPFC patients choose the disadvantageous decks, and thus, make irrational decisions, they are not guided by emotional sensitivity (Bechara, Damasio et al. 1994).

However, in an attempt to address whether vmPFC patients were lacking emotional sensitivity to the risk associated with this task or, instead, were demonstrating a value assessment deficit, researchers Fellows and Farah (2005) re-tested vmPFC patients using a modified version of the IGT. Fellows and Farah hypothesized that vmPFC patients were choosing the risky decks because they were having trouble re-learning stimulus-outcome associations of value when the reward contingencies changed, an ability known as reversal learning (Fellows and Farah 2003, Fellows and Farah 2005). Specifically, the original IGT task that Bechara, Damasio et al. (1994) used consistently offered large rewards before the participants experienced the even larger losses of those rewards. In Fellows and Farah (2005)’s modified version of the IGT, they shuffled the decks so that the patients would first experience the payoffs of the decks that offered the smaller rewards, and smaller losses. In this shuffled version of the IGT, the authors observed that vmPFC
patients performed similarly to controls (Fellows and Farah 2005). Hence, these authors offered a more simplistic explanation to the behavior observed by Bechara, Damasio et al. (1994): instead of the patients lacking the capacity to process affective information, these patients instead have a deficit in assessing the basic value of stimuli due to deficits in stimulus-outcome learning, specifically in this case, reversal learning. In other words, the patients have an inability to let go of previously learned rewarded responses so that when they were first rewarded from the high risk desks and later punished by those very same decks, they had difficulty readjusting their previous stimulus-outcome value associations. Due to this deficit in basic value learning, the patients appeared to behave in risk-seeking and unemotional ways but instead were behaving in this manner because they were having difficulty readjusting previously learned value associations (Fellows and Farah 2003, Fellows and Farah 2005).

In fact, it has been shown that the vmPFC is critical for learning both initial and subsequent stimulus-outcomes associations of value, especially in extinction, reappraisal, and reversal learning tasks (which all involve the re-associating stimulus-outcome values) (Rolls, Hornak et al. 1994, Schoenbaum, Chiba et al. 1998, O'Doherty, Kringelbach et al. 2001, Gottfried, O'Doherty et al. 2002, Hornak, Bramham et al. 2003, Kringelbach and Rolls 2003, Schoenbaum, Setlow et al. 2003, Holland and Gallagher 2004, Ostlund and Balleine 2005, Schoenbaum and Roesch 2005, Salzman, Paton et al. 2007, Tsuchida, Doll et al. 2010, Liljeholm, Tricomi et al. 2011, Maia and Frank 2011, McDannald, Lucantonio et al. 2011, Jones, Esber et al. 2012, Tsuchida and Fellows 2012, Tsuchida and Fellows 2013). In addition, it has been specifically demonstrated that vmPFC patients have marked difficulty in reversal learning tasks (Fellows and Farah 2003, Hornak, O'Doherty et al. 2004) and in learning the initial value of stimulus-outcome associations (Wheeler and Fellows 2008, Tsuchida, Doll et al. 2010). Thus, what was once viewed as a deficit in
processing emotionally salient information has later been explained by an information processing
deficit in re-learning the value of options and outcomes.

2.4.3.2. vmPFC Patient Performance on Simple Preference Tasks

Fellows and Farah’s work opened the door to testing basic value deficits of vmPFC patients
in judgment and decision-making. Specifically, Fellows has continued to test the vmPFC role in
value assessment by exploring how patients make preference judgments. Modeled from Rational
Choice Theory in behavioral economics, preference judgment tasks aim to measure the axiom of
transitivity in rational choice theory, which predicts that rational individuals will make consistent
preference judgments across a large sample of stimuli that can be reliably rank ordered. If they do
not, this lack of consistency is a violation of transitivity, more formally known as a violation of
the Generalized Axiom of Revealed Preference, or GARP. For instance, in a pairwise choice task,
if an individual prefers A > B, and B > C, GARP predicts that the individual will also prefer A >
C, a choice that proves consistent based on the individual’s previous choice history. However, if
an individual instead prefers C > A, they have made an inconsistent choice and have violated the
axiom of transitivity, a mark of irrational behavior

In multiple experiments that have aimed to measure vmPFC patient performance in
preference judgment tasks, vmPFC patients were asked to make pairwise preference judgments
between a wide variety of stimuli, ranging from which puppy they think is the cutest to which food
item they like the most (as well as preferences of colors, food, faces, and landscapes). As a control,
vmPFC patients were also asked to make perceptual judgments regarding whether or not two lines
on the screen were of equal or different sizes. Results from these studies indicate that vmPFC
patients tend to selectively make inconsistent judgments in both simple and complex measures of
preference when compared to control groups (Fellows 2007, Camille, Griffiths et al. 2011,
In addition, a later study has confirmed these results measuring the transitive capabilities of vmPFC patients using stimuli of visual patterns of which the participants had to initially learn transitive associations after which novel stimuli were added, resulting in transitive deficits. Notably, in this study the transitive deficits were only found once the novel stimuli were added (Koscik and Tranel 2012). Regardless of whether transitive deficits arise from initial or novel stimuli, overall researchers have concluded that the vmPFC is necessary for making normal transitive inferences, no matter the content of the stimuli (Fellows 2007, Camille, Griffiths et al. 2011, Camille, Tsuchida et al. 2011, Henri-Bhargava, Simioni et al. 2012, Koscik and Tranel 2012). Fellows and colleagues have specifically suggested that the patients’ lack of ability to make consistent choices is because the patients have difficulty computing, and keeping track of, value assessments between options. As hypothesized, if the vmPFC is involved in subjective and relative value assessments, as well as the comparison of values, then patients with vmPFC damage will have marked difficulty in preference judgment tasks such as these. Notably, once again, the deficit that vmPFC patients demonstrated in making inconsistent preference judgments is indifferent to stimuli content and none of the stimuli used for these preference judgment tasks involved affective content, supporting the basic information processing perspective of vmPFC functionality.

2.4.3.3. vmPFC Patient Performance on a Complex Multi-Attribute Task

As vmPFC patients have difficulty making consistent value judgments in preference tasks across a wide variety of stimuli, they also have difficulty when comparing value between options. Even for the simplest judgment or decision, a single option has more than one qualifying attribute that needs to be valued and weighed. For instance, apples can be valued based by taste but also size, cleanliness, and where they were cultivated (e.g., local or foreign, organic or conventional).
Thus, individuals who have deficits in making basic value assessments will have difficulty deciding on which attribute to best base their judgments and decisions, no matter how simple the judgment or decision task is.

In order to measure how vmPFC patients make choices between options across multiple attributes, Fellows (2006) asked vmPFC patients to assess and choose what type of living situation (e.g., one bedroom apartments) they would prefer in a task that involved the analysis and comparison of multiple attributes (i.e., noise level, neighborhood, size) across three different apartment options. Fellows (2006) found that vmPFC patients, unlike control groups, appear to behave in ways that minimize the need to compare the multiple attributes across all of the options by focusing on only one option at a time, going through each attribute per option in serial order. Specifically, the patients would evaluate apartment A by first considering noise level, then neighborhood, and then size, and then do the same thing for apartments B and C. Control groups, on the other hand, take an attribute-based approach in which they evaluate each attribute for every option at the same time: for instance, they would evaluate noise level across apartments A, B, and C, and then evaluate the neighborhood location, etc.. Overall, the pattern of choice evaluation for vmPFC patients was different than that of control groups and demonstrated a need for the vmPFC patients to minimize the complexity of the task when comparing the multiple attributes between the multiple options. In other words, if the information is complex, or too many options and/or attributes are present, Fellows (2006) hypothesizes that vmPFC patients adapt by adopting a different decision strategy (Fellows 2006). This pattern of behavior is consistent with other reports that vmPFC patients have difficulty with abstraction, especially when the situation, or consequences related to the situation, is not immediately apparent or present (Camille, Coricelli et al. 2004, Anderson, Barrash et al. 2006, Moretti, Dragone et al. 2009). Notably, again, the stimuli
used in this multi-attribute task were not comprised of affective content, supporting the view that the information processing deficits of vmPFC functionality are not specific to emotion.

2.5. Reinterpreting vmPFC Patient Contribution to the Emotion-Reason Debate

It is possible that the deficits observed in vmPFC patients when making moral judgments and decisions is a general deficit in the capability to make value assessments and not a specific deficit in emotion processing and/or regulation. After all, the ability to make moral judgments does involve evaluation, that is, the assessment of value. As has been demonstrated above, if the vmPFC is responsible for value assessment regardless of whether emotional content is present, then vmPFC patients would have difficulty making value judgments in any task, no matter the content. In addition, if vmPFC patients particularly have difficulty making value assessments in tasks that involve complexity and the comparison of multiple attributes, especially if what is being valued involves abstract concepts, then vmPFC patients would especially demonstrate deficits. With this in mind, I reinterpret vmPFC patient performance in Greene, Sommerville et al. (2001)’s battery of dilemmas as well as descriptions of vmPFC behavior in the real world and their performance in other laboratory tasks using the information processing perspective of vmPFC functionality.

2.5.1. Reinterpreting vmPFC Patient Performance on Greene, Sommerville et al. (2001)’s Battery of Dilemmas

While vmPFC patients undoubtedly make different moral judgments in personal moral dilemmas compared to control groups, it should be noted that in one study, there was no difference between vmPFC patients and controls in the personal moral dilemmas until the personal moral dilemmas were further divided into high and low conflict (Koenigs, Young et al. 2007) and critics argue that this post-hoc divide to assert the moral content of the dilemmas is arbitrary (Kahane and Shackel 2010, Kahane 2012). In addition, in two of the four studies, the differences between
vmPFC patients and healthy controls were only marginally significant (p ≥ 0.05 and p = 0.04, respectively) (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007), while the clear significant difference found in one of these studies was actually between vmPFC patients and other, brain-damaged controls (p = 0.006) (Koenigs, Young et al. 2007). In fact, in each of the four studies, vmPFC responses to non-moral, impersonal moral, and personal moral dilemmas were approximately 50%, plus or minus 10 (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011), a possible indication of an overall randomness in response. In addition, RTs were also faster when vmPFC patients made the utilitarian judgments in personal moral dilemmas compared to the control groups (Ciaramelli, Muccioli et al. 2007), indicating a lack of deliberative reasoning that is typically associated with making utilitarian judgments (Greene, Morelli et al. 2008). Therefore, if vmPFC patients are making more utilitarian responses, which are supposed to be based on reasoning areas of the brain and associated with longer deliberation times, their short RTs argue otherwise, that being, that the patients are either not attending to the stimuli at hand or using a simple rule of thumb, or heuristic, to quickly guide their judgments.

The use of heuristics in not uncommon in judgment and decision-making, even in normal populations, or as applied to morality (Sinnott-Armstrong, Young et al. 2010, Gigerenzer and Gaissmaier 2011). Importantly, individuals do not have to be conscious of using them (Gigerenzer and Gaissmaier 2011). Heuristics can often be the reliance on quick, gut-based intuitive judgments or some other factor, such as using a single information indicator in order to make a quick judgment or choice. One possible explanation for why vmPFC patients may make more utilitarian judgments in personal moral dilemmas is that in order to minimize the complexity of the information presented in the dilemmas, vmPFC patients use a heuristic to more easily guide their judgments.
Specifically, vmPFC patients could be relying on outcome information alone in order to minimize the complexity of the multiple attributes and abstract concepts described in the dilemmas, especially since the outcome question is the last information presented to the participants (e.g., “Would you push the stranger on to the tracks in order to save the five workmen?” (Koenigs, Young et al. 2007)). It is possible that after reading the scenarios, which are arguably complex and abstract, vmPFC patients make their judgments solely based on the last information presented in the scenario, that being information about the outcome.

In support of this hypothesis, when analyzing the dilemmas used by Koenigs, Young et al. (2007), which were taken from Greene, Sommerville et al. (2001)’s battery of dilemmas and also used, at least in part, in Ciaramelli, Muccioli et al. (2007), Thomas, Croft et al. (2011), and Moretto, Ladavas et al. (2010)’s experiments, there is a marked difference in levels of complexity between the dilemma categories. One way to measure complexity is word count. When the word count averages for each type of dilemma is compared, descriptive statistics supports the notion that there is an increase in complexity from non-moral to personal moral dilemmas, including both low- and high-conflict (Table 1).

One-way ANOVA reveals a significant difference of word count between the type of dilemmas used when comparing non-moral, impersonal moral, and personal moral (F (2,47) = 11.44, p < 0.000) and non-moral, impersonal moral, personal moral low-conflict, and personal moral high-conflict (F (3, 46) = 8.44, p < 0.000) dilemmas. Post-hoc analyses using Tukey’s Honest Significant Difference (HSD) test reveals significance differences between non-moral and personal moral (p < 0.000) dilemmas, specifically between both non-moral and personal low- (p < 0.05) and high- (p < 0.000) conflict dilemmas. Notably, significant differences were not observed between impersonal and personal moral dilemmas (p = 0.10), no matter if it were personal low- (p
and high- (p = 0.07) conflict dilemmas. A significant difference was also not observed between impersonal and non-moral dilemmas (p = 0.13). However, when using t-tests to determine the significance between just two of the dilemma types, a significant difference between impersonal and personal moral dilemmas (t (30) = -2.14, p < 0.05) but not between impersonal moral and non-moral dilemmas (t (27) = -1.96, p = 0.06) was found, indicating non-moral and impersonal moral dilemmas are similar in word count complexity.

If the vmPFC is responsible for processing outcome value and comparing the value between options in even the simplest judgment and decision-making scenarios, especially when value processing and comparison requires future projections, as in expected value, then it would not be surprising that vmPFC patients would have marked difficulty when making value judgments in situations that are arguably complex and abstract. One hypothesis is that vmPFC patients may just be randomly responding to these dilemmas, due to each dilemma category being complex to some degree and the patients not being able to process and compare value assessments, as indicated by their average response rates and fast RTs as well as the additional research findings that vmPFC patients have deficits in even simple value assessments (Fellows and Farah 2003, Hornak, O'Doherty et al. 2004, Fellows and Farah 2005, Fellows 2006, Fellows 2007, Tsuchida, Doll et al. 2010, Camille, Griffiths et al. 2011, Camille, Griffiths et al. 2011, Camille, Tsuchida et al. 2011, Henri-Bhargava, Simioni et al. 2012).

Another hypothesis that is being presented here is that vmPFC patients may just be relying on outcome information alone in all three types of dilemmas (non-moral, impersonal moral, personal moral). This second hypothesis supports findings from Kahane and colleagues (Kahane and Shackel 2008, McGuire, Langdon et al. 2009, Kahane and Shackel 2010, Kahane 2012, Kahane, Wiech et al. 2012, Kahane 2015, Kahane, Everett et al. 2015), who, in an attempt to
determine the validity of Greene and colleagues’ conclusion that utilitarian and deontological moral judgments recruit distinct neural systems, measured a selection of Greene, Sommerville et al. (2001)’s battery of dilemmas using functional imaging while controlling for content (utilitarian or deontological judgments) and intuitiveness of the judgment (intuitive or counterintuitive). Kahane and colleagues were interested in whether Greene and colleagues’ results could be more simply explained by whether the judgments were easy, intuitive or more difficult, counterintuitive regardless of the content. Results demonstrated that utilitarian/deontological and intuitive/counterintuitive judgments did not activate the same brain regions found in Greene and colleagues’ studies. Instead, when content was controlled, there was considerable overlap in the activated neural regions associated with judgment, a finding that challenges the claim that utilitarian and deontological moral judgments recruit distinct brain regions. Importantly, activation of the OFC was consistent regardless of whether the judgment was utilitarian/deontological or intuitive/counterintuitive. The researchers suggest that the content categorizations of utilitarian and deontological judgments can be more simply explained by how intuitive the judgment is (Kahane, Wiech et al. 2012). Specifically, counterintuitive judgments, which are associated with deontological judgments, are inherently more complex due their counterintuitive nature. Further, the fact that the OFC was active regardless of whether the judgments were intuitive/counterintuitive or utilitarian/deontological supports the role of the OFC as a common neural currency used to compare values for multiple options. In other words, individuals with vmPFC damage would inherently have difficulty in both intuitive and counterintuitive scenarios and would especially have more difficulty making relative value judgments in complex, counterintuitive scenarios rather than in simpler, intuitive scenarios.
The use of vmPFC patients using outcome information as a heuristic may be evident in other moral psychology tasks that do not use the dilemmatic approach. Researchers have found that when evaluating the permissibility of actions, vmPFC patients tend to ignore certain types of information while focusing solely on other types of information. Specifically, these tasks measure whether participants use cognitive ToM (e.g., an agent’s intentionality) or outcome information when judging the moral permissibility of actions that require different types of harm, such as accidental or attempted harm. Specifically, vmPFC patients’ permissibility judgments were measured using scenarios in which intention information, outcome information, or both were manipulated (Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012). Take, for instance, one such scenario:

Grace and her friend are touring a chemical plant when Grace and her friend decide they want coffee. While Grace is preparing cups of coffee, her friend asks for sugar. Grace either knows, or does not know, that the white powdery substance in the container labeled “Sugar” is, or is not, sugar (i.e., intention manipulation) resulting in different outcomes (i.e., outcome manipulation) that are categorized as “No Harm” (e.g., Grace thinks the substance is sugar, prepares her friend’s cup of coffee, her friend drinks the coffee and is fine; neutral intention, neutral outcome), “Accidental Harm” (e.g., Grace thinks the substance is sugar, but instead it is a toxic chemical, prepares her friend’s cup of coffee, her friend drinks the coffee and dies; neutral intention, negative outcome), “Attempted Harm” (e.g., Grace thinks the substance is a toxic chemical, prepares her friend’s cup of coffee anyway, her friend drinks the coffee and survives; negative intention, neutral outcome), and
“Successful Harm” (e.g., *Grace thinks the substance is a toxic chemical, prepares her friend’s cup of coffee anyways, her friend drinks the coffee and dies; negative intention, negative outcome*). (Refer to Table 2 for a 4x4 representation of the intention and outcome manipulations associated with this scenario.)

Both healthy and other, brain damaged patient control groups rate, from least to most permissible the following: Successful Harm (e.g., intentional, first degree murder), Attempted Harm (e.g., attempted murder), Accidental Harm” (e.g., manslaughter), and No Harm. However, vmPFC patients displayed a different pattern of permissibility judgments. From least to most permissible, vmPFC patients reverse the order of Attempted and Accidental harm. Refer to Table 3 for a detailed description of control group and vmPFC patient performance.

Authors from this study conclude that vmPFC patients neglect crucial ToM information of the agents and instead make judgments based on the outcome information alone. Indeed, this seems to be the case when evaluating the outcome of the actions (i.e., Successful Harm, Accidental Harm, Attempted Harm, No Harm). Both Successful Harm and Accidental Harm result in a negative outcome (i.e., death) whereas Attempted Harm and No Harm do not. In other words, vmPFC patients rated the permissibility of the actions based on what the outcome result would be rather than the intention behind it (Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012). Refer to Table 4.

Further, in order to explore whether foreshadowing of the outcome was affecting vmPFC patient assessment of the scenarios, a second study measured participant behavior when belief states were introduced before the knowledge of whether the powder was sugar or a toxic chemical. Control groups and vmPFC patients demonstrated similar results, suggesting that vmPFC patients
were not subject to a bias of the first information received. However, when outcome information was taken out of the scenarios entirely, while vmPFC patient rating of Accidental and Attempted harms did not match controls groups in magnitude, the order of vmPFC patients ratings of Attempted and Accidental harm switched. In other words, when there was no outcome information to rely on, vmPFC patients’ preference order of permissibility judgments mimicked that of control groups, as exemplified in Table 4b (Ciaramelli, Braghittoni et al. 2012).

These results support the notion that vmPFC patients rely on outcome information for their judgment of permissibility in these types of scenarios (Young and Dungan 2012). Whether it is because the patients strive to minimize option evaluation, particularly in complex, emotional, and abstract moral dilemmas, is undetermined; however, it is reasonable to suggest that this may be the case.

Further, the authors from these non-dilemma studies suggest a role for the vmPFC in intentionality (Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012), a theory that has also been supported in electroencephalogram (EEG) and functional imaging studies (Decety and Cacioppo 2012, Decety, Michalska et al. 2012, Escobar, Huepe et al. 2014, Li, Yang et al. 2016). However, perhaps the use of the words “emotion”, and now “intention”, are not the right level of description when describing the decision deficits of these patients. Instead, vmPFC patients may be using a different decision strategy than control groups in order to minimize task complexity due to having general information processing difficulty in assessing the value associated with the task attributes, options, and abstraction.
2.5.2. Reinterpreting vmPFC Patient Behavior in the Real World and on other Laboratory Tasks

The information processing perspective of vmPFC patient behavior can explain not only patient performance on the above moral judgment tasks but also other observations of vmPFC aberrant behavior in both the real world and abnormal performance on emotion and moral cognition laboratory tests.

For one, vmPFC patients fail to demonstrate subjective expressions of emotion through embodied emotion by demonstrating less attenuation of their anticipatory SCRs to situations that are emotionally salient when compared to control groups. Their lack of SCRs has been exemplified in Bechara, Damasio et al. (1994)’s IGT as well as in Moretto, Ladavas et al. (2010)’s moral dilemma experiments. It has also been found during vmPFC patients’ passive viewing of emotionally salient moral visual scenes (Damasio, Tranel et al. 1990) and has been used as evidence of the SMH in that physiological expressions of emotion is necessary to guide judgment and decision-making (Damasio 1994, Bechara, Damasio et al. 2000). First, if the vmPFC is implicated in the processing of expected values, that being the projected value of future stimulus-outcome associations, then it is not surprising that vmPFC patients have difficulty producing anticipatory responses to stimuli, that being the ability to anticipate future outcomes. Indeed, it has been shown that vmPFC patients have marked difficulty making future projections about value (Camille, Coricelli et al. 2004, Fellows and Farah 2005). Without the ability to project what the anticipated outcome of a stimulus is, there would be no need for the vmPFC patients to feel anxious about what they are viewing or regret what they have missed. Second, there is recent evidence that the vmPFC controls top-down attention to relevant stimuli, another deficit that falls under the umbrella of basic information processing (Hornak, O'Doherty et al. 2004, Lim, O'Doherty et al.
In other words, in addition to vmPFC patients having information processing deficits in value assessment, vmPFC patients may also be making the different judgments and decisions that they do because they have information processing deficits of the top-down control of attention to salient features of situation or task. If this is the case, then it is likely that vmPFC patients, especially in Damasio, Tranel et al. (1990)’s experiment that measured a lack of attenuation of vmPFC patient SCR while passively viewing moral pictures, were not attending to the salient information in the first place. Third, the vmPFC is reciprocally connected with the hypothalamus, which controls autonomic visceral states. If the vmPFC is not getting the information it needs to process and compare the values of stimuli, then there is no information to be sent to the hypothalamus to indicate emotional reactivity. In other words, input deficiency will result in deficient outcomes (Huebner, Dwyer et al. 2009).

Further, there is some evidence that suggests that adult-onset vmPFC lesions do not affect long term storage of previously learned information (Ostlund and Balleine 2005). This may explain why early-onset vmPFC patients fail to learn social and moral norms whereas late-onset vmPFC patients can recall previously learned social and moral knowledge but have difficulty adhering to such knowledge, often due to poor impulse control (Ackerly and Benton 1947, Eslinger and Damasio 1985, Saver and Damasio 1991, Anderson, Bechara et al. 1999, Barrash, Tranel et al. 2000, Anderson, Barrash et al. 2006, Boes, Graff et al. 2011). A lack of impulse control is often described as having poor cognitive control over emotional processes but can also be explained by the hypothesized role of the vmPFC as a common neural currency. In this context, vmPFC patients may have difficulty deciding what to do with certain value signals after they are computed in other, disparate areas of the brain. For instance, if the vmPFC is necessary in value comparison as a center of the brain to calculate common neural currency, then without a properly functioning
vmPFC, these disparate value signals would not have a place to be normalized, sorted, and weighed. Thus, there would not be a stopping, regulatory process while comparing values before a judgment or decision is made and instead, whichever value signal is computed first, timing wise, may be the value signal that determines the behavior of the patient. In support of this hypothesis, often the value signals that are computed first are ones that are relayed from reward and emotion centers of the brain, that being the ventral striatum and amygdala (Decety and Cacioppo 2012, O'Doherty, Cockburn et al. 2017). Such value signals often result in poor choices and lack of impulse control (Steinberg 2007) and judgments and decisions made solely off of impulses and desires do not always adhere to social and moral norms.

The vmPFC has also been implicated in empathy (Shamay-Tsoory 2011, Reniers, Corcoran et al. 2012, Sebastian, Fontaine et al. 2012, Spikman, Timmerman et al. 2012), especially affective, and not cognitive empathy (Shamay-Tsoory, Tomer et al. 2005, Shamay-Tsoory and Aharon-Peretz 2007) (although cognitive empathy deficits have been reported (Shamay-Tsoory, Tomer et al. 2003, Shamay-Tsoory, Tomer et al. 2004, Shamay-Tsoory, Aharon-Peretz et al. 2009, Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012)). vmPFC patients also have marked difficulty in objectively recognizing the emotional states of others, especially when looking at facial expressions (Hornak, Rolls et al. 1996, Blair and Cipolotti 2000, Spikman, Timmerman et al. 2012, Tsuchida and Fellows 2012). However, these results could be also be explained by information processing deficits of attention (Hornak, O'Doherty et al. 2004, Lim, O'Doherty et al. 2011, O'Doherty 2014, Wolf, Philippi et al. 2014). In one study which aimed to measure the attention orientation of vmPFC patients using eyetracking while completing an emotion identification task of faces, vmPFC patients avoided looking at the eye region of faces, a crucial area for reading the emotions of others (Wolf, Philippi et al. 2014). If the vmPFC is also implicated
in the cognitive control of attention, then once again an input deficient explanation for vmPFC patients as a general information processing deficit can be applied. In other words, vmPFC patients may be missing the salience of the information because they are simply not attending to it.

Notably, vmPFC patients report subjectively experiencing emotion, so they are not emotionally void, per se. Self-report of vmPFC patients indicates that vmPFC damage results in a disruption of the subjective experience of emotion (Damasio, Tranel et al. 1990, Bechara, Damasio et al. 2000) in that patients are reported as having both increased and decreased emotional profiles. Specifically, vmPFC patients have increased emotional reactivity, often as a result of their diminished capability to behaviorally control negative emotions, such as anger and frustration (Grafman, Schwab et al. 1996, Barrash, Tranel et al. 2000, Anderson, Barrash et al. 2006, Koenigs and Tranel 2007). Often described as apathy (Barrash, Tranel et al. 2000, Anderson, Barrash et al. 2006, Njomboro, Humphreys et al. 2014), decreased emotions of vmPFC patients have also been observed, specifically for embarrassment, disgust, envy, guilt, regret, shame, compassion, and empathy (Damasio 1994, Eslinger 1998, Beer, Heerey et al. 2003, Camille, Coricelli et al. 2004, Koenigs and Tranel 2007, Krajbich, Adolphs et al. 2009, Koenigs, Kruepke et al. 2010, Ciaramelli, Sperotto et al. 2013). Observations of vmPFC patients acting out in aggressive manners, such as in tasks that measure cooperation and trust in economic exchange (Koenigs and Tranel 2007, Krajbich, Adolphs et al. 2009) may just be the negative emotions felt by any subject that, in the case of vmPFC patients, can again be explained by not having a common neural currency valuation center required for impulse regulation. Likewise, the common neural currency view of the vmPFC can also explain why these patients choose options in these economic games that benefit themselves more than others. Therefore, without an area of the brain necessary for value comparison before a judgment or decision is made, once again, whichever value signal was
computed first may be the value signal that determines the behavior of the patient. In addition, vmPFC patient performance and behavior on these economic tasks can also be explained by the patients lacking the capacity make basic value assessments associated with the information presented to them. Importantly, a study that measured whether vmPFC patients even comprehended the values associated with ultimatum games found that patients were missing crucial information related to the task demands. When researchers made the information of the value associated with the options more apparent, and easier to comprehend through decreased complexity, vmPFC patients performed similarly to controls, in that they cooperated just as often and did not act out in emotionally negative ways. In other words, once the patient’s information processing deficits were compensated for, the abnormal behavior of the patients went away (Moretti, Dragone et al. 2009).

Further, apathy, which is defined by having a lack of emotion, can also be explained by lacking the capability to assess subjective values (Fellows and Farah 2005, Hogeveen, Hauner et al. 2016). If the vmPFC is responsible for assessing the subjective value of stimuli and outcomes, vmPFC patients would have marked difficulty in making any value assessment about the world, especially one that involves subjectivity. In one study that investigated the apathetic responses of vmPFC patients regarding experience of regret, vmPFC patients failed to report feeling regret as well as failed to adjust their behavior based on learned and anticipated outcomes (Camille, Coricelli et al. 2004). Subjective value relies on having made a previous stimulus-outcome association in the past and/or at least being able to make one in the present. If an individual cannot compute stimulus-value associations in the first place, how could they even compute a subjective value? Also, without the ability to compute expected values, which require future projections of
stimulus-outcome associations, how would a patient be able to anticipate the future, as in the case of planning and regret?

### 2.6. Conclusion

While current explanations of vmPFC functionality have incorporated the role of the vmPFC in value assessment in moral cognition (Moretti, Dragone et al. 2009, Shenhav and Greene 2010, Hu and Jiang 2014, Shenhav and Greene 2014, Blair 2015), these explanations have still largely embraced emotion-centric views of vmPFC functionality. The alternative perspective of vmPFC functionality in basic information processing as proposed in this manuscript suggests an independence from an explanation that incorporates emotion.

Importantly, the information processing perspective of vmPFC functionality also explains vmPFC patient deficits in judgment and decision-making in tasks that do not incorporate affective content whereas the emotion view of vmPFC functionality cannot. Therefore, describing vmPFC functionality in terms of selective emotion processing and/or regulation and vmPFC patient deficits in terms of emotional dysfunction does not take into account all of the other studies that support the functional role of the vmPFC outside of emotional processing and/or regulation nor vmPFC patients deficits in judgment and decision-making tasks that are void of emotional content.

In addition, it should not be surprising that the vmPFC is implicated in emotion processing and/or regulation because both of these processes require the assessment of value. In many of these tasks, some form of value assessment is required. Specifically, emotionally provocative stimuli incite subjective valuation (Winecoff, Clithero et al. 2013). If the vmPFC is involved with determining the subjective value of stimuli, then the vmPFC would be involved in emotion processing. Further, studies that have measured emotional regulation typically involve reappraisal of stimuli and outcomes (Kanske, Heissler et al. 2011, Vrticka, Sander et al. 2011), a process that
involves the re-evaluation of stimuli, similar to reversal learning. If the vmPFC is involved in evaluation and reevaluation of stimuli and outcomes, then it makes sense that the vmPFC would be involved. Likewise, it should not be surprising that the vmPFC would also be activated during social and moral cognition tasks, as these domains also require evaluation and often involve judgments of the situations at hand.

In conclusion, because the vmPFC has been implicated in basic information processing of value assessment instead of specific involvement in emotion processing and/or regulation, I suggest that vmPFC patient performance on moral psychology tasks should not be used a causal evidence that emotion is cognitively necessary for moral judgment. Instead, the term ‘emotion’ may not be the correct level of description to explain vmPFC functionality and vmPFC patient deficits. Instead, the vmPFC plays a critical role in assessing the value of every stimuli, option, and outcome. The behavioral deficits of vmPFC patient may look like deficits in emotion; however, these deficits are due to a dysfunctional basic information processing inputs rather than a dysfunction in emotion.
2.7. Tables

<table>
<thead>
<tr>
<th>Dilemma Type</th>
<th>Total</th>
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<th>Question</th>
</tr>
</thead>
<tbody>
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<td>Non-Moral</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>94.56 (17.67)</td>
<td>76.22 (17.46)</td>
<td>18.33 (3.99)</td>
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<tr>
<td>Moral, Impersonal</td>
<td>N = 11</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>107.45 (16.35)</td>
<td>91.82 (15.55)</td>
<td>15.64 (2.01)</td>
</tr>
<tr>
<td>Moral, Personal (all)</td>
<td>N = 21</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>121.06 (18.19)</td>
<td>102.67 (17.19)</td>
<td>18.05 (2.96)</td>
</tr>
<tr>
<td>Moral, Personal, Low Conflict</td>
<td>N = 8</td>
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<td></td>
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<tr>
<td></td>
<td>114.13 (19.19)</td>
<td>97.25 (15.55)</td>
<td>16.88 (1.89)</td>
</tr>
<tr>
<td>Moral, Personal, High Conflict</td>
<td>N = 13</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>124.77 (14.52)</td>
<td>106.00 (13.52)</td>
<td>18.77 (3.14)</td>
</tr>
</tbody>
</table>

**Table 1.** Descriptive statistics of average word count for each type of dilemma (non-moral, impersonal, personal) for Total (scenario and question), Scenario (scenario only), and Question (question only) word counts. Mean word count in parentheses. Original data from Koenigs, Young et al. (2007)’s supplementary information.

<table>
<thead>
<tr>
<th>Intention</th>
<th>Neutral</th>
<th>Outcome</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neutral</td>
<td></td>
<td><strong>No Harm:</strong></td>
<td><strong>Accidental Harm</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grace thinks the powder is sugar.</td>
<td>(e.g., accidental murder; manslaughter):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It is sugar.</td>
<td>Grace thinks the powder is sugar.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Her friend is fine.</td>
<td>It is toxic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Her friend dies.</td>
</tr>
<tr>
<td>Negative</td>
<td>Attempted Harm</td>
<td><strong>Attempted Harm</strong></td>
<td><strong>Successful Harm</strong></td>
</tr>
<tr>
<td></td>
<td>(e.g., attempted murder):</td>
<td>Grace thinks the powder is toxic.</td>
<td>(e.g., intentional, first degree murder):</td>
</tr>
<tr>
<td></td>
<td></td>
<td>It is sugar.</td>
<td>Grace thinks the powder is toxic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Her friend is fine.</td>
<td>It is toxic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Her friend dies.</td>
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</tbody>
</table>

**Table 2.** Corresponding 4x4 Diagram of Intention and Outcome information from Young, Bechara et al. (2010), borrowed with permission and reformatted here.
Table 3. Comparison of Control Groups and vmPFC Patient Performance. Preference order of permissibility judgments for control groups (healthy controls (HC), brain-damaged controls (BDC)), and vmPFC patients. Gray shadowing highlights crucial information.

(a) vmPFC Performance Table with Corresponding Intentionality and Outcomes.

<table>
<thead>
<tr>
<th>Permissibility Judgment</th>
<th>Control Groups</th>
<th>vmPFC Patients</th>
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<tbody>
<tr>
<td>Negative</td>
<td>Successful Harm</td>
<td>Successful Harm</td>
</tr>
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<td></td>
<td>Attempted Harm</td>
<td>Accidental Harm</td>
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<td>Accidental Harm</td>
<td>Attempted Harm</td>
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<td>Neutral</td>
<td>No Harm</td>
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(b) Control Group Performance Table with Corresponding Intentionality and Outcomes.

<table>
<thead>
<tr>
<th>Permissibility Judgment</th>
<th>Corresponding Intentionality</th>
<th>Corresponding Outcome</th>
</tr>
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<tbody>
<tr>
<td>Negative</td>
<td>Successful Harm</td>
<td>Negative</td>
</tr>
<tr>
<td></td>
<td>Attempted Harm</td>
<td>Negative</td>
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<td></td>
<td>Accidental Harm</td>
<td>Neutral</td>
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<td>Neutral</td>
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Table 4. Participant Performance with Corresponding Intentionality and Outcomes Ranking. (a) Corresponding intentionality and outcomes associated with vmPFC patient permissibility judgments. (b) For comparison to (a), corresponding intentionality and outcomes associated with control groups permissibility judgments. Gray shadowing highlights crucial information.
2.8. References


Lim, S. L., J. P. O'Doherty and A. Rangel (2011). "The decision value computations in the vmPFC and striatum use a relative value code that is guided by visual attention." Journal of Neuroscience 31(37): 13214-13223.


resonance imaging investigation of basic and moral emotions." Journal of Neuroscience 22(7): 2730-2736.


The second manuscript of this dissertation, indexed as Chapter 3, addresses moral cognition studies using individuals with psychopathy, focusing on studies that correlate psychopathic performance on moral cognition tasks with the multidimensional characteristics that are used to diagnose psychopathy. In this manuscript, I evaluate whether abnormal moral performance of psychopaths correlates with having deficits with emotion, as assessed by having a lack of affective characteristics. I find that abnormal performance is instead correlated with deficits in interpersonal and lifestyle characteristics of psychopathy, with lifestyle characteristics reflecting deficits in both information processes of attention as well as cognitive control deficits in inhibition. From this, I continue to argue the information processing perspective.
CHAPTER THREE: Does Psychopathy Support Claims that Emotion is Necessary for Moral Cognition? The answer is also 'No'.

3.1. Abstract

The observations and measurements of poor social and moral behavior of those diagnosed with psychopathy along with one of the main criteria of psychopathy being an affective disorder have been used to support the notion that emotion is cognitively necessary to behave in morally appropriate ways. However, an affective deficit may not be the appropriate explanation of why psychopaths display the immoral behaviors that they do. Instead, individuals with psychopathy have notable information processing deficits that may account for their behavioral abnormalities. One way to determine the influential factors behind psychopathy aberrant moral behavior and abnormal cognition is to evaluate which diagnostic Factors and facets of psychopathy correlate with moral performance. A criminal diagnosis of psychopathy includes categories of interpersonal, affective, lifestyle, and antisocial facets; therefore, a diagnosis of psychopathy alone does not necessarily imply a deficit in affect. The work in this manuscript highlights that both the interpersonal and lifestyle, but not affective, facets of psychopathy correlate with abnormal moral cognition of psychopaths. Specifically, a Factor divide of psychopathy does not support an affective deficit, as it is the interpersonal, not affective, facet of psychopathy that seems to be driving Factor 1 effects. Further, psychopathy moral cognition is associated with deficits in the lifestyle facet of Factor 2, which align with information processing and cognitive control etiologies of psychopathy. A detailed diagnosis of a Factor and facet divide as well as controlled experimentation in order to rule out information processing confounds need to be included in research methodology before an exclusive deficit of affect is determined.
3.2. Introduction


One population of individuals who have been used in both pop culture and in the scientific community as evidence that emotion is cognitively necessary to behave in morally appropriate ways are those who display psychopathic tendencies. Psychopathy is clinically defined as having multidimensional maladaptive personality characteristics in four categorical dimensions which remain relatively stable throughout one’s lifespan (Hare 1993, Harpur and Hare 1994). These dimensions are interpersonal, affective, lifestyle, and antisocial (Hare 1991, Hare 2003). Importantly, theories regarding the etiology of psychopathy largely suggest that psychopathic interpersonal, lifestyle, and antisocial behavioral deficits can be explained by having a deficit in affect, that is, in feeling emotion and understanding the emotional experiences of others (Cleckley
Affective deficits in psychopathy are identified as, but are not limited to, behaviors such as displaying a lack of remorse or guilt, having an overall shallow affect, and acting with callousness and a lack of empathy (Hare 1991, Hare 2003). Importantly this affective deficit is independent from having decreased intelligence and reasoning capabilities. Accounts of psychopathy have noted that while psychopathic individuals have intact intelligence that is measurably similar to control groups (Cleckley 1976/1941, Sutker, Moan et al. 1983, Hare 1984, Sutker and Allain 1987, Hart, Forth et al. 1990), as well as intact logic and reasoning capabilities in certain paradigms (e.g., the Logical Cognition Tasks such as the Pendulum and Balance tests (Inhelder and Piaget 1958)), unlike non-psychopaths, psychopaths fail to exhibit any kind of emotional response (Cleckley 1976/1941, Hare 1993), including, but not limited to, subjectively feeling emotion, as in displaying a lack of physiology responses to affective stimuli (Simon, Holzberg et al. 1951, Lykken 1957, Hare and Craigen 1974, Hare 1978, Hare 1978, Hare, Frazelle et al. 1978, Fowles 1993, Patrick 1994, Levenston, Patrick et al. 2000, Newman and Lorenz 2003, Patrick 2008), behaviorally demonstrating a lack of affective empathy (Shamay-Tsoory, Harari et al. 2010, Gray, Jenkins et al. 2011), or being able to objectively detect the emotional states of others by identifying facial, vocal, or verbal expressions (Blair, Jones et al. 1997, Blair and Coles 2000, Blair, Colledge et al. 2001, Blair, Mitchell et al. 2002, Richell, Mitchell et al. 2003, Blair, Mitchell et al. 2004, Verona, Patrick et al. 2004, Blair, Budhani et al. 2005, Richell, Mitchell et al. 2005, Blair 2006, Deeley, Daly et al. 2006, Dolan and Fullam 2006, Book, Quinsey et al. 2007, Hastings, Tangney et al. 2008, Patrick 2008, Bagley, Abramowitz et al. 2009, Marsh and Cardinale 2012). These theories posit that psychopaths display abnormal

However, there are other theories as to why psychopathic individuals behave the way they do. Specifically, instead of having specific deficits in emotion, psychopathy may be caused by having deficits in the ability to process basic information as in deficits in top-down, cognitive control of attention (Newman, Patterson et al. 1990, Newman and Lorenz 2003, Hiatt, Schmitt et al. 2004, Kiehl 2006, Glass and Newman 2009, Zeier, Maxwell et al. 2009, Newman and Baskin-Sommers 2011). Specifically, psychopaths have notable deficits in the ability to attend to salient features of stimuli (Patterson and Newman 1993, Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011, Newman and Baskin-Sommers 2011, Larson, Baskin-Sommers et al. 2013, Zeier and Newman 2013, Hoppenbrouwers, van der Stigchel et al. 2015) in paradigms that measure both attention and response inhibition (Munro, Dywan et al. 2007, Munro, Dywan et al. 2007, Zeier and Newman 2013) as well as in tasks that measure electroencephalogram (EEG) event related potentials (ERP) that index attentional processes during both affective (Howard and McCullagh 2007) and non-affective (Raine and Venables 1988, Kiehl, Hare et al. 1999) contexts (but see Jutai, Hare et al. (1987) and Raine and Venables (1988) for differential results). Interestingly, the attention deficits of psychopathy seem to be specific when attentional demands increase, as psychopathic individuals have intact early attention but difficulties keeping their attention as time goes on. Because of this, and referred to as the response inhibition theory of psychopathy, psychopaths are believed to make behavioral decisions solely based on information
that is presented early in time and have difficulties in adjusting their behavioral responses as time passes because they are no longer attending to new and updated information (Levenston, Patrick et al. 2000, Baskin-Sommers, Curtin et al. 2011, Larson, Baskin-Sommers et al. 2013).

Psychopathy is also associated with cognitive control deficits, as in the top-down control of behavior. Known as inhibition (i.e., impulse control), psychopaths are believed to have deficits in the ability to control and regulate their behaviors, often resulting in reactive aggression against others (Blair 1995, Blair, Mitchell et al. 2005, Kiehl 2006, Patrick 2008). The response modulation theory of psychopathy accounts for these cognitive control deficits by asserting that psychopaths lack of inhibition is caused by information processing deficits of attention (Pham, Vanderstukken et al. 2003, Vitale, Newman et al. 2005, Zeier, Maxwell et al. 2009). In other words, because psychopathic individuals only pay attention and respond to information presented early in time, they neglect information updates and continue to respond as if the updated information were not present (Levenston, Patrick et al. 2000, Baskin-Sommers, Curtin et al. 2011, Larson, Baskin-Sommers et al. 2013).

It is possible then, that the abnormal moral cognition and behaviors of psychopaths are due basic information processing disruptions rather than to deficits in emotion. One way to pinpoint whether psychopathy is correlated with deficits in emotion or other types of disruption is to perform multidimensional analyses of the characteristics that make up psychopathy (Sokal 1974, Blackburn, Logan et al. 2008). Specifically, since psychopathy is composed of a multidimensional construct of interpersonal, affective, lifestyle, and antisocial categories, correlating which categories are associated with abnormal responses on moral cognition tasks could shed light on which deficits contribute to the aberrant social and moral behaviors of psychopaths. Importantly, because of the multidimensional nature of psychopathy diagnoses, not every psychopath has the
exact same pattern of deficits across dimensions and it cannot be assumed that every diagnoses of psychopathy includes significant deficits in the affective dimension.

Interestingly, there is little work that examines the multidimensional correlations of psychopathy diagnosis with performance on moral cognition tasks and no published study to date reviews the evidence that has been found. In line with recent work that has explored multidimensional correlations of psychopathy with performance on tasks that investigate emotion (Patrick 2015), this manuscript reviews published studies in the moral cognition literature that has correlated the multidimensions of psychopathy with moral cognition performance. Because psychopathy is diagnosed using a variety of methods across criminal, general, adult, and adolescent populations, this manuscript first introduces the relevant tools that have been used to diagnose psychopathy in the moral cognition literature and then discusses how each of these tools distinguishes between the interpersonal, affective, lifestyle, and antisocial dimensions. This manuscript then highlights which dimensions based on which diagnostic criteria correlate with abnormal responses on moral psychology tasks, finding that psychopathy is less associated with the affective dimension and more associated with both the interpersonal and lifestyle dimensions, the latter likely due to having deficits in basic information processing deficits of attention.

3.3. Psychopathy Diagnoses

The gold standard for measuring psychopathy is the 20-item clinical and forensic psychopathy interview known as the Psychopathy Checklist (PCL (Hare 1980), most currently the revised version, the Psychopathy Checklist – Revised, PCL-R (Hare 1991, Hare 2003)). Specifically, PCL-R assessment requires a 60 – 90 minute interview as well as clinical and forensic file review in order to score a 20-item psychopathy criterion as 0, 1, or 2. Total scores can range from 0 to 40 with a standard diagnosis of psychopathy including individuals who score 30 and
higher. Individuals who are clinically determined non-psychopaths are those who score 20 and below. Intermediate scores of 21 – 29 are not considered a true diagnoses of psychopathy and, for experimental purposes, are typically excluded from analyses (Hare 2003).

The PCL-R stems from the work of psychiatrist Hervey Cleckley who was the first researcher to clinically describe and outline specific criteria for the diagnoses of psychopathy. Specifically, Cleckley established 16 criteria of psychopathy embracing interpersonal, affective, and antisocial tendencies of the disorder but not in a dimensional fashion (Cleckley 1976/1941). Cleckley's descriptive criteria was later operationalized by researcher Robert Hare, who developed the PCL that embraced both Cleckley's criteria as well as a multidimensional construct (Hare 1980, Cooke, Michie et al. 2007). This multidimensional construct was originally created to reduce population heterogeneity (Hare 1980) and is composed of two distinct categories referred to as Factors that can be further sub-divided into the four distinct dimensional categories of psychopathy referred to as facets. Factor 1 embraces the interpersonal and affective dimensions of the 20-item interview (with each dimension composing of 4-items each) and Factor 2 embraces the lifestyle and antisocial dimensions of the 20-item interview (with each dimension composing of 5-items each; the remaining 2-items that equate the total of the 20-question interview are unclassified) (Hare 1991, Hare 2003). In addition, based on the PCL-R, individuals scoring high on Factor 1 are thought to possess more primary psychopathy characteristics, that is, in being less emotional and less anxious which theoretically enables more instrumental (i.e., intentional and for a purpose) aggression. Likewise, individuals scoring high in Factor 2 are thought to possess more secondary psychopathy characteristics, that is they are highly anxious making them more prone to reactive, and not instrumental, violence (Blackburn 1975, Cleckley 1976/1941, Fagan and Lira 1980, Hare 1991, Patrick and Zempolich 1998, Brinkley, Newman et al. 2004, Newman, MacCoon et al. 2005,
Vassileva, Kosson et al. 2005, Hicks and Patrick 2006, Skeem, Johansson et al. 2007, Koenigs, Kruepke et al. 2012, Gao and Tang 2013). Refer to Table 1 for a breakdown of Factor/facet multidimensional divide of the PCL-R.

Within the clinical and forensic domain, the PCL-R has been adapted into a shorter, 12-item version (Psychopathy Checklist – Screening Version, PCL-SV (Hart, Cox et al. 2008)), a version specific to adolescents between the ages of 12 and 18 (Psychopathy Checklist – Youth Version, PCL-YV (Forth, Kosson et al. 2003)), and a version specific to diagnoses in children (Psychopathy Screening Device, PSD (Frick and Hare in press)). Both the PCL-SV and PCL-YV encompass the PCL-R's two factor and four facet dimensional divides (refer to Table 1). The PSD is also an extension of the PCL-R; however, it is composed of a three factor divide including “Callous-Unemotional Traits”, “Narcissism”, and “Problems with Impulse Control” dimensions (Frick, Bodin et al. 2000, Frick and Hare in press). However, there have been attempts to divide the PSD into the traditional two factor divide with Factor 1 described as the Callous/Unemotional Factor (also referred to as the interpersonal and motivational factor which encompasses interpersonal and affective characteristics such as lack of guilt, empathy, and superficial charm) and Factor 2 described as the Impulsivity/Conduct Problems Factor (also known as the impulsivity and conduct disorder factor which encompasses lifestyle and antisocial characteristics such as impulsivity and delinquency) (Frick, O’Brien et al. 1994, Blair, Monson et al. 2001). Refer to Table 2 for a comparison of the PSD with the PCL-R.

For measuring psychopathy in the general population using self-report, three scales have been primarily used: the Self-Report Psychopathy scale (SRP; 4th edition: SRP-4 (Williams and Paulhus 2004, Williams, Paulhus et al. 2007)), the Levenson Self-Report Psychopathy scale (LSRP (Levenson, Kiehl et al. 1995)), and the Psychopathic Personality Inventory (PPI or PPI for short,
The SRP was the first official self-report version of the PCL-R and measured 64-items associated with psychopathy. Both it and its 29-item short form adhere to the PCL-R's two factor and four facet dimensional divides (Williams and Paulhus 2004, Williams, Paulhus et al. 2007) (refer to Table 1).

The LSRP is a 26-item questionnaire not modeled off of the PCL-R and is meant to measure primary psychopathy, identified through lack of emotional affect, and secondary psychopathy, identified through lifestyle behaviors (Levenson, Kiehl et al. 1995). However, recent research has questioned this theoretical divide and the items that compose it (Wilson, Frick et al. 1999, Brinkley, Schmitt et al. 2001, Lilienfeld and Hess 2001, Miller, Gaughan et al. 2008), concluding that primary psychopathy of the LSRP (indexed by the LSRP Factor 1 scale) closely resembles the interpersonal facet in Factor 1 of the PCL-R due to its correlations with antagonistic personality characteristics such as low agreeableness and high narcissism. Likewise, secondary psychopathy of the LSRP (indexed by the LSRP Factor 2 scale) closely resembles interpersonal and lifestyle facets in both Factors 1 and 2 of the PCL-R due to its correlations with negative emotionality (i.e., neuroticism), general personality traits and disorders, and disinhibition (i.e., a lack of conscientiousness) (Miller, Gaughan et al. 2008). In other words, while the LSRP categorization of primary psychopathy was meant to encompass affective characteristics, it actually reflects the interpersonal, and not affective, facets of the PCL-R. In addition, while the LSRP categorization of secondary psychopathy was meant to encompass lifestyle and antisocial characteristics, and does so through the disinhibition characteristic which is closely related to impulsivity item in the lifestyle facet and poor behavioral controls item in the antisocial facet, it also reflects the interpersonal facet of the PCL-R through negative emotionality (which is the antithesis to having
a lack of affect) and having general personality traits and disorders. Refer to Table 3 for a comparison of the LSRP with the PCL-R.

The PPI is also not modeled off of the PCL-R and has its own identified subfactors of psychopathy, namely, Impulsive Nonconformity, Blame Externalization, Machiavellian Egocentricity, Carefree Nonplanfullness, Stress Immunity, Social Potency, Fearlessness, and Coldheartedness (Neumann, Malterer et al. 2008). These subfactors are grouped into two general uncorrelated factors meant to distinguish psychopathic subtypes: the Fearless/Dominance Factor (composed of Stress Immunity, Social Potency, and Fearlessness subfactors) and the Impulsive/Antisociality Factor (composed of Impulse Nonconformity, Blame Externalization, Machiavellian Egocentricity and Carefree Nonplanfullness subfactors). Importantly, the Coldheartedness subfactor does not correlate significantly with either of the two factors (Benning, Patrick et al. 2003, Benning, Patrick et al. 2005, Neumann, Malterer et al. 2008) (but see Gao and Tang (2013) and Smith, Edens et al. (2011) for evidence that Coldheartedness actually does correlate with the Fearless/Dominance Factor). Some have argued that these two factors parallel PCL-R Factors 1 and 2 with the Fearless/Dominance Factor mirroring the PCL-R Factor 1 and the Impulsive/Antisociality Factor mirroring the PCL-R Factor 2 (Benning, Patrick et al. 2005, Benning, Patrick et al. 2005). However, as suggested here, these two factors do not clearly fit into PCL-R factorial classifications. Specifically, while the Fearless/Dominance Factor of the PPI does embrace characteristics within the interpersonal and affective facets of the PCL-R Factor 1 (i.e., Social Potency, Stress Immunity, and Fearlessness), it also can embrace characteristics of the antisocial facet of the PCL-R Factor 2 (i.e., Social Potency). Likewise, while the Impulsive Antisociality Factor of the PPI does embrace the lifestyle and antisocial facets of the PCL-R Factor 2 (i.e., Impulsive Nonconformity and Carefree Nonplanfullness), it also embraces the interpersonal
(i.e., Machiavellian Egocentricity) and affective (i.e., Blame Externalization) facets of the PCL-R Factor 1. Refer to Table 4 for a comparison of the PPI with the PCL-R.

In addition, other psychopathy measures have been used in the investigation of psychopathy and moral psychology. These additional scales are referred to as Quay's criterion, unspecified psychiatric diagnoses, other psychopathy diagnoses, the Dark Triad, and the Triarchic Psychopathy Measure (TriPM). Quay's criterion was an early measure of psychopathy that was developed in order to identify three subgroups within criminal delinquency, specifically in the juvenile population. These three subgroups are labeled unsocialized-psychopathic, neurotic-disturbed, and socialized-subcultural. Unsocialized-psychopathic individuals are characterized as displaying antisocial behaviors while lacking impulse control, anxiety, and guilt. Neurotic-disturbed individuals are deemed more socialized with antisocial behaviors being related more to inner emotional conflicts rather than a lack of emotion, per se. Socialized-subcultural individuals are also deemed socialized but lack responsiveness to authority figures (Quay and Parsons 1971, Quay 1987). Importantly, Quay's criterion does not adhere to any of the PCL-R Factor or facet multidimensional divides and is mentioned only to report general results that have used Quay's criterion for diagnoses (Jurkovic and Prentice 1977, Lee and Prentice 1988). Likewise, other early studies of psychopathy also diagnosed psychopathy using unspecified psychiatric methods (Simon, Holzberg et al. 1951, Fodor 1973, Link, Sherer et al. 1977) while some notable modern studies of psychopathy use other methods (e.g., van Vugt, Asscher et al. (2012)) which also do not adhere to any of the PCL-R Factor or facet multidimensional divides. These studies are also mentioned in this manuscript to report general results and to reflect a comprehensive review.

The Dark Triad and the TriPM, however, can relate to the PCL-R Factor of facet multidimensional divides. The Dark Triad inherently identifies three different, though related,
malignant personality types that can be related to traditional Factor and facet divides of the PCL-R: Machiavellianism, Psychopathy, and Narcissism. Here, Machiavellianism is defined as manipulativeness, callous affect, and strategic-calculating orientation, corresponding to Factor 1 of the PCL-R, specifically to the conning/manipulative behavior item in the interpersonal facet and the callous/lack of empathy item in the affective facet. Psychopathy, according to the Dark Triad, is related to Machiavellianism in that it is defined as callous manipulation paired with recklessness and thrill seeking, specifically in regard to short-term, or impulsive, interests. This factor corresponds to both Factors 1 and 2 of the PCL-R, specifically as it builds on the Factor 1 associations with Machiavellianism by adding lifestyle facet associations of the items “need for stimulation/proneness to boredom” and “impulsivity”. Lastly, Narcissism according to the Dark Triad is defined as grandiose identity, corresponding specifically to the interpersonal facet of the PCL-R (Paulhus and Williams 2002, Jones and Paulhus 2014). Refer to Table 5 for a comparison of the Dark Triad with the PCL-R.

Likewise, the TriPM inherently identifies three characteristic aspects of psychopathy that can be related to traditional factor and facet divides of the PCL-R: Boldness, Meanness, and Disinhibition. The Boldness scale corresponds to the Factor 1 of the PCL-R, specifically correlated strongly with the interpersonal facet but also has minor correlation with antisocial facets of Factor 2. The Meanness and Disinhibition scales together make up what authors refer to as the Externalizing Spectrum Inventory (ESI) meant to encompass the externalization and inability to control psychopathological behaviors. Within the ESI are two sub-factors, specifically relating to 'callous aggression' and 'addiction'. The 'callous aggression' sub-factor is driven mainly by the Meanness factor, encompassing empathy, excitement seeking, and honesty which corresponds to interpersonal, affective, and antisocial facets of the PCL-R, with the strongest correlation being
with the affective facet. The Disinhibition scale encompasses overall ESI scores and is composed of irresponsibility, impulsivity, and proneness to boredom, corresponding mainly to the lifestyle facet of the PCL-R (Patrick 2010). Refer to Table 6 for a comparison of the TriPM with the PCL-R.

3.4. Psychopathy, Moral Cognition, and Factor/facet Correlations


The following subsections will review what has been found regarding Factor and facet correlations of psychopathy in the moral cognition literature, highlighting that there is weak evidence that supports the notion that affective disruption in psychopathy correlates with abnormal moral performance. The moral cognition literature that has been reviewed here includes performance measurements on moral dilemma tasks (e.g., Greene, Sommerville et al. (2001)’s battery of moral dilemmas), on tasks that measure Intention/Outcome assessments in moral scenarios (Young, Bechara et al. 2010, Ciaramelli, Braghitto et al. 2012), on moral knowledge tasks that use either traditional or modified versions of Turiel (1983)’s moral/conventional distinction task (Turiel 1983) or the Moral Foundation Questionnaire (MFQ (Graham, Haidt et al. 2009, Graham, Nosek et al. 2011)), on moral reasoning tasks that measure Kohlberg (1969)’s Moral Dilemma Questionnaire (MDQ (Kohlberg 1969)), the Defining Issues Task (which is based off of Kohlberg's structured interview and is focused on a component model of moral development (Rest, Cooper et al. 1974)), and the Wason Selectin Task (which measures deductive reasoning.
about social exchange, precautionary, and descriptive rules (Wason 1966)), as well as other tasks that measure moral judgment and decision-making.

3.4.1. Factor 1 Correlations

Across domains and differential methodology in diagnosing psychopathy as well as differential methodology within each domain, psychopathy performance on moral judgment tasks has been largely associated with Factor 1 correlations (Blair, Monson et al. 2001, Glenn, Iyer et al. 2009, Ermer and Kiehl 2010, Glenn, Koleva et al. 2010, Seara-Cardoso, Neumann et al. 2012, Borg, Kahn et al. 2013, Seara-Cardoso, Dolberg et al. 2013, Tassy, Deruelle et al. 2013, Kahane, Everett et al. 2015, Patil 2015, Ritchie and Forth 2016, Pletti, Lotto et al. 2017). Specifically, Factor 1 correlations have been shown in tasks that have found abnormal responses in tasks that measure: (1) moral judgments in moral dilemmas and psychopathy using the SRP (Seara-Cardoso, Neumann et al. 2012, Seara-Cardoso, Dolberg et al. 2013, Ritchie and Forth 2016) and the LSRP (Tassy, Deruelle et al. 2013, Kahane, Everett et al. 2015, Patil 2015, Pletti, Lotto et al. 2017); (2) moral knowledge tested using Turiel (1983)'s moral/conventional distinction paradigm and psychopathy using the PSD (Blair, Monson et al. 2001) as well as the MFQ and psychopathy using the LSRP (Glenn, Iyer et al. 2009); (3) moral reasoning measured using the Wason Selectin Task and psychopathy using the PCL-R (Ermer and Kiehl 2010); and (4) in other moral tasks that measure moral judgment regarding punishment and psychopathy using the PCL-R (Borg, Kahn et al. 2013) and moral identification and psychopathy using the LSRP (Glenn, Koleva et al. 2010). Notably, most Factor 1 correlations have been found in the general population with the exception of one study (Ermer and Kiehl 2010). In addition, correlations of LSRP primary psychology, which is traditionally believed to mirror Factor 1 characteristics of the PCL-R, have been included in this

Importantly, Factor 1 is composed of both the interpersonal and affective facets (refer to Table 1). Therefore, an association with Factor 1 does not rule out non-affective characteristics of psychopathy. In other words, Factor 1 correlations could be driven by the interpersonal, and not the affective, facet of psychopathy. Interestingly, there is ample evidence that it is the interpersonal, and not the affective, facet that has been shown to correlate with abnormal moral performance in these moral cognition tasks (Trevathan and Walker 1989, Chandler and Moran 1990, Dolan and Fullam 2010, Young, Koenigs et al. 2012, Borg, Kahn et al. 2013, Rosas and Koenigs 2014, Almeida, Seixas et al. 2015, Kahane, Everett et al. 2015, Ritchie and Forth 2016, Seara-Cardoso, Sebastian et al. 2016). In addition, because primary psychopathy of the LSRP has been associated with the interpersonal and not affective facet of the PCL-R (Miller, Gaughan et al. 2008) (refer to Table 3), the studies that have found primary psychopathy associations with abnormal moral judgment support interpersonal, and not affective, disruption (Glenn, Iyer et al. 2009, Glenn, Koleva et al. 2010, Tassy, Deruelle et al. 2013, Kahane, Everett et al. 2015, Patil 2015, Pletti, Lotto et al. 2017). Only one study has found an affective facet correlation (Aharoni, Sinnott-Armstrong et al. 2012). In addition, two studies have correlated one of the PCL and PCL-R individual items of the affective facet, "lack of remorse/guilt", with diminished ability to make the moral/conventional distinction (Blair 1995, Blair, Jones et al. 1995).

Specifically regarding the studies that have correlated the affective facet with abnormal moral performance, the one study that determined a correlation with the affective facet measured moral knowledge using a modified version of Turiel (1983)'s moral/conventional task and, measuring psychopathy using the PCL-R, also found significant correlations with the lifestyle and
antisocial facets. Both the affective and antisocial facets predicted overall reduced moral accuracy whereas the lifestyle facet predicted increased moral accuracy. Correlations with the interpersonal facet or with either of the two factors were not found (Aharoni, Sinnott-Armstrong et al. 2012). However, the authors from this study noted that these initial results have notable limitations (Aharoni, Sinnott-Armstrong et al. 2012, Aharoni, Sinnott-Armstrong et al. 2014). Specifically, Aharoni, Sinnott-Armstrong et al. (2012) used a novel moral/conventional task, based loosely, but not exactly, on Turiel (1983)'s moral/conventional distinction task and the sample of psychopathic participants in Aharoni, Sinnott-Armstrong et al. (2012) only composed of six criminals (Aharoni, Sinnott-Armstrong et al. 2012, Aharoni, Sinnott-Armstrong et al. 2014). In order to re-test these results, and to account for these limitations, Aharoni, Sinnott-Armstrong et al. (2012) conducted an additional study using Turiel (1983)'s traditional moral/conventional distinction task and a larger psychopathy group from which no factor nor facet correlations were observed (Aharoni, Sinnott-Armstrong et al. 2014).

In addition, two studies led by psychopathy researcher James Blair and which also used Turiel (1983)'s moral/conventional distinction task to measure moral knowledge found that the lack of remorse/guilt as indexed as an individual item in the PCL and PCL-R, respectively, significantly predicted abilities to distinguish moral from conventional transgressions, meaning that abnormal moral/conventional responses were correlated with the psychopaths' inability to experience remorse and guilt (Blair 1995, Blair, Jones et al. 1995). Specifically, Blair (1995) found that when conducting an individual item analyses of each of the PCL items, only the lack of remorse/guilt item (a feature of the affective facet in Factor 1) significantly predicted abnormal moral/conventional distinctions (Blair 1995). Using similar methodology and the updated PCL-R, Blair, Jones et al. (1995) confirmed and expanded on this result, finding that both the itemized
characteristics of lacking remorse/guilt and early behavioral problems (a feature of antisocial facet in Factor 2) items significantly predicted abnormal moral/conventional distinctions (Blair, Jones et al. 1995). However, this result did not rely on traditional Factor or facet analysis but instead on post-hoc analysis of individuals’ item characteristics, a procedure that is not standard in the field.

More commonly the interpersonal facet (Dolan and Fullam 2010, Young, Koenigs et al. 2012, Borg, Kahn et al. 2013, Ritchie and Forth 2016, Seara-Cardoso, Sebastian et al. 2016) or item characteristics of the interpersonal facet (Trevathan and Walker 1989, Chandler and Moran 1990, Rosas and Koenigs 2014, Almeida, Seixas et al. 2015, Kahane, Everett et al. 2015) have been correlated with abnormal moral response. Specifically, the interpersonal facet has been negatively correlated with increased utilitarian judgment in moral dilemmas and psychopathy measured using the SRP (Ritchie and Forth 2016), abnormal responses to judgments of harm caused by accidents compared to harm caused by intention and psychopathy using the PCL-R (Young, Koenigs et al. 2012), abnormal moral/conventional distinctions using Turiel (1983)'s moral/conventional distinction task and psychopathy using the PCL-YV (Dolan and Fullam 2010), less severe punishments for moral violations and psychopathy using the PCL-R (Borg, Kahn et al. 2013), and poor predictability of feeling guilt after participating in immoral acts and psychopathy using the SRP (Seara-Cardoso, Sebastian et al. 2016).

Recall that the interpersonal facet of Factor 1 is composed of the following individual item characteristics: glibness/superficial charm, grandiose sense of self-worth, pathological lying, and conning/manipulative behavior (refer to Table 1). Because each of these items is distinct and not correlated as individual items with behavioral data, it is impossible to know which of these items contribute to interpersonal facet correlations. However, indications may come from other sources. Specifically, the concept of having a grandiose sense of self-worth is similar to having an inflated
ego, also analogous with narcissism. Interestingly, research has indicated that egotistic values are
what not only drives psychopathic judgment in moral cognition tasks (Trevathan and Walker 1989,
Kahane, Everett et al. 2015) but also “utilitarian” judgment in trolley-type moral dilemmas
(Kahane, Everett et al. 2015).

To elaborate, Kahane, Everett et al. (2015) conducted a study using only the primary
measure of psychopathy from the LSRP in order to explore associations between utilitarian moral
judgment in moral dilemmas and a large range of personality traits, attitudes, judgments, and
behaviors. Recall that the primary measure of psychopathy has been associated with the
interpersonal and not affective facet of the PCL-R (Miller, Gaughan et al. 2008) (refer to Table 3).
Regardless of this, Kahane, Everett et al. (2015) found that endorsement of utilitarian moral
judgment in both other and self-benefiting sacrificial dilemmas but not in real-life moral situations,
is positively correlated with the LSRP measurement of primary psychopathy. In addition, primary
psychopathy was positively correlated with three types of egoism: psychological (e.g., believing
others do things out of self-interest), ethical (e.g., the moral attribution of performing an action out
of self-interest), and rational (e.g., the value of doing any action should be out of self-interest).
Importantly, Kahane, Everett et al. (2015) found that utilitarian judgment in sacrificial moral
dilemmas like the Trolley dilemmas is not related to altruistic motivation but instead to rational
egoism, arguing that the use of moral dilemmas in the investigation of moral judgment overall
cannot measure anything but pure utilitarianism (and not ‘true’ morality in terms of helping others
or self-sacrifice) (Kahane, Everett et al. 2015). Importantly, this result further links the LSRP
measurement of primary psychopathy with the interpersonal, and not affective, facet of Factor 1,
suggesting that primary psychopathy has more to do with egotism than lacking emotion.
Further, Trevathan and Walker (1989) did not conduct a factor or facet analysis of the PCL scores; however, they did measure moral orientation (i.e., normative, fairness, egoistic utilitarianism, social utilitarianism, and perfectionism) along with moral reasoning in Kohlberg (1969)’s MDQ in juvenile criminals. Trevathan and Walker (1989) found that psychopathic juveniles had a lower stage of moral reasoning compared to controls, especially when reasoning about real-life versus hypothetical scenarios. Importantly, in real life scenarios, psychopaths relied on the moral orientation of egoistic utilitarianism reasoning more than the control groups, indicating that the psychopathic group has more invested interest in themselves rather than in others (Trevathan and Walker 1989), mirroring results of egotism by Kahane, Everett et al. (2015).

In support of the idea that abnormal psychopathic moral behavior is driven by egotistic desires instead of affective disruption, further evidence has found that utilitarian responses of psychopaths occurs in moral dilemmas that specifically evoke egotistical and self-interest responses. To elaborate, Rosas and Koenigs (2014) reevaluated the data from a previous study that had measured the responses of psychopaths to moral dilemmas using the PCL-R as well as a measurement of anxiety as a unique way to classify primary and secondary psychopathic participants (Koenigs, Kruepke et al. 2012, Rosas and Koenigs 2014). Specifically, these authors classified primary psychopaths as those who have low and secondary psychopaths as those who have high anxiety profiles. Interestingly, these authors (Koenigs, Kruepke et al. 2012) (as well as authors from a similar study (Gao and Tang 2013)) did not correlate anxiety profiles to either of the PCL-R factors, suggesting that anxiety does not contribute to traditional primary and secondary psychopathy categorizations using the factorial divide. In addition, and unfortunately, these authors did not conduct any additional Factor or facet analyses of their behavioral data (Koenigs, Kruepke et al. 2012, Rosas and Koenigs 2014); however, in this subsequent study, Rosas and
Koenigs (2014) did find that low-anxious primary psychopaths made significantly more utilitarian responses in moral dilemmas categorized as 'selfish reason' and 'guilty victim' dilemmas, which evoke responses regarding selfishness, guilt avoidance, and anger towards the victim in healthy individuals (Rosas and Koenigs 2014). This finding once again mimics mostly the interpersonal facet of psychopathy suggesting that, once again, Factor 1 correlations may be driven by the interpersonal facet.

Lastly, there is further indication that the interpersonal facet may be driving Factor 1 correlations. In one study that investigated moral knowledge using the MFQ and psychopathy using the TriPM, results indicated a negative correlation between the psychopathy characteristic of Boldness and valuation of the purity foundation (Almeida, Seixas et al. 2015). Recall that the TriPM’s measurement of Boldness has correlations with both the interpersonal and affective facets of the PCL-R; however, its correlation is strongest with the interpersonal and not affective facet (Patrick 2010). Specifically, pathological lying and conning/manipulative behaviors exemplify bold behaviors. While this study also found a negative correlation between the psychopathy characteristic of Meanness and endorsements of harm and justice foundations (Almeida, Seixas et al. 2015), unfortunately associations with the TriPM’s measurement of Meanness equally embrace the interpersonal and affective facets (Patrick 2010), giving little insight as to which facet is contributing most to this result (refer to Table 6).

3.4.2. Factor 2 Correlations

In addition to the finding that psychopathy scores on moral psychology tasks correlate with the interpersonal facet of Factor 1, research has also largely correlated Factor 2 scores with abnormal performance on moral judgment tasks across domains and differential methodology in diagnosing psychopathy as well as differential methodology within each domain (Glenn, Koleva
et al. 2010, Borg, Kahn et al. 2013, Gao and Tang 2013, Fede, Borg et al. 2016). Specifically, Factor 2 correlations have been shown in tasks that have found abnormal responses in one study that measured moral judgments in moral dilemmas and psychopathy using the PPI (Gao and Tang 2013). In addition, two other studies using the PCL-R, found Factor 2 correlations with judgments of acceptability of morally and emotionally evocative statements (Fede, Borg et al. 2016) and of punishments (Borg, Kahn et al. 2013). Notably, this latter study found correlations with both factors. In addition, another study measuring psychopathy using the LSRP found that abnormal moral identity is associated with both primary and secondary psychopathic subtypes (Glenn, Koleva et al. 2010).

Importantly, Factor 2 is composed of both the lifestyle and antisocial facets (refer to Table 1). While some research has correlated the antisocial facet with abnormal moral performance (Dolan and Fullam 2010, Aharoni, Sinnott-Armstrong et al. 2012, Borg, Kahn et al. 2013), most research has found lifestyle correlations alongside antisocial (Dolan and Fullam 2010, Aharoni, Sinnott-Armstrong et al. 2012, Borg, Kahn et al. 2013), interpersonal (Dolan and Fullam 2010, Borg, Kahn et al. 2013, Seara-Cardoso, Sebastian et al. 2016) and/or affective (Aharoni, Sinnott-Armstrong et al. 2012) dimensions. This finding suggests that lifestyle characteristics may be related to antisocial and interpersonal tendencies. In addition, characteristics of lifestyle deficits have been found in other studies that have not used the traditional PCL-R Factor and facet divisions (Chandler and Moran 1990, Gao and Tang 2013, Almeida, Seixas et al. 2015), lending support that lifestyle deficiencies are likely contributing to Factor 2 correlations.

Specifically, in the studies that have found antisocial facet correlations with abnormal moral performance, lifestyle and/or interpersonal facet correlations have also been found (Dolan and Fullam 2010, Aharoni, Sinnott-Armstrong et al. 2012, Borg, Kahn et al. 2013). While Dolan
and Fullam (2010) found interpersonal correlations with abnormal moral/conventional distinctions using Turiel (1983)'s moral/conventional distinction task and the psychopathy measurement of the PCL-YV, these authors also found that the higher one scored on the lifestyle and antisocial facet, the less likely they were to properly distinguish conventional from moral norms (Dolan and Fullam 2010). Likewise, while Aharoni, Sinnott-Armstrong et al. (2012) found that both PCL-R affective and antisocial facets predicted overall reduced moral accuracy in a modified version of Turiel (1983)'s moral/conventional task, the PCL-R lifestyle facet predicted increased moral accuracy. However, as previously discussed, a replication of this study with modifications failed to find any significant Factor or facet correlations (Aharoni, Sinnott-Armstrong et al. 2014). Further, Borg, Kahn et al. (2013) found no association between total psychopathy scores and either of the PCL-R factors in the severity of punishment judgments until the shared variance between both factors was controlled, resulting in the finding that the interpersonal facet predicted normal and the antisocial facet predicted abnormal ratings of punishment. Neither the affective nor lifestyle facets were associated with punishment ratings (Borg, Kahn et al. 2013).

Interestingly, one study found correlations with both interpersonal and lifestyle facets. Specifically, Seara-Cardoso, Sebastian et al. (2016) measured whether psychopathic individuals in the general population using the SRP could predict whether or not they would feel guilty for immoral actions and found that both the interpersonal and lifestyle facets were negatively correlated with the anticipation of guilt, meaning that if individuals scored high on egotistical-type qualities as well as lifestyle irregularities, the less likely they would predict themselves feeling remorseful in moral situations. This finding is particularly interesting because it details a specific emotional effect, correlated with each of these, but not the affective, facets.
Further, nontraditional measures of itemized characteristics also give insight to lifestyle deficits (Chandler and Moran 1990, Gao and Tang 2013, Almeida, Seixas et al. 2015). For instance, while Chandler and Moran (1990) did not conduct a traditional two factor divide using the PCL, the authors instead used a post-hoc three factor divide to further analyze their results. Specifically, Chandler and Moran (1990) diagnosed juvenile criminal psychopathy using the PCL and measured moral reasoning using a version of Kohlberg (1969)’s MDQ, Turiel (1983)’s moral/conventional distinction task (which has traditionally been used to measure moral knowledge but can be adapted to also measure developmental stages of moral cognition (Turiel 1978)), and an additional measure of moral maturity that can be divided into socialization (i.e., the ability to get along with others), autonomy (i.e., the ability to be self-sufficient), and empathy (i.e., the ability to feel for others) subscales (Hogan and Busch 1984). Results indicated no correlation between psychopathy measured as a continuous variable and Kohlberg (1969)’s MDQ or Turiel (1983)’s moral/conventional distinction task. Only the socialization measure reached significance. However, Chandler and Moran (1990)’s post-hoc three-factor divide yielded some interesting results. Specifically, Chandler and Moran (1990)’s categorized Moral Sentiment (i.e., lack of remorse/guilt, lack of empathy, callousness, grandiose sense of self worth, shallow affect, glibness; a combination of both the interpersonal and affective facets of the PCL-R Factor 1), Moral Will (i.e., lack of goals, no responsibility, irresponsibility, impulsive/poor behavioral controls, proneness to boredom; a direct mirror of the PCL-R Factor 1 lifestyle facet), and Behavioral Deviance (i.e., pathological lying, promiscuous sexual behavior, criminal versatility, conning/manipulative behavior, early behavioral problems, parasitic lifestyle; a combination of the interpersonal facet of Factor 1 and the antisocial facet of Factor 2 of the PCL-R) as separate constructs. Measuring psychopathy as a continuous variable, the socialization measure negatively
correlated with all three factors whereas performance on Kohlberg (1969)’s MDQ negatively correlated with only the factor symbolizing Moral Will, the post-hoc three factor divide that directly mirrors the lifestyle facet of Factor 1 of the PCL-R. When the psychopathy group was further analyzed with a standard cut-off score of 37 instead of as a continuous construct, only the autonomy measure of moral maturity significantly differentiated the psychopathic from the non-psychopathic group, in that high levels of personal autonomy in combination with low levels of socialization were predictive of psychopathy (Chandler and Moran 1990). Overall, these results once again supports both interpersonal and lifestyle disruptions in psychopathy.

In addition, although Gao and Tang (2013) conducted a factor analyses using the PPI which does not adhere to traditional PCL-R factor divides and instead is largely disbursed across all PCL-R facets, meaningful insight can still be made. Specifically, Gao and Tang (2013) found that the PPI Impulsivity/Antisociality Factor, traditionally believed to be analogous to Factor 2 of the PCL-R, was positively correlated with abnormal performance in moral dilemmas as well as positively correlated with both instrumental and reactive aggression (Gao and Tang 2013). However, as previously suggested, the Impulsive/Antisociality Factor encompasses many characteristics across each of the PCL-R Factors and facets, with the most congruency with the lifestyle facet. Therefore results from Gao and Tang (2013) largely suggest that the Impulsive/Antisociality Factor correlations are largely associated with PCL-R lifestyle characteristics among the other PCL-R facets (refer to Table 4).

Lastly, while Almeida, Seixas et al. (2015) found negative correlations between the psychopathy characteristic of Boldness and endorsement of the purity foundation and the psychopathy characteristic of Meanness and endorsements of harm and justice foundations of the MFQ using the TriPM, these authors also found a positive correlation between the psychopathy
characteristic of Disinhibition and the moral foundation of justice and negative correlations of Disinhibition with authority and purity foundations (Almeida, Seixas et al. 2015). As suggested here (refer to Table 6), Disinhibition is largely analogous with impulse control problems and the antithesis of inhibition which is similar to item characteristics within the lifestyle facet. Thus the lifestyle facet is once again correlated with abnormal moral performance.

3.5. Discussion

According to affective theories of psychopathy, aberrant psychopathic behavior is caused by psychopaths having deficits in the affective facet which, in turn, results in deficits in the other three facets (Cleckley 1976/1941, Hare 1993, Blair 1995, Blair, Jones et al. 1995, Blair 1995, Hare 1998, Nichols 2002, Moll, de Oliveira-Souza et al. 2003, Blair, Mitchell et al. 2005, Raine and Yang 2006, Prinz 2008, Cushman, Young et al. 2010, Young and Dungan 2012). If abnormal psychopathic moral cognition were related to having significant deficits in affect, it is surprising that no affective correlations have been found with abnormal moral performance. Instead, what has been found are correlations with the interpersonal facet, which reflects personality-type disorders and characteristics, and correlations with the lifestyle facet, which reflects attention and inhibition deficits, rather than deficits in emotion.

One could argue that if psychopathic individuals have specific deficits in making judgments and decisions about affective content (such as acting in ways that appear to lack emotion and/or having difficulty in understanding affective information) then this should also indicate specific deficits in affective and emotion processing. However, this does not necessarily have to be the case. First, one cannot rule out multi-determinism for these observed behaviors, that is the assertion that a single behavior can arise from multiple distinct causes, when assessing why psychopaths display the behaviors they do (Dretske 1988, Juarrero 1999, Miller and Keller 2000,
Gazzaniga 2010, Gazzaniga 2011). Likewise, because a deficit is expressed in a particular content category does not necessarily mean that the deficit is also cognitively specific to that same content. In other words, specific deficits in tasks that measure emotional capability does not necessarily indicate deficient emotional processing; other processes, such as the information processes of attention (Erthal, de Oliveira et al. 2005, Pessoa, Padmala et al. 2005, Mitchell, Nakic et al. 2007, Silvert, Lepsien et al. 2007, Lim and Pessoa 2008), can contribute to deficient emotional responses. In fact, one study actually found deficits in emotional content that were not correlated with the affective facet but instead correlated with the interpersonal and lifestyle facets (Seara-Cardoso, Sebastian et al. 2016), demonstrating that deficits in emotional content are not necessarily related to having deficits in affective processing. Thus, determining whether a behavioral deficit is due to having deficits in emotion processing or in information processing is important.

Likewise, one of the items that make up the affective facet, ‘failure to accept responsibility for own actions’, could be caused by (a) impression management (knowing the norms, not caring, and ‘masking sanity’), as psychopaths are believed to do (Cleckley 1976/1941), or (b) knowing the norms, caring, but trying to cover up any outwardly impression of caring as a self-protecting, egotistical coping mechanism, as could be driven by the interpersonal facet. In particular, if (b) is the case, the reason for why the behavior is observed could actually be due to having emotion and not wanting to appear vulnerable or at fault: why bother to deny responsibility if you do not care? As exemplified in this manuscript, egotistic/narcissistic concern has been found to be of great importance to those scoring high on psychopathy measures (Trevathan and Walker 1989, Kahane, Everett et al. 2015), which is as good a reason as any to reject social and moral normativity. Importantly, once again, (b) is not due to having a deficit of affect.
As mentioned in the introduction, information processing theories of psychopathy assert that aberrant psychopathic behavior could be caused by psychopaths having deficits in the ability to perceive and process relevant information that is important for judgment and decision-making. One such information process is attention (Newman, Patterson et al. 1990, Newman and Lorenz 2003, Hiatt, Schmitt et al. 2004, Kiehl 2006, Glass and Newman 2009, Zeier, Maxwell et al. 2009, Newman and Baskin-Sommers 2011). Likewise, the ability to regulate behavioral responses, through cognitive control, can also lead to disruptive social and moral behaviors (Blair 1995, Blair, Mitchell et al. 2005, Kiehl 2006, Patrick 2008). Interestingly, it is the lifestyle facet, and not the antisocial facet, of Factor 2 of the PCL-R that appears to be largely correlated with abnormal moral performance across multiple moral cognition domains and differential methodology as well as across differential methodology within each domain. Recall that the lifestyle facet itemizes need for stimulation and proneness to boredom, parasitic lifestyle, lack of realistic, long-term goals, impulsivity, and irresponsibility. It is possible that attentional and cognitive control deficits within the lifestyle facet are related, in that regulating behavior requires attentional demand (Levenston, Patrick et al. 2000, Pham, Vanderstukken et al. 2003, Vitale, Newman et al. 2005, Zeier, Maxwell et al. 2009, Baskin-Sommers, Curtin et al. 2011, Larson, Baskin-Sommers et al. 2013), suggesting an overall information processing deficit in attention being the root cause of cognitive control disruptions.

Research has found that psychopaths do have notable attentional deficits (Newman, Patterson et al. 1990, Newman and Lorenz 2003, Hiatt, Schmitt et al. 2004, Kiehl 2006, Glass and Newman 2009, Zeier, Maxwell et al. 2009, Newman and Baskin-Sommers 2011). In support of the theory that basic information processing deficits of attention are causing psychopathic abnormal behavior, studies that measured startle responses of fear to threatening stimuli found that
psychopaths demonstrated abnormal emotional responding until task demands were designed to enforce better attention (Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011). Further, it has been found that deficient responses by psychopaths in a task known as the Iowa Gambling Task (IGT), which measures task-switching, reversal learning, and the capability to process affective information, is mediated by attention (Losel and Schmucker 2004). This evidence suggests that not only do psychopaths perform similarly to controls once their basic information processing deficit is controlled, but that psychopaths’ seemingly deficient affective processing in this and similar tasks may be due to having attention and not emotion deficits.

Likewise, research has shown that the information process of attention plays a significant role in mediating behavioral responses, especially to emotional stimuli (Erthal, de Oliveira et al. 2005, Pessoa, Padmala et al. 2005, Mitchell, Nakic et al. 2007, Silvert, Lepsien et al. 2007, Lim and Pessoa 2008). Psychopaths have notable inhibition deficits (Blair 1995, Blair, Mitchell et al. 2005, Kiehl 2006), especially when attentional demands increase. Because of this, psychopaths are believed to make behavioral decisions solely based on information that is presented early in time and have difficulties adjusting their behavioral responses as time passes because they are no longer attending to new and updated information, a theory of psychopathy known as the response modulation theory (Levenston, Patrick et al. 2000, Baskin-Sommers, Curtin et al. 2011, Larson, Baskin-Sommers et al. 2013). From this, and other evidence (Vitale, Newman et al. 2005, Zeier, Maxwell et al. 2009) it is likely that psychopathic inhibition deficits are also caused by deficits in attention. Taken together, this evidence strongly implicates information processing deficits in psychopathy.

Importantly, research has also indicated that both attentional and inhibition deficits can cause characteristic traits within interpersonal, affective, and antisocial facets. Individuals with
attention deficits are more likely to have personality disorders (Matthies and Philipsen 2016), emotional disruptions (Shaw, Stringaris et al. 2014), and are more likely to commit crimes (Mohr-Jensen and Steinhausen 2016) as well as to have antisocial tendencies (Babinski, Hartsough et al. 1999). Likewise, individuals who have difficulty cognitively controlling their behaviors, as with inhibition, impulse, and hyper-reactivity deficits, have also been associated with psychopathology (Wright, Lipszyc et al. 2014) and likeliness to commit crimes (Babinski, Hartsough et al. 1999). Therefore it is likely that when other facet correlations have been found, they may be due to having lifestyle deficits, particularly in attention.

Interestingly, some studies within the exploration of moral psychology of psychopaths did not reveal any Factor or facet correlations (Chandler and Moran 1990, Cima, Tonnaer et al. 2010, Seara-Cardoso, Neumann et al. 2012, Aharoni, Sinnott-Armstrong et al. 2014). In addition, no narcissistic correlations were measured using the Dark Triad (Tremoliere and Djeriouat 2016). Instead, only the Dark Triad psychopathy feature was a significant predictor of utilitarian judgment in moral dilemmas and value ratings of harm/care in the MFQ (Djeriouat and Tremoliere 2014); however, as highlighted in Table 5, psychopathy as measured in the Dark Triad encompasses characteristics within the interpersonal, affective, and lifestyle facets of both factors of the PCL-R, thus giving little insight on which facet actually drives this response. Although it is impossible to know exactly why these results were null, reasons could be due to methodological differences (Koenigs, Baskin-Sommers et al. 2011).

3.6. Conclusion

In conclusion, research outlined in this manuscript highlights that psychopathy performance on moral psychology tasks correlate with the interpersonal facet of Factor 1 and the lifestyle facet of Factor 2 dimensions of psychopathy. Importantly, meaningful correlations with
the affective facet were not observed. If psychopathy were caused by a disruption of affect, then correlations of psychopathy response in these moral paradigms would implicate the affective facet; however, this is not the case. This conclusion is supported by other research suggesting that abnormal performance in tasks that measure emotion processing and/or structural or functional correlates of psychopathy also largely do not find correlations with the affective facet (see Patrick (2015) for a detailed review).

One possibility as to why research is not revealing affective correlations may be because most psychopaths that participate in these studies do not have an affective disorder. Criminal psychopaths that have been measured in these studies are known criminals, meaning that they were 'unsuccessful' at getting away with their crimes, likely because they represent the PCL-R traditional conception of more reactive, secondary psychopaths rather than the cold, calculating instrumental primary psychopaths that are commonly dictated in popular culture. Another possibility may be because, realistically, there are not that many stereotypical, 'true' primary psychopaths out there. In reality, the PCL-R traditional conception of primary psychopaths that truly lack emotion is extremely rare. Regardless of even the largest sample sizes, the existence of PCL-R primary psychopaths in terms of data representation likely become normalized when averaged alongside secondary psychopaths who score high in interpersonal, lifestyle, and antisocial facets rather than the affective facet.

In conclusion, because of the multidimensional nature of psychopathy diagnoses, it is important to look at which Factors and facets both drive individual psychopathy diagnoses as well as correlate with psychopathic behavior. It is likely that not every individual within a psychopathic sample, nor every group diagnosed as psychopathic, is going to exhibit the same deficits. Further, additional measures to rule out potential confounds, such as information processing deficits (e.g.,
attentional tasks) are suggested. Importantly, this manuscript reveals that research regarding the moral psychology of psychopaths does not support an affective disruption. Instead, it is likely that both interpersonal and lifestyle facets of psychopathy are what contributes to their deviant social and moral behavior.
3.7. Tables

<table>
<thead>
<tr>
<th>Interpersonal facet</th>
<th>Factor 1</th>
<th>Lifestyle facet</th>
<th>Factor 2</th>
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<td>Glibness/Superficial charm</td>
<td>Need for stimulation/Proneness to boredom</td>
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<td>Grandiose sense of self-worth</td>
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<td>Pathological lying</td>
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<td>Poor behavioral controls</td>
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<td>Criminal versatility</td>
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**Table 1.** PCL-R Factor and facet divide (Hare 2003). The two additional PCL-R items, promiscuous sexual behavior and many 'short-term' marital relationships, are not included in Factor and facet divides. The PCL-SV, PCL-YV, and SRP adhere to these Factor/facet multidimensions.

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<tr>
<th>Interpersonal facet</th>
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**Table 2:** Comparison overlay of the PSD with the PCL-R as suggested by Frick, O'Brien et al. (1994) and Blair, Monson et al. (2001).
Table 3: Comparison overlay of the LSRP with the PCL-R as suggested by Miller, Gaughan et al. (2008).

<table>
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<th>Affective facet</th>
<th>Factor 1</th>
<th>Antisocial facet</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of remorse/guilt</td>
<td>Glibness/Superficial charm</td>
<td>Need for stimulation/Proneness to boredom</td>
<td></td>
</tr>
<tr>
<td>Shallow affect</td>
<td>Shallow affect</td>
<td>Parasitic lifestyle</td>
<td></td>
</tr>
<tr>
<td>Callous/Lack of empathy</td>
<td>Paranoia</td>
<td>Impulsivity</td>
<td></td>
</tr>
<tr>
<td>Failure to accept responsibility for action</td>
<td>Conning/Manipulative</td>
<td>Irresponsibility</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Comparison overlay of the PPI with the PCL-R. Coldheartedness, as it is not included in either PPI factors, likely embraces the lack of remorse/guilt, shallow affect, and callous/lack of empathy items of the affective facet of the PCL-R.
### Table 5: Comparison overlay of the Dark Triad with the PCL-R.

<table>
<thead>
<tr>
<th>Interpersonal facet</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
</table>
|                    | Glibness/Superficial charm | Need for excitement 
|                    | Narcissism | Psychopathy |
| Pathological lying | | Parasitic lifestyle |
| Conning/Manipulative | | Lack of realistic, long-term goals |
| Machiavellianism | | Impulsivity |
| Psychopathy | | Irresponsibility |

<table>
<thead>
<tr>
<th>Affective facet</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of remorse/guilt</td>
<td></td>
<td>Poor behavioral controls</td>
</tr>
<tr>
<td>Machiavellianism</td>
<td></td>
<td>Early behavioral problems</td>
</tr>
<tr>
<td>Psychopathy</td>
<td></td>
<td>Juvenile delinquency</td>
</tr>
<tr>
<td>Failure to accept responsibility for action</td>
<td></td>
<td>Revocation of conditional release</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Criminal versatility</td>
</tr>
</tbody>
</table>

### Table 6: Comparison overlay of the TriPM with the PCL-R.

<table>
<thead>
<tr>
<th>Interpersonal facet</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Glibness/Superficial charm</td>
<td>Meanness &amp; Disinhibition</td>
</tr>
<tr>
<td></td>
<td>(strong correlation)</td>
<td>Parasitic lifestyle</td>
</tr>
<tr>
<td>Pathological lying</td>
<td></td>
<td>Lack of realistic, long-term goals</td>
</tr>
<tr>
<td>Conning/Manipulative</td>
<td></td>
<td>Impulsivity</td>
</tr>
<tr>
<td>Meanness</td>
<td></td>
<td>Irresponsibility</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Affective facet</th>
<th>Factor 1</th>
<th>Factor 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of remorse/guilt</td>
<td></td>
<td>Poor behavioral controls</td>
</tr>
<tr>
<td>Shallowness</td>
<td></td>
<td>Early behavioral problems</td>
</tr>
<tr>
<td>Callous/Lack of empathy</td>
<td></td>
<td>Juvenile delinquency</td>
</tr>
<tr>
<td>Meanness</td>
<td></td>
<td>Revocation of conditional release</td>
</tr>
<tr>
<td>(callous/lack of empathy item)</td>
<td></td>
<td>Criminal versatility</td>
</tr>
</tbody>
</table>
Table 7: Overall Results of Psychopathy Performance in Moral Cognition Tasks. Factor/facet correlations are highlighted in light gray. Abbreviations in order of presentation: I/O, Intention/Outcome assessments; MFQ, Moral Foundations Questionnaire; Turiel’s M/C, Turiel’s Moral/Conventional task; MDQ, Kohlberg’s Moral Dilemma Questionnaire; ToM, Theory of Mind; F, Factor (F1, Factor 1; F2, Factor 2); f, facet; SRP, Self-Report Psychopathy Scale; PPI, Psychopathic Personality Inventory; PCL, Psychopathy Checklist (PCL-R, Psychopathy Checklist – Revised; PCL-YV, Psychopathy Checklist – Youth Version, PCL-YV; PCL-SV, Psychopathy Checklist – Screening Version); LSRP, Levenson Self-Report Psychopathy Scale; TriPM, Triarchic Psychopathy Measure; PSD, Psychopathy Screening Device.
3.8. References


the same constructs as Hare's Psychopathy Checklist-Revised?" Pers Individ Dif 31(7): 1021-1038.


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The third manuscript of this dissertation, indexed as Chapter 4, examines the neuropsychological testing of vmPFC patients and adult criminal psychopathic individuals in select moral cognition tasks as well in studies that have specifically investigated neurocognitive capabilities of the populations. In this manuscript, I demonstrate that, as opposed to what is commonly claimed, vmPFC patients and psychopaths actually do have deficits in attention, memory, and reason, supporting the assertion that the information processing deficits of the populations affect the higher-order processes of both emotion and reason similarly.
CHAPTER FOUR: Does Neuropsychology Support the Claim that vmPFC Patients and Psychopaths Have Intact Reasoning? The answer is, once again, “No”.

4.1. Abstract

It is commonly claimed that ventromedial prefrontal cortex (vmPFC) patients and individuals diagnosed with psychopathy have intact intelligence, memory, and reasoning capabilities, and that their aberrant social and moral behaviors as well as abnormal performance on emotion and moral cognition laboratory tests are due to having select deficits in emotion. Because of this, both populations have been used to support the claim that emotion is necessary for moral cognition. However, in order to make the claim that both populations have intact intelligence, memory, and reasoning capabilities, one has to explore the detailed neuropsychological data that were collected on each participant for each study. In this manuscript, I evaluate the neuropsychological testing that has been conducted in the primary studies that have measured vmPFC patient and adult criminal psychopathic moral judgment in Trolley-type dilemmas and intention/outcome assessments. I also evaluate the prominent studies that specifically measure neuropsychological capabilities of each of the populations. Despite popular claims, I conclude that the populations do have deficits in a variety of cognitive functions including in attention, memory, and reasoning. Importantly, these deficits are in tasks that are not composed of affective content, supporting the view that these populations have deficits in judgment and decision-making across both emotion and reasoning paradigms.

4.2. Introduction

Data from vmPFC patients and individuals with psychopathy have been used to support the claim that emotion is necessary for moral cognition. Specifically, individuals in both populations display aberrant social and moral behaviors in the real world and tend to perform
abnormally on psychological tasks that measure emotion processing and/or moral cognition. The prevailing theory as to why these populations have social and moral deficits is that both populations have specific deficits in emotion – that is, both populations are not able to detect, process, and/or regulate emotional experience, resulting in reduced capability to act empathetically and heightened capability to act either apathetically or aggressively (Eslinger and Damasio 1985, Hare 1993, Anderson, Bechara et al. 1999, Bechara, Damasio et al. 2000, Blair, Mitchell et al. 2005, Anderson, Barrash et al. 2006, Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Shamay-Tsoory and Aharon-Peretz 2007, Shamay-Tsoory, Harari et al. 2010, Ciaramelli, Braghittoni et al. 2012, Koenigs, Kruepke et al. 2012). From these observations, the emotion view of moral cognition is supported, specifically that emotion is necessary to behave morally (Hume 1739).

In support of the view that both populations have deficits specific to emotion (Cleckley 1976/1941, Damasio 1994, Blair 1995, Blair, Jones et al. 1995, Hare 1998, Anderson, Bechara et al. 1999, Bechara, Damasio et al. 2000, Habel, Kuhn et al. 2002, Anderson, Barrash et al. 2006, Porter and Woodworth 2006, Young and Koenigs 2007, Moll, De Oliveira-Souza et al. 2008, Cushman, Young et al. 2010), it is commonly claimed that both populations have intact intelligence, memory, and reasoning capabilities, as measured through standard neuropsychological testing (Cleckley 1976/1941, Sutker, Moan et al. 1983, Hare 1984, Eslinger and Damasio 1985, Sutker and Allain 1987, Hart, Forth et al. 1990, Bechara, Damasio et al. 1994, Anderson, Bechara et al. 1999, Anderson, Barrash et al. 2006). This claim, as it relates to vmPFC patients, originates from early frontal lesion case studies, such as the famous case of Phineas Gage (Harlow 1868/1993), in which the personality and emotion reactivity of patients change after brain trauma yet retain other cognitive functions such as intelligence and memory. In addition, early
decision-making research with vmPFC patients often relied on single case studies, such as with patient E.V.R., in which these cognitive functions, as assessed through neuropsychological testing, were intact (Bechara, Damasio et al. 1994). Likewise, this claim, as it relates to psychopathy, originates from early studies in which neuropsychological measures were not different from controls (Sutker, Moan et al. 1983, Hare 1984, Sutker and Allain 1987, Hart, Forth et al. 1990).

However, the claim that both populations have intact neurocognitive functions as assessed through standard neuropsychology testing of intelligence, language, attention, memory, and executive functioning is not necessarily accurate. One has to look at the neuropsychological data for each participant in the experimental group as presented for each publication in order to assess whether or not there is disturbance in the participant’s neurocognitive functionality. This matters because typically sample sizes using these populations are relatively small ($N = 1 – 11$ participants for vmPFC patients and $14 – 24$ adult criminal psychopaths as reported for the moral cognition studies in this manuscript) and even if no significant difference between experimental and control groups is found on basic cognitive functioning tasks, abnormal performance of even just one participant could drive experimental effects. Unfortunately, neuropsychological measures are rarely correlated (with the exception of intelligence scores) with task performance, so there is little evidence to support or renounce the claim that a deficit in emotion alone is contributing to performance results.

Further, there are methodological discrepancies between populations. Specifically, most vmPFC patient studies include measurements of intelligence and some combination of neuropsychological data regarding basic cognitive functions of language comprehension, memory, and executive functioning. However, most psychopathy studies rarely collect neuropsychological data of basic cognitive functioning, unless the study aim is to specifically to test for
neuropsychological deficits. The only psychometric measurement that is normally collected in psychopathy studies is some version on an intelligence measure, ranging from years of education to standardized intelligence tests. Therefore, there is very little data in the literature to compare the neuropsychological capabilities between the two populations.

More so, both populations also have basic information processing deficits in attention and in assessing (as in learning, comparing, and predicting) value. Specifically, vmPFC patients have difficulty attending to relevant stimuli in social tasks (Vecera and Rizzo 2004) as well as in attending to the eye region of faces (Wolf, Philippi et al. 2014). Psychopaths also have notable attentional deficits in the ability to attend to salient features of stimuli (Patterson and Newman 1993, Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011, Newman and Baskin-Sommers 2011, Larson, Baskin-Sommers et al. 2013, Zeier and Newman 2013, Hoppenbrouwers, van der Stigchel et al. 2015). Psychopathic individuals also commonly performed poorly on odd-ball and Flanker tasks that measure attention and inhibition (Munro, Dywan et al. 2007, Munro, Dywan et al. 2007, Zeier, Maxwell et al. 2009). Specifically, odd-ball tasks require individuals to detect changes of stimuli (Squires, Squires et al. 1975) whereas Flanker tests require individuals to detect whether a target arrow in a group of other, distracting arrows is pointing in the same or different direction, forcing the individual to inhibit impulse responses (Eriksen and Eriksen 1974).


The goal of this manuscript is to evaluate the neuropsychological testing that has been conducted in primary studies that have measured vmPFC patient and adult criminal psychopathic moral cognition in order to assess whether the populations really do have intact neurocognitive functioning. In addition, I evaluate the prominent neuropsychological studies that specifically measure neurocognitive capabilities of each population. Unlike popular claims that the populations have intact intelligence, memory, and reasoning capabilities (Cleckley 1976/1941, Eslinger and Damasio 1985, Hare 1991, Damasio 1994, Anderson, Bechara et al. 1999, Bechara, Damasio et al. 2000, Beer, Heerey et al. 2003, Anderson, Barrash et al. 2006, Burgess, Alderman et al. 2006), I conclude that the populations have deficits in a variety of information processes including in
attention, memory, and reasoning. Therefore, data from these populations should not be used as evidence that the populations have specific deficits in emotion or that emotion deficits cause the populations’ abnormal performance in moral cognition tasks.

4.3. Moral Cognition Experiments

4.3.1. Trolley-Type Dilemmas

The most popular paradigm that has been used in the literature to investigate the moral cognition of the populations has been the use of a battery of dilemmas developed by Greene, Sommerville et al. (2001) that was founded on the famous Trolley dilemma in which one has to judge the moral permissibility of sacrificing one individual in order to save five others in a situation where an out-of-control trolley is speeding down a railway track (Foot 1967). Famously, there are two variations of this dilemma, known as the Bystander, or Switch, and Footbridge dilemmas. The Bystander dilemma details making this judgment in a scenario in which the decision maker is observing the situation as a bystander who happens to be standing near a lever, or switch, that they can pull/push in order to turn the out-of-control trolley onto an alternate sidetrack where only the one individual will be harmed. The Footbridge dilemma, on the other hand, requires the decision-maker to physically push the one individual to their death in order to prevent the out-of-control trolley from harming the five others (Thomson 1976).

Importantly, an endorsement to sacrifice one in order to save multiple others is considered a utilitarian response in which the ends justify the means. A non-endorsement, on the other hand, is considered a deontological response in which no matter the means, the end is never justified (but see Kahane and Shackel (2008), Kahane and Shackel (2010), Kahane (2012), Kahane, Wiech et al. (2012), Kahane (2015), Kahane, Everett et al. (2015), McGuire, Langdon et al. (2009) for alternative explanations). Decades of research have demonstrated that normal individuals judge it
permissible to sacrifice one in order to save five in the Bystander, but not in the Footbridge, dilemma. In other words, normal individuals endorse the utilitarian response in the Bystander dilemma whereas they endorse a deontological response in the Footbridge dilemma (Greene, Sommerville et al. 2001, Cushman, Young et al. 2006, Hauser, Cushman et al. 2007, Greene 2009, Mikhail 2011). These differential responses in these two seemingly analogous scenarios give rise to the term 'the Trolley Problem' (Foot 1967, Thomson 1976) and explanations for these differential responses have yet to be determined (Cushman, Young et al. 2006, Waldmann and Dieterich 2007, Greene 2009, Greene, Cushman et al. 2009, McGuire, Langdon et al. 2009, Waldmann and Wiegmann 2010, Mikhail 2011, Waldmann, Nagel et al. 2012).

Greene, Sommerville et al. (2001)'s battery of dilemmas is an expansion of the Bystander and Footbridge dilemmas and includes non-moral and moral dilemmas with the moral dilemmas split into two categories: impersonal and personal. These categories differ in emotional saliency ratings pretested before the battery was finalized. Specifically, impersonal and personal moral dilemmas are similar to the Bystander and Footbridge dilemmas, respectively (Greene, Sommerville et al. 2001), despite the fact that the emotional saliency rating between these two specific dilemmas is, in actuality, indistinguishable, 5.3 and 5.5 out of 7 respectively (data personally analyzed from Koenigs, Young et al. (2007)'s supplemental material). In line with participants' behavioral responses in the Bystander and Footbridge dilemmas, Greene, Sommerville et al. (2001) found that individuals generally judge that it is acceptable to choose the utilitarian option in non-moral and impersonal moral dilemmas whereas they judge that it is not acceptable to choose the deontological option in personal moral dilemmas.
4.3.1.1. vmPFC Patient Performance in Trolley-Type Dilemmas

Four studies have measured vmPFC patient performance in Greene, Sommerville et al. (2001)'s battery of dilemmas, demonstrating that vmPFC patients consistently make abnormal moral judgments in highly emotional Trolley-type dilemmas. Specifically, vmPFC patients endorse the utilitarian option in non-moral and impersonal moral dilemmas similarly to controls but also more often than controls in personal, and especially high-conflict (i.e., an additional divide of personal moral dilemmas by Koenigs, Young et al. (2007)) moral dilemmas (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011). In addition to measuring behavior, one study measured SCR responses and found that vmPFC patients had diminished SCR responses leading up to, and following, their judgments (Moretto, Ladavas et al. 2010). Since vmPFC patients have response deficits specific to personal moral dilemmas, especially high-conflict personal moral dilemmas which are rated as being the most emotionally salient dilemmas in the battery, researchers claim that the vmPFC must be necessary for computing emotion (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011). Further, because this deficit is selective to personal moral scenarios, the authors claim it is indicative that vmPFC patients do not have general decision-making deficits and that the patients’ deficit is specific to emotion (Ciaramelli, Muccioli et al. 2007).

4.3.1.2. Psychopathy Performance in Trolley-Type Dilemmas

Two studies have measured adult criminal psychopathic moral cognition using Greene, Sommerville et al. (2001)'s battery of dilemmas. Unlike vmPFC patients, results are not as consistent. Adult criminal psychopaths make similar (Cima, Tonnaer et al. 2010, Pujol, Batalla et al. 2012) and different (Koenigs, Kruepke et al. 2012) moral judgments compared to control
groups. Specifically, Cima, Tonnaer et al. (2010) found no significant difference between the psychopathic, non-psychopathic, and normal groups regarding moral judgment, suggesting that psychopaths know right from wrong but do not care. On the other hand, after controlling for some potential confounds from Cima, Tonnaer et al. (2010), another group of researchers Koenigs, Kruepke et al. (2012) found that adult psychopathic criminals do make different moral judgments when compared to controls, specifically by endorsing the utilitarian response in impersonal moral dilemmas more often than non-psychopaths. Koenigs, Kruepke et al. (2012) also correlated moral judgment responses with anxiety profiles and found that psychopaths who were low anxious (often referred to as ‘primary’ psychopaths) endorsed the personal moral dilemmas more often than high anxious (i.e., ‘secondary’) psychopaths who were not significantly different from controls.

Further, an additional study that did not use Greene, Sommerville et al. (2001)’s battery of dilemmas also found that adult criminal psychopaths make similar moral judgments to controls (Pujol, Batalla et al. 2012). Specifically, this study used computerized pictorial versions of some of the dilemmas used by Greene, Sommerville et al. (2001), finding that overall results indicate that psychopathic individuals perform similarly to controls, with the exception of responses in two specific moral scenarios. Specifically, psychopaths are more likely to endorse scenarios in which one chooses to kill a person for money and in which one endorses cannibalism in order to survive an extreme disaster situation.

4.3.2. Intention/Outcome Assessments

Another moral cognition task that has become popular is one that measures what information individuals use when making moral judgments, that being information about the intention of an action or the outcome/consequence of the action after the action has been made in situations that correspond to real-life legality (e.g., first-degree murder, manslaughter, etc.).
Specifically, individuals are asked to judge the moral acceptability of causing harm in situations in which (1) the harm was intended and harm was caused (bad-intention, bad-outcome = Intended Harm), (2) the harm was intended but no harm was caused (bad-intention, good-outcome = Attempted Harm), (3) the harm was not intended but harm was caused (good-intention, bad-outcome = Accidental Harm), and (4) no harm was intended and no harm was caused (good-intention, good-outcome = No Harm) (Young and Koenigs 2007, Cushman 2008, Young and Saxe 2008, Young, Bechara et al. 2010). Healthy individuals stereotypically judge Intended Harm as being worse than Attempted Harm, Attempted Harm as being worse than Accidental Harm, and Accidental Harm being worse than No Harm scenarios.

4.3.2.1. vmPFC Patient Performance in Intention/Outcome Assessments

Two studies have measured vmPFC patient moral cognition of Intention/Outcome Assessments, finding that, unlike controls, vmPFC patients judge attempted harms as more permissible than accidental harms. In other words, from least to most permissible, vmPFC patients reverse the order of Attempted and Accidental harm, judging Accidental Harm as worse than Attempted Harm. The investigators concluded that vmPFC patients use information about outcomes rather than intentions when making these types of moral judgments (Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012) and that the vmPFC plays an integral role in processing the intentions of others (Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012).

4.3.2.2. Psychopathy Performance in Intention/Outcome Assessments

Only one study has measured adult criminal psychopathic moral cognition of Intention/Outcome Assessments, finding that the order of how psychopathic individuals rated moral acceptability in these four categories was similar to controls, with the magnitude of
judgments in only the accidental harm condition being slightly higher, but still ranked in the same order, as in control groups (Young, Koenigs et al. 2012).

4.4. Neuropsychological Testing

Neuropsychological measurements are used to assess general and specific cognitive deficits in individuals who have suffered brain injury or who are being evaluated for a variety of neurodevelopmental disorders such as intellectual disabilities, communication and language disorders, learning disorders, attention deficit disorder (ADD), and autism. Neuropsychological tests aim to measure specific neurocognitive processes such as intelligence, language, attention, memory, executive functioning, and perceptual (as in visuospatial) capability. However, many of the tests used to measure one specific cognitive capability often require the use of other cognitive capabilities in order to meet task demands. For instance, executive functioning tests measure higher-order cognitive capabilities (such as capabilities necessary for reason, i.e., planning, organization, and goal direction; in addition, executive functioning tests measure abilities to flexibility adapt to changing environments, understand abstraction, and the ability to cognitively control reactions, referred to as response inhibition), yet, in order to attend to, understand, and complete these tests, individuals rely on lower-order cognitive functions, such as attention, learning and memory. Even simple attention tests may require other cognitive functions such as memory processing (specifically working memory) or the executive function of inhibition control (Podell, Gifford et al. 2010). Therefore, unless a large and inclusive battery of tests is used for each patient, it is difficult to know which exact process is deficient when participants perform poorly in one of these tests. Further, neuropsychological measurements are standard practice when evaluating vmPFC patients but not when conducting studies on psychopathy. In fact, few
psychopathic studies include neuropsychology testing unless they aim to measure neurocognitive functioning specifically.

There are many different categories of neuropsychological testing and within each category, many different tests, each of which is unique. Categories include measuring general or specific cognitive impairment in intelligence, language, attention, memory, executive function (e.g., capabilities necessary for reason, i.e., planning, organization, and goal direction; in addition, executive functioning tests measure abilities to flexibility adapt to changing environments, understand abstraction, and response inhibition), and perceptual (i.e., visuospatial) capabilities. Tests within each category that are discussed in this manuscript are depicted in Table 1. The following subsections will detail neuropsychological tests reported in this manuscript for each category.

4.4.1. Intelligence

The Wechsler Adult Intelligence Scale (WAIS (Wechsler 1955)) has been the primary measure for intelligence as well as measures of attention, working memory, and abstraction. Versions of the WAIS as reported here include the WAIS-R (revised edition (Wechsler 1981)) and WAIS-III (the third edition (Wechsler 1997)) which each distinguish categories of Verbal Intelligence Quotient (VIQ), Performance Intelligence Quotient (PIQ) and Full Scale Intelligence Quotient (FSIQ). However, there are important differences between the WAIS-R and WAIS-III. Specifically, WAIS-R VIQ categories include information, comprehension, arithmetic, Digit Symbol (DS, see below under “Attention”), similarities (a measure of abstraction such as similarities between objects), and vocabulary whereas WAIS-III divides VIQ into two main categories of Verbal Comprehension Index (VCI: vocabulary, similarities, information, and comprehension) and a Working Memory Index (WMI: arithmetic, Digit Symbol (DS), letter-
number, and sequencing). Likewise, WAIS-R PIQ includes categories of picture arrangement, picture completion, block design, object assembly, and DS whereas WAIS-III further divides PIQ into the Perceptual Organization Index (POI: picture completion, block design, and matrix reasoning) and the Processing Speed Index (PSI: digit symbol-coding and symbol speech,) categories. Because of these categorization differences, it is important to know for each study which version of WAIS has been used and which categories are reported.

Notably, other tests have also been used as measures of intelligence including the Wide Range Achievement Test (WRAT (Jastek and Jastek 1965, 1976, & 1978) or the WRAT-R revised edition (Jastak 1984)) and Standard Raven Matrices (SRM (Raven, Raven et al. 1998)). The WRAT reflects general intelligence measurements of reading, spelling, and arithmetic. The SRM, on the other hand, focuses on non-verbal intelligence (similar to PIQ in WAIS scales, and specifically POI in WAIS-III) and requires attention and working memory as well as executive functioning process of abstract reasoning. Specifically, SRM requires participants to evaluate a pattern of shapes that vary in design and to select a similar pattern in order to fill in the missing ‘piece’.

4.4.2. Language

Language capability (e.g., similar to VIQ in WAIS versions, and specifically VCI in WAIS-III) is used to measure language fluency and comprehension. Language fluency has been measured using the Controlled Oral Word Association Test (COWA or COWAT) of the Multilingual Aphasia Examination (MAE (Benton, Hamsher et al. 1994)) which measures both letter (e.g., list as many words that begin with the letter “F”) and semantic (e.g., list as many animals as you can) fluency. In addition, the Hayling Sentence Completion Test (HSCT (Burgess and Shallice 1997)) measures language fluency and response inhibition in which individuals are
asked to complete sentences with either sensible or nonsensical words. Further, the Boston Naming Test (BNT (Kaplan, Goodglass et al. 1983) can also be considered a measure of language fluency. Specifically, the BNT presents participants with line drawings of objects ranging from simple (e.g., “tree”) to complex (e.g., “abacus”) words and asks the participants to identify them.

Language comprehension has been measured using the Token Test (TT) of the MAE which measures basic comprehension by presenting participants with objects that are different in color and shape and then asking them to interact with the objects through a list of verbal commands, such as “Touch the blue square”. The Boston Diagnostic Aphasia Examination (BDAE (Goodglass, Kaplan et al. 2001), which is a long and intense tests with many complex language categories, also measures language comprehension, specifically through its Reading Sentences and Paragraphs (RSP) measure. The BDAE also has a Complex Ideational Material (CIM) measure which asks participants abstract questions such as “Will a cork sink in water?” as well as misleading questions about short stories. While the CIM was designed to be a measure of language comprehension, some claim that the CIM also requires cognitive processes of memory and executive functioning (e.g., abstraction and reasoning) (Podell, Gifford et al. 2010).

4.4.3. Attention

Expansive attention tests are uncommon in vmPFC neuropsychological testing and are not including in psychopathy studies unless the measurement of attention is the relevant to the research question. Also, like many neuropsychological tests, measurements of attention often require other cognitive processes (e.g., working memory). For instance, Digit Symbol tests (DS (Blankenship 1938), included in the WASI versions) measures both attention and working memory - individuals are asked to verbally repeat (by remembering) a list of numbers spoken to them in either forward or backwards order. Number sequences can range from 3 to 10 numbers, allowing for complexity
measures. Further, the Trail Making Test (TMT (Reitan 1955)) in which individuals are asked to logically draw lines from starting to ending points, such as A to B, B to C, and so forth, also is a measure of attention as well as the executive functions of logical procession (e.g., reason) and task switching. For instance, individuals are asked to alternate between progressions of letters to numbers and so forth (e.g., A to 1, 1 to B, B to 2, etc. in the MoCA).

In addition, attention is a primary task component in executive functioning tasks that also measure inhibition. For instance, Stroop tests measure attention and executive functions of response inhibition and to some degree working memory. Stroop tests are when individuals view words of colors that are written in different colored text and are asked to identify either the word or the color of the text. Reaction time (RT) measurements in Stroop tests indicate attentive processing while response errors and RT combined measure the executive function of inhibiting incongruent response. (Stroop 1935). In addition, other tests have been developed to measure attention as well as response inhibition. One such measure is the D-II Cancellation test (D-II (Brickencamp 1981)) which measures attention through a visual search paradigm in which one has to identify a target letter among distraction letters.

4.4.4. Memory

Memory measurements include the Wechsler Memory Scale (WMS (Wechsler 1945), WMS-R revised edition (Wechsler 1987)), Rey Auditory Verbal Learning Tests (RAVLT, also referred to as AVLT, (Rey 1941)), Prose Recall (PR (Wechsler 1945, Russell 1975)), and basic visual recognition tests and matching tests such as the Benton Visual Retention Test (BVRT (Benton 1945)) and the Sequential Matching Memory Task (SMMT (Lezak 1976)). The WMS includes two main scales of memory: a General Memory Index (GMI) and Working Memory Index (WMI). Notably, a WMI is also associated with both versions of the WAIS. However, both GMI
and WMI of the WMS includes total composite scores across a variety of memory categories, with GMI encompassing only delayed recall measures (e.g., memorize these words and recall the words at a later time) and WMI encompassing measures of both immediate and delayed recall. In addition, both versions of the WMS-R (Wechsler 1987) include the Paired Associate Learning test (PAL) component that is used to measure both verbal learning and recall.

The RAVLT/AVLT also measures both immediate and delayed recall, specially by asking participants to verbally recall up to 15 specific words that do not have to be in the same order. PR tests, on the other hand, measure retention of stories that have been presented to the participants rather than specific words and are included as components of the WMS. The BVRT measures the ability to attend and remember visual images instead of verbal information. Lastly, the SMMT is a task that measures working memory; however, it also requires abstract visuospatial recognition of matching abstract object placements. Arguably, all of these (and all) memory tasks rely on other cognitive functions and capabilities, such as attention and learning respectively. Specifically, individuals need to attend to stimuli in order to retain it for recall. Likewise, retention of information is, by definition, learning.

4.4.5. Executive Function

Neuropsychological testing of executive function measures the cognitive capabilities necessary for reason such as planning, organization, and goal direction. In addition, executive functioning tests measure abilities to flexibility adapt to changing environments, understand abstraction, and the ability to cognitively control reactions, referred to as response inhibition. Importantly, executive functioning tasks often require multiple cognitive processes. One of the most common executive function measurements is the Wisconsin Card Sorting Test (WCST (Grant and Berg 1948, Heaton, Chelune et al. 1993)) which primarily measures cognitive
flexibility through attention, learning, memory, abstraction, and reason, as in problem-solving. Specifically, the WCST measures task, or “set” shifting, that is the cognitive flexibility to adapt to task demands. Participants are shown a set of cards face-up that have different colored symbols and different numbers of the symbols on each card. Participants then have to decide how to match the cards and are given immediate feedback as to whether their matches are correct. There are three main ways to classify the cards: color of symbols, shape of symbols, or the number of symbols on the cards. However, the classification rules change after every few cards. Minus a few mistakes at first after every set shift, participants with normal executive functions are able to adjust and relearn rule contingencies. In addition, another task that measures cognitive flexibility is a task known as the Brixton Spatial Anticipation test (BSA (Burgess and Shallice 1997)), which is a simple visual version of the WCST in that it also requires individuals to detect rules, follow them, and then “set” shift; however, the task does not use cards but instead a visual layout of dots, with one highlighted in a different color, in which individuals have to select where they predict the corresponding color dot to follow. Further, cognitive flexibility can also be measured in TMT tasks that are typically used for attention. Specifically, TMT tasks technically measure executive function of cognitive flexibility through set shifting, as individuals have to shift between matching letters and numbers and remember (i.e., attention and memory) which placement they are at before they move on.

Tower Tests, such as the Tower of Hanoi (ToH) and Tower of London (ToL, a simpler version of the ToH) tasks (Shallice 1982) have also been used to measure abstract thinking, logic, and reasoning skills. In these tasks, individuals are presented with puzzles in which they must stack disks or objects of different sizes or colors on three different rods moving only one disk or object
at a time and without placing larger disks or objects on top of smaller ones. The end goal is to recreate the original formation of the stacked disks or objects.

Further, Category Tests (CT (Wetzel and Boll 1987)), such as the Short Category Test, Booklet Format (SCT-BF (Wetzel and Boll 1987)) and abbreviated version of Halstead Category Test (HCT (Reitan and Wolfson 1985)) are also non-verbal abstract reasoning tests in which individuals are presented with different objects or shapes that also differ in size and color and are asked to categorize them. CTs measures executive functions of planning and organization.

Likewise, Complex Figure tests (CF (Lezak 1983), most commonly the Rey-Osterrieth Complex Figures test (ROCF (Rey 1941, Osterrieth 1944)) measure the executive functions of planning but also, as the name suggests (i.e., ‘complex’) other cognitive processes. Specifically, these tasks require participants to recreate complicated geometric figure drawings, using attention, working memory, and visuospatial processes. Similarly, a task known as the Necker Cube (NC (Teuber 1964)) measures both visuospatial processing but also the executive function of abstraction and arguably attention and working memory. Specifically, the cube is slightly rotated and individuals have to indicate when they notice rotation changes.

Other tests measure non-verbal abstract reasoning and planning. The Visual Organization Test (VOT (Hooper 1958)), which has traditionally been considered a perceptual test (Farver and Farver 1982) but has also been considered a test which requires executive functions of planning, organization, and abstract reasoning (Whelihan and Lesher 1985), is a perceptual puzzle that requires individuals to select missing “pieces” to complete puzzles that range in complexity. Likewise, the Porteus Maze Test (PMT (Porteus 1950)) measures an individual’s ability to solve a visual maze using the executive function of planning by not getting distracted by interferences, lifting their drawing apparatus, crossing boundaries, or backtracking.
In addition, there are verbal measurements of reasoning. The Verbal Judgment tests (VJ (Spinnler and Tognoni 1987)) measures reasoning by giving individuals a set of short stories after which they are asked to making reason judgments and inferences about them. In addition, the Visual-Verbal Test (VVT (Feldman and Drasgow 1960)) requires individuals to view objects on cards, usually shapes and lines, and construct verbal representations of the objects.

In addition, response inhibition is also an executive functioning task typically measured through Stroop and Flanker tasks (which also requires attentional processes). However, the Hayling Sentence Completion Test (HSCT (Burgess and Shallice 1997)) measures response inhibition in which individuals are asked to complete sentences with nonsensical words. Likewise, the SRM, which is a measure of non-verbal intelligence, also requires attention, working memory and the executive function process of abstract reasoning by requiring participants to evaluate a pattern of shapes that vary in design and to select a similar pattern in order to fill in the missing ‘piece’. Both of these latter tasks demand participants to inhibit confusing distractors in order to select the appropriate option.

4.4.6. Perceptual (Visuospatial)

Lastly, visuospatial perceptual capabilities are typically measured as a control for other neuropsychological functions. In other words, it is important to know if participants have difficulty in these tasks because they have deficits in higher-order cognitive functioning or basic processing of visual information. Arguably, most tasks already reviewed require visuospatial processing (e.g., SSMT, VOT, PMT, NC, CF, TMT, Tower Tests, etc.; however, they also require other cognitive processes as well). One common task was designed to solely measure visuospatial processing is the Judgment of Line Orientation test (JLO (Benton, Varney et al. 1978)), which measures whether participants believe a set of lines are similar to or different from each other, often by length.
4.5. Populations Neuropsychology Performance

This section will highlight both populations’ neuropsychology measures and scores in the prominent studies that have been used to measure their moral cognition and their neurocognitive capacities through standardized neuropsychological testing. Refer to Tables 2 and 4 for an analyses of these results.

4.5.1. vmPFC Patients Neuropsychological Performance

For the measurement of moral cognition, I explored the reported neuropsychological measurements of vmPFC patients in Trolley-type tasks ($N = 4$) (Ciaramelli, Muccioli et al. 2007, Koenigs, Young et al. 2007, Moretto, Ladavas et al. 2010, Thomas, Croft et al. 2011) and in tasks that measured Intention/Outcome Assessments ($N = 2$) (Young, Bechara et al. 2010, Ciaramelli, Braghittoni et al. 2012). I also evaluated the neuropsychological measurements of two prominent studies that have aimed to assess the cognitive (and affective) dysfunctions of vmPFC patients ($N = 2$) (Anderson, Bechara et al. 1999, Anderson, Barrash et al. 2006), making a total of eight studies analyzed. I found that, vmPFC patients overall have retained cognitive, intellectual, and language capabilities with the following exceptions. Refer to Table 2 for a breakdown of these results.

First, these retained abilities are highly variable between patients. For instance, Anderson, Bechara et al. (1999) reports on two patients WAIS-R performance with detailed measures of four VIQ categories (information, arithmetic, digit symbol, and similarities, which can also be measures of attention and abstract reasoning) as well as two PIQ categories (block design, digit symbol, which can also be measures of attention and abstract reasoning). In addition, the patient’s WRAT-R and COWA measures are also reported. From these measures, these two patients performed very differently (see Table 3). Likewise, from the three other studies that reported raw scores for each patient instead of averages and standard deviations (Koenigs, Young et al. 2007, Young, Bechara
et al. 2010, Thomas, Croft et al. 2011), individual vmPFC patients ranged from low (80 – 89), average (90 – 109), high (110 – 119), and superior (120+) WAIS-III performance even though average of the scores reflect average performance. Particularly, Koenigs, Young et al. (2007) WAIS-III scores (N = 6) range from 89 – 142 for VIQ, 80 – 134 for PIQ, and 84 – 143 for FSIQ whereas both Young, Bechara et al. (2010) and Thomas, Croft et al. (2011) scores (N = 9 for both) range from 89 – 142 for VIQ, 80 – 134 for PIQ, and 84 – 143 for FSIQ (often the same subjects are used across studies; also see Young, Bechara et al. (2010) for a potential typo in which one patient was reported to have scored 11 for FSIQ, a number that would remarkably be a very low score). Refer to original publications for reported data.

Second, vmPFC patients did not exhibit retained intelligence or language comprehension for SRM measurements in Ciaramelli, Muccioli et al. (2007) (N = 7) or BDAE measurements of RSP and CIM in Thomas, Croft et al. (2011) (N = 9), two studies which claimed that abnormal vmPFC patient responses to Trolley-type dilemmas was due to emotion deficits alone. Recall that SRM measures non-verbal intelligence as well as the executive function of abstract reasoning and that the BDAE measures language comprehension through the RSP and CIM sub-categories. Importantly, the CIM measure is also thought to require memory and executive functioning components (Podell, Gifford et al. 2010).

Very few studies that measure vmPFC patient performance included measures of attention, often assuming that if the patients are able to perform certain tasks, then attention must be intact. This is interesting because vmPFC patients have been reported as having attentional deficits (Vecera and Rizzo 2004, Wolf, Philippi et al. 2014). In reference to the eight studies analyzed in for this manuscript, only two studies demonstrated deficits in Stroop tasks, which measures attention as well as the executive function of inhibition (Koenigs, Young et al. 2007, Moretto,
Ladavas et al. 2010). vmPFC patients did, however, perform normally on DS tasks in both Ciaramelli, Braghittoni et al. (2012) and Koenigs, Young et al. (2007).

Memory measurements indicated that vmPFC patients had difficulty with basic memory processes as well. vmPFC patients performed poorly in memory measures of the AVLT in Anderson, Barrash et al. (2006), Thomas, Croft et al. (2011), and Koenigs, Young et al. (2007). In addition, in Thomas, Croft et al. (2011) and Koenigs, Young et al. (2007), vmPFC patients also performed poorly on BDAE CIM, which as mentioned above, is a measurement of language comprehension requiring memory and executive function components (Podell, Gifford et al. 2010). Further, although Anderson, Barrash et al. (2006) did not find a significant difference between groups for the BVRT measurements, vmPFC patients did have descriptively higher error rates in this task, compared to non-vmPFC and healthy controls (7.9 compared to 5.8 and 5.2, respectively). Further, in Anderson, Bechara et al. (1999), one of the two vmPFC patients also performed notably different compared to the other vmPFC patient in RAVLT trial 5 (78 compared to 11) and in the 30 minute recall condition (99 compared to 68), indicating extreme variability between the patients in memory performance (refer to Table 3).

Likewise, as analyzed for the intelligence measure, the range of competence for vmPFC in memory measures is also relatively wide, spanning from low (80 – 89), average (90 – 109), high (110 – 119), and superior (120+) in WAIS-III WMI and WMS-III GMI and WMI performance. For the three studies that reported raw scores for each patient instead of averages and standard deviations (Koenigs, Young et al. 2007, Young, Bechara et al. 2010, Thomas, Croft et al. 2011), WASI-III WMI ranged from 80 – 119 in Young, Bechara et al. (2010) ($N = 9$) and from 80 – 121 in Thomas, Croft et al. (2011) ($N = 9$). WMS GMI ranged from 59 – 109 and WMI from 88 – 134 in Koenigs, Young et al. (2007) ($N = 6$).
Importantly, executive functions of vmPFC do not seem to be intact. vmPFC patients appear to perform poorly on the WCST, which measures cognitive flexibility and goal-directed behavior in a reinforcement learning paradigm. Specifically, in Anderson, Bechara et al. (1999) one of the two and in Koenigs, Young et al. (2007) one of the six vmPFC patients performed poorly on the WCST. In Ciaramelli, Muccioli et al. (2007) the entire vmPFC group (\( N = 7 \)) performed poorly on the WCST regarding retaining, or perseverative, error-type responses. Only one study reported normal performance on the WCST; however, the errors were descriptively larger with wider standard deviations (SD) for vmPFC patients (46.3, SD = 16.2) compared to non-vmPFC (37.7, SD = 15.0) and healthy (41.2, SD = 23.9) controls (Anderson, Barrash et al. 2006).

More so, patients performed poorly on the Stroop Task, which measures attention and inhibition, in Moretto, Ladavas et al. (2010) and Koenigs, Young et al. (2007), suggesting overall deficits in attention and cognitive control. vmPFC patients also tended to perform poorly on other measures of executive functioning that require planning, organization, abstract thinking, and reasoning. Specifically, in Anderson, Bechara et al. (1999), both patients were unable to complete the ToH. Interestingly, one patient happened to do well in one out of five ToH trials, perhaps suggesting that they were able to attend to the task for at least one trial but not the other four trials (refer to Table 3). Further, vmPFC patients also had difficulty with TMT tasks, which measures both attention and cognitive flexibility through task switching. In particular, in Thomas, Croft et al. (2011) two out of the nine patients and in Young, Bechara et al. (2010) one out of nine patients performed poorly on this task. In addition, group statistics from Anderson, Barrash et al. (2006) indicate that vmPFC patients took longer times (measured in seconds) to complete the task, also with wide SDs. Specifically, vmPFC patients (Trail A: 62.4, SD = 58.6; Trail B: 136.7, SD = 80.3)
took longer than non-vmPFC patient (Trail A: 36.6, SD = 19.1; Trail B: 79.8, SD = 41) and healthy controls (Trail A: 42.7, SD = 15.8; Trail B: 131, SD = 58.2) (Anderson, Barrash et al. 2006).

In addition, vmPFC patients performed poorly on the SRM (Ciaramelli, Muccioli et al. 2007) and the BDAE measurement of CIM (Thomas, Croft et al. 2011) in some tasks, yet performed well on the SRM (Moretto, Ladavas et al. 2010) and the BDAE measurement of CIM in others (Young, Bechara et al. 2010). Recall that SRM measures non-verbal intelligence and requires attention and working memory as well as executive functioning process of abstract reasoning while CIM measures complex language processing also requiring the cognitive processes of memory and executive functioning through abstract reasoning. Lastly, and notably, vmPFC patients also performed poorly on VJ in Ciaramelli, Muccioli et al. (2007) and CF in Anderson, Bechara et al. (1999). VJ measures reasoning while CF tests measure the executive functions of planning but also require other cognitive processes of attention, working memory, and visuospatial processing.

Taken together, vmPFC patients do not all necessarily have retained basic cognitive functionality as assessed in standard neuropsychological testing. Specifically, instances in which aggregate data indicate retained cognitive capabilities still include patients who are deficient in certain cognitive tasks. Unless all individuals are capable of these basic cognitive functions, then data from these populations should not be used to support the claim that the patients have specific deficits in emotion. Importantly, many of these tasks measure deficits in reason that are not composed of affective content, suggesting that vmPFC patients have deficits in reason despite emotion. In addition, neuropsychological deficits that are observed are not correlated with overall task performance; therefore, there is not a way to tell if the patients’ abnormal performance on moral cognition tasks has anything to do with basic deficits in cognition. Interestingly, direct
measures of basic processes, such as attention, are rarely measured and failure to perform normally on certain neuropsychological tasks that measure as memory and executive function are often ignored in terms of how these cognitive deficits could affect task performance.

### 4.5.2. Psychopathy and Neuropsychological Performance


Specifically, Cima, Tonnaer et al. (2010), which found that psychopaths respond similarly to controls in Trolley-type tasks, reported IQ performance but did not specify which IQ test was used. Overall, IQ scores were descriptively lower, though not significantly, than control populations. Likewise, Trolley-type performance measured in Koenigs, Kruepke et al. (2012) and Intention/Outcome performance measured in Young, Koenigs et al. (2012), which both found abnormal moral judgments of psychopathic participants, only took a measure of IQ, specifically using estimated IQ using the Shipley Institute of Living Scale (Zachary 1986), which also did not significantly differ between the experimental groups.
The only study out of the four moral cognition studies analyzed within the adult criminal psychopathic population that did include more standardized neuropsychological measurements was Pujol, Batalla et al. (2012). Specifically, Pujol, Batalla et al. (2012) measured psychopathic participants on WAIS-III and the Stroop Task as well as some additional measures of sensitivity to rewards and punishments (i.e., using the Torrubia Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) (Torrubia, Avila et al. 2001)), impulsivity (i.e., using the Barratt Impulsiveness Scale (BIS) (Patton, Stanford et al. 1995)), and obsessive compulsiveness (i.e., using the Yale-Brown Obsessive Compulsive Scale (Y-BOCS) (Goodman, Price et al. 1989)).

Pujol, Batalla et al. (2012)’s overall findings support Cima, Tonnaer et al. (2010)’s results that psychopaths are not deficient in moral judgment in Trolley-type tasks. In addition, Pujol, Batalla et al. (2012) found that psychopaths performed similarly to controls on the WAIS-III VIQ measure of VCI. Psychopaths also performed similarly to controls on the Stoop Task, suggesting no impairment in attention or the executive function of inhibition. However, psychopaths did perform poorly on the BIS, suggesting inhibition, as in impulsivity, deficits. Further the obsessive compulsive measure of the Y-BOCS showed no significant difference between groups even though descriptively, psychopathic individual demonstrated more obsessive compulsive tendencies. Interestingly, unlike most research that suggests that psychopaths are specifically deficient in processing punishment (Lykken 1957, Hare 1965, Hare 1965, Hare 1965, Hare and Quinn 1971, Hare and Craigen 1974, Hare 1978, Hare 1978, Hare, Frazelle et al. 1978, Hare 1982, Patrick 1994, Lykken 1995, Verona, Patrick et al. 2004, Fung, Raine et al. 2005), results from Torrubia’s Sensitivity to Rewards and Punishment scale revealed no significant difference between groups for punishments but a significant difference between groups for rewards (Pujol, Batalla et al. 2012).
Given that only one out of four studies actually collected neuropsychological and other performance measures (i.e., BIS and Y-BOCS) of psychopaths, there is not sufficient evidence to support or deny any claim that psychopaths have intact or deficient neuropsychological processes in attention, memory, or executive functioning. This is alarming because psychopaths have notable attention (Raine and Venables 1988, Patterson and Newman 1993, Kiehl, Hare et al. 1999, Howard and McCullagh 2007, Munro, Dywan et al. 2007, Munro, Dywan et al. 2007, Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011, Newman and Baskin-Sommers 2011, Larson, Baskin-Sommers et al. 2013, Zeier and Newman 2013, Hoppenbrouwers, van der Stigchel et al. 2015) and learning (Lykken 1957, Shmauk 1970, Newman, Widom et al. 1985, Newman and Kosson 1986, Newman, Schmitt et al. 1997, Blair, Colledge et al. 2001, Flor, Birbaumer et al. 2002, Mitchell, Colledge et al. 2002, van Honk, Hermans et al. 2002, Budhani, Richell et al. 2006, Kiehl 2006, Mitchell, Fine et al. 2006, Beszterczey, Nestor et al. 2013, Dargis, Wolf et al. 2017) deficits. Without a measure of the neuropsychological capabilities of each individual psychopathic participant, there is no way to know whether the participants have intact neurocognitive functioning nor is there a way to correlate potential neurocognitive deficits with overall task performance. Unfortunately, research regarding the higher-order cognitive capabilities of psychopaths, as in moral cognition, are not employing additional measures to test basic cognitive functioning, resulting in many questions left unanswered.

While moral psychology research rarely takes neuropsychological measurements when using psychopathic populations, there are plenty of studies that have specifically measured the neurocognitive functions of psychopaths, especially within adult criminal populations (Gorenstein 1982, Sutker, Moan et al. 1983, Hare 1984, Sutker and Allain 1987, Hart, Forth et al. 1990, Smith, Arnett et al. 1992, Cornell, Roberts et al. 1997, Nestor, Kimble et al. 2002, Pham, Vanderstukken

Studies that demonstrated significant deficits in adult criminal psychopaths found deficits in cognitive processes that require attention, memory, and all of the executive functions regarding reasoning (i.e., planning, organization, and goal direction), cognitive flexibility, abstraction, and response inhibition. IQ levels overall appear to be intact, or at least, no different from controls. Specifically, attention deficits were found in TMT (Smith, Arnett et al. 1992, Pham, Vanderstukken et al. 2003), Stroop tasks (Gorenstein 1982), D-II (which also measures attention but among distractors) (Losel and Schmucker 2004). Likewise, memory deficits were found in WMS-R (Nestor, Kimble et al. 2002) and SMMT (which measures memory as well as executive functions of abstraction) (Gorenstein 1982).

Importantly, adult criminal psychopaths also have deficits in the WCST (Gorenstein 1982, Nestor, Kimble et al. 2002) and BSA (Bagshaw, Gray et al. 2014). Likewise, psychopaths have reported deficits in ToL (Bagshaw, Gray et al. 2014), which measures abstracting planning, organization, abstract thinking, and reasoning skills. In addition, adult criminal psychopaths have difficulty with the NC (Gorenstein 1982) and the block design category of the WAIS scales, which requires abstract thinking and reasoning about shapes (Smith, Arnett et al. 1992). Interestingly,

However, other studies have not found deficient neurocognitive functions in each of these same and additional categories. Specifically, adult criminal psychopaths have been found to have intact WAIS-R scores (Sutker and Allain 1987, Hart, Forth et al. 1990, Smith, Arnett et al. 1992, Nestor, Kimble et al. 2002), which measure a variety of cognitive functions including attention, memory, abstraction and reasoning through its multiple categories. Likewise, language fluency measured through the COWA (Hart, Forth et al. 1990, Smith, Arnett et al. 1992) and HSCT (Bagshaw, Gray et al. 2014) (which also measures abstraction) seem to be intact. Further, adult criminal psychopaths have been shown not to have attention and/or task switching deficits in the TMT (Hart, Forth et al. 1990) (although SDs within groups are very high (Smith, Arnett et al. 1992) likely resulting in a null effect), attention and/or response inhibition (i.e., executive functioning) deficits in Stroop tasks (Smith, Arnett et al. 1992, Pham, Vanderstukken et al. 2003), or in attention in general, as measured with the D-II (Pham, Vanderstukken et al. 2003) (although psychopaths did make descriptively more errors with larger SDs in the D-II task (Pham, Vanderstukken et al. 2003)). Memory functioning has also been found to be intact in the PAL subset of the WMS (Smith, Arnett et al. 1992), the AVLT (Hart, Forth et al. 1990), BVRT (Hart, Forth et al. 1990), and SMMT (Hare 1984).

Importantly, some research has also found that adult psychopaths perform similarly to controls in the WCST (Sutker, Moan et al. 1983, Hare 1984, Sutker and Allain 1987, Smith, Arnett
et al. 1992, Pham, Vanderstukken et al. 2003, Mol, Van den Bos et al. 2009); however, even if a significant difference between psychopath and control groups was not found, in two of these studies, psychopaths descriptively committed more errors and the SDs within each group are extremely high (Smith, Arnett et al. 1992, Mol, Van den Bos et al. 2009).

Likewise, adult criminal psychopaths seem to perform similarly to controls on the ToL (Pham, Vanderstukken et al. 2003) (again, though not significantly different than controls, psychopaths descriptively made more errors with high SDs) and on CT (Smith, Arnett et al. 1992) tests. Specifically regarding CT, one study found that ROCF, which includes executive functioning of abstraction, correlates with poor psychopathic performance on CT, TMT, and Block DESIGN of WAIS-R (Cornell, Roberts et al. 1997). Likewise, adult criminal psychopaths displayed normal responses in the SCT-BF (Smith, Arnett et al. 1992) and HSCT (Smith, Arnett et al. 1992) as well as PM, with the exception of having descriptively more errors with larger SDs in the PM task (Pham, Vanderstukken et al. 2003).

Abstract visuospatial judgments were also intact in psychopaths measured by the NC (Hare 1984) and VOT (Hart, Forth et al. 1990). Likewise abstract reasoning and descriptions through PM (Sutker, Moan et al. 1983, Sutker and Allain 1987, Pham, Vanderstukken et al. 2003) and VVT (Sutker and Allain 1987) seem to be intact.

Taken together, the results are truly mixed. Interestingly, not all studies that measured psychopathic neuropsychological capabilities, especially the ones that claim that psychopaths have intact capability, actually used control groups. Specifically, these studies just measured within the psychopathic population, comparing between low, medium, and high scoring psychopaths based on how they scored on their diagnoses (Hare 1984, Hart, Forth et al. 1990). Further, one group of researchers have found that regarding the WCST, psychopaths perform similarly to controls.
(Smith, Arnett et al. 1992) until real financial incentives are at stake (Howland and Newman 1987). Importantly, these mixed results further support the notion that unless studies control for potential information processing confounds then data from these populations should not be used to support the claims that psychopaths have specific deficits in emotion.

4.6. Conclusion

In conclusion, one cannot rule out the possibility that the populations have deficits in more basic cognitive processes that are necessary for the higher-order processes of both emotion and reason. Importantly, because of this, data from the populations should not be used as evidence to support the notion that the populations have specific deficits in emotion or that emotion is necessary for moral cognition. In fact, in support of information processing theories of psychopathy, it appears that both populations have basic neurocognitive deficits in attention and memory which affect their performance in more complicated, and complex, executive functioning tasks. Notably, many of these tasks measure reasoning capability without a hint of affective content. Therefore, as evidenced in this manuscript, both populations have deficits in basic information processes that likely affect higher-order processes of both emotion and reason.

In order to control for potential confounds of having deficits in basic cognitive processes, future studies should employ standardized batteries of neuropsychological testing when measuring the moral cognition of the populations and exclude participants who perform poorly on these basic tasks. Further, all studies should report neuropsychological measurements and correlate overall behavioral performance with neurocognitive scores. In addition, because many of these neuropsychological tests require multiple processes, and because both populations have known information processing deficits in attention and value, all studies using these and similar populations should also employ standardized, and more direct, measures of attention, such as by
using D-II, as well as including odd-ball and Flanker tests in standardized neuropsychological testing.

Further, both attention and value deficits can be controlled by minimizing task complexity. Specifically, the populations’ information processing deficits in attention and value seem to be pronounced when situations become complex, such as when too many options are present (Fellows 2006) or when there is a time limit (Kiehl 2007, Chen, Muggleton et al. 2008). Specifically, vmPFC patients have difficulty making judgments and decisions in tasks that require comparing multiple options at the same time, as evidenced by the strategy they use when comparing options. The patients tend to evaluate options in a way to minimize complexity, suggesting difficulty in assessing and comparing value of and between the options (Fellows 2006). More so, while psychopaths are able to pay attention to stimuli at the very beginning of tasks, they have difficulty keeping their attention as the task progresses. This is known as early and late attention, with psychopathy associated with intact early attentional but deficient late attentional processes. Studies that have controlled for these basic information processing deficits have in fact found that the populations’ abnormal task responses diminish and are no longer different from controls (Fellows and Farah 2005, Moretti, Dragone et al. 2009, Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011).

Importantly, until studies take the appropriate measures in order to control for potential information processing deficits of cognition function, then it is uncertain if the populations’ main effect in moral cognition tasks are due to emotion deficits alone. In other words, it is too early to conclude that data from these populations definitely support the claim that emotion is necessary for moral cognition.
4.7. Tables

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<td></td>
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<td>DI</td>
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**Table 2.** vmPFC patient neuropsychological performance on both moral cognition tasks (N = 6) and tasks that aimed to measure only neuropsychological functioning (N = 2). TP = Trolley-type Problem tasks, IO = Intention/Outcome Assessment type tasks. Red text indicates deficient processing. Refer to Table 1 for neuropsychological testing abbreviations.
Table 3. Table comparing two vmPFC patients’ neuropsychological performance. From Anderson, Bechara et al. (1999) borrowed with permission.
Table 4. Psychopathy neuropsychological performance discussed in this manuscript as measures outside of moral cognition task. Studies are listed in order by date. IQ, Language, and Visuospatial (Perceptual) categories are not included.
4.8. References


CHAPTER FIVE: Summary and Discussion

The primary objective of this dissertation is to suggest that data from the populations should not be used to support the view that emotion is necessary for moral cognition because vmPFC patient and psychopathic populations have basic information processing deficits that affect high-order processes of both emotion and reason which can be used to alternatively explain the populations’ aberrant moral behavior and abnormal moral cognition. This objective is accomplished in three distinct manuscripts that demonstrate the following:

- vmPFC functionality and vmPFC patient behavior have been associated with basic information processing of value, as in assessing (learning, comparing, and predicting) value of stimuli and outcomes, of both affective and non-affective content. From this, vmPFC patient behavior in moral cognition tasks could otherwise be explained by having deficits in value assessment, especially in tasks that are inherently complex, and may in fact be using a heuristic in order to minimize task demand (Manuscript 1, indexed by Chapter 2).

- Abnormal moral cognition of psychopaths does not necessarily correlate with having deficits in affective characteristics but instead with deficits in interpersonal and lifestyle psychopathy characteristics, with lifestyle deficits reflecting disruption in information processing of attention (Manuscript 2, indexed by Chapter 3).

- Both vmPFC patients and psychopaths have deficits in basic cognitive functions, as indexed through neuropsychological testing. These deficits are in tasks that measure attention, memory, and executive functioning, particularly in reasoning paradigms that are void of affective content (Manuscript 3, indexed by Chapter 4).  


Overall, the information processing perspective of the populations’ deficits suggests that data from the populations should not be used to support the claim that emotion is necessary for moral cognition because using the terms “emotion” and “reason” inaccurately describe the deficits the populations actually have. Attempts to adhere to the age-old dichotomic Emotion-Reason debate ignore other possible, more simple explanations of the populations’ behaviors and cognition and may simply be the wrong level of description.

The following subsections detail notable flaws with the emotion view and the benefits of the information processing perspective. Further, the populations’ similarities and differences are discussed after which controls for future research and applications for therapy are suggested.

5.1. Flaws with the Emotion View

While the emotion view is an obvious explanation for the observed behavioral deficits of the populations, the emotion view is flawed. First, the emotion view largely relies on evidence that assumes that observations of particular behaviors automatically equate to having deficits in the interpretation of what is observed. For instance, as discussed in Manuscript 2 (Chapter 3), behaving in ways that appear to display failure to take responsibility for one’s actions does not necessarily mean that the individual does not care. In fact, the individual could care immensely and be acting in ways to avoid being further emotionally affected by their actions. In addition, both populations are described as having abnormal emotional responses from observations of caregivers and/or clinicians; however, descriptions of behaviors from caregivers and/or clinicians are mere interpretations of the behavior that is observed and these interpretations may not necessarily be correct. For example, what appears to be a behavior lacking in emotion (e.g., an apathetic response to an emotional situation) does not necessarily mean that behavior is caused by having a deficit in emotion. The person could just not be paying attention to the situation at hand, perhaps because
they are distracted, or failing to comprehend the significance of the situation because they have difficulty assessing value. Known as multi-determinism in philosophy and demonstrated by many-to-one mapping in neuroscience (Dretske 1988, Juarrero 1999, Miller and Keller 2000, Gazzaniga 2010, Gazzaniga 2011), the same behavior can arise from multiple causes and interpretations of behavior based on observation does not necessary mean that the most obvious interpretations are correct. Importantly, many of the assertions that the populations have emotional deficits are in fact descriptions from others (care-givers and/or clinicians) (Anderson, Barrash et al. 2006, Hare and Neumann 2008) and are not verified using other measurements.

In addition, while both populations have described abnormal subjective emotional experience through self-report and have failed laboratory testing of measurements of embodied emotion, methods of self-report and laboratory testing also are flawed. For instance, self-report measures can be skewed by participant bias and/or lack of truthfulness due to perception and memory. Psychopathic individuals are known to lie, either for a ‘mask of sanity’ (Cleckley 1976/1941) or perhaps to even bolster their impression to others out of egotistic desire (i.e., the interpersonal facet that is likely driving Factor 1 diagnosis as demonstrated in Manuscript 2 (Chapter 3)). In addition, memory is very important in self-identification and self-perception (Kihlstrom, Beer et al. 2003, Singer and Blagov 2004). As evidenced in Manuscript 3 (Chapter 4), not every vmPFC patient has intact memory, which could, in turn, obstruct self-report perceptions of one’s self. Further, research explorations often use novel measurements which must be evaluated by research communities in order for conclusions based on results to be accepted. Even research methods that are widely replicated within research communities are not necessarily fully accepted as being sound. For instance, Greene, Sommerville et al. (2001)’s battery of dilemmas still receives gross criticism for not being conceptually sound (Kahane and Shackel 2008,
Further, even though both populations overwhelmingly display deficient subjective expressions of emotion (i.e., embodied emotion) when exposed to emotionally salient stimuli, there is some evidence that suggests that failure to display physiological expressions of emotion does not necessarily mean that one does not still experience emotion. Particularly, there are reports of healthy participants performing well on the IGT yet displaying reduced SCRs or not performing well yet displaying normal SCRs (Crone, Somsen et al. 2004), suggesting variance in physiological expressions of emotion. In other words, not every individual automatically responds to emotion in the same way, challenging the prevailing assumption that emotional expression is uniform (Izard 1977, Ekman 1992, Izard 1992, Ekman 2003). Further, recent studies have found heterogeneity in how individuals express emotions, both in behavioral (facial expressions and approach/avoidance reactions) as well as physiological expressions of emotional experience (Barrett, Lindquist et al. 2007, Harmon-Jones, Harmon-Jones et al. 2009, Kassam and Mendes 2013, Siegel, Sands et al. 2018). Likewise, there is heterogeneity in the individual capability of recognizing the emotional expressions of others (Barrett, Mesquita et al. 2007, Barrett 2017, Siegel, Sands et al. 2018) as well as neural responses to emotion (Touroutoglou, Lindquist et al. 2015). These new findings challenge the SMH (Damasio 1994, Bechara, Damasio et al. 2000) and current theories as to what subjective processes (e.g., bodily arousal, expressive behaviors, and conscious experience) constitute emotion (Myers and DeWall 2015).

Further, both populations do report that they still subjectively experience emotion, so they are not emotionally void per se. As mentioned in the Introduction, both vmPFC patients and psychopaths report having retained, diminished, or exaggerated emotions. While diminished
emotion implies not subjectively experiencing emotion through emotion processing, at least not to the same degree as others, exaggerated emotion implies having emotion but a lack of emotion regulation. Both emotion processing and emotion regulation deficits under the umbrella of the emotion view imply emotion disruption and each relate to Hume and Kant’s differing view of which process contributes the most to morality. Specifically, emotion processing directly relates to Hume’s theory that feeling emotion is necessary to guide moral judgment and behavior and without this ability, individuals would behave no differently than the pop-culture conceptualization of the emotionally void, stone-cold psychopath. Emotion regulation, on the other hand, implies that after emotion has been processed, the emotion can be controlled through processes of cognitive and executive control in order to prevent outbursts of emotional reactivity, relating to Kant’s theory that cognitive control over emotional reactivity through reason (e.g., the remembrance of rational principles) is necessary to preserve moral character and conduct. However, the observation that the populations have difficulty in both emotion processing and emotion regulation suggests that the dichotomy between these two views is not clear, demonstrating that the vmPFC functionally is responsible for both and/or that the Emotion-Reason framework may not be the right level of description with which to categorize the populations deficits. Uniquely, the information processing perspective can explain why the populations have difficulty in both emotion processing and emotion regulation while also leaving the terms “emotion” and “reason” out of it.

Lastly, similar to vmPFC patients and psychopaths, amygdala lesioned patients have traditionally been believed to lack emotional experience but have recently been found to have information processing deficits that can otherwise explain their abnormal behaviors. Specifically, amygdala lesioned patients were believed to not experience emotion through self-report as well as
through lack of physiological and behavioral expressions of emotion, especially to the negative emotional state of fear (Adolphs, Tranel et al. 1994, Adolphs, Gosselin et al. 2005, Feinstein, Adolphs et al. 2011). In addition, the amygdala has been a structure that has been traditionally functionally associated with aggression, then more generally negative emotional states, and lastly emotion in general (Davis 1992, Feinstein, Adolphs et al. 2011). However, recent evidence has demonstrated that amygdala patients do in fact report experiencing emotion and retain the ability to make judgments and decisions about emotional stimuli, even when they lack physiological and behavioral reactions (Piech, McHugo et al. 2010, Bach, Talmi et al. 2011, Feinstein, Adolphs et al. 2011, Edmiston, McHugo et al. 2013, Feinstein, Buzza et al. 2013, Feinstein, Khalsa et al. 2016). In addition, functional imaging has associated the amygdala with basic information processes, such as attention and learning (i.e., value processing) when exposed to affective content (Gallagher and Holland 1994, Holland and Gallagher 1999, Williams, McGlone et al. 2005). More so, new research has implicated the amygdala in novelty detection not specific to emotion. This latest research demonstrates that despite the content of stimuli (e.g., with or without affective content), the amygdala is selectively active when participants are exposed to novel stimuli (Blackford, Buckholtz et al. 2010, Blackford, Avery et al. 2011). It is then hypothesized that amygdala lesioned patients may have select difficulties in recognizing fear because fear is, fortunately, a relatively novel emotional feeling and expression to observe (Barrett 2017). Arguably, similar explanations could be made for vmPFC patient and psychopathic populations. Both vmPFC patients and psychopaths also have marked deficits in the objective identification of fear (among other negative emotional states) (Hornak, Rolls et al. 1996, Blair and Cipolotti 2000, Blair and Coles 2000, Blair, Colledge et al. 2001, Stevens, Charman et al. 2001, Blair, Mitchell et al. 2004, Dolan and Fullam 2006, Hastings, Tangney et al. 2008, Vandekerkhove, Plessers et al.
Amygdala patients also avoid looking at the eye region of faces when objectively identifying the emotions of others (Adolphs, Gosselin et al. 2005) and like research with psychopaths (Newman, Curtin et al. 2010), deficits in identifying fearful expressions of faces is diminished once the participants are explicitly instructed to pay better attention (Adolphs, Gosselin et al. 2005). Therefore, while the emotion view was once the prominent explanation of the abnormal behaviors of amygdala patients (and of amygdala functionality), new research has adopted the more parsimonious information processing perspective which can be similarly applied to vmPFC patient and psychopathic populations.

5.2. Benefits of the Information Processing Perspective

The information processing perspective encompasses a larger collection of psychological and neuroscientific findings from diverse methodologies that the emotion view cannot. Specifically, the information processing perspective utilizes research from both non-human animal and human studies and can explain findings that implicates vmPFC functionality in tasks that include both affective and non-affective content. The information processing perspective can also explain why the populations have both diminished and exaggerated subjective experiences of emotion and how deficits in the objective identification of emotion (or of anything) can cause abnormal behavior, especially regarding processes necessary for empathy. Lastly, the information processing perspective can also explain why the populations’ deficits are pronounced in content that involves affect while highlighting that any content that involves inherent complexity will likely result in response deficiencies.
First, the information processing perspective can account for vmPFC functional activity in emotion processing, emotion regulation, moral cognition, and in tasks that are not composed of affective content whereas the emotion view can only account for results within an affective framework (i.e., in tasks that only involve affective content). For instance, evaluating stimuli, affective or not, requires value assessment which is necessary for emotion processing, moral judgment and decision tasks that require evaluation, and in any task that involves the evaluation of an option. In addition, if the vmPFC does have a functional role as a common neural currency (Montague and Berns 2002, Grabenhorst and Rolls 2011, O’Doherty 2011, Levy and Glimcher 2012), it would, in turn, also regulate emotional responses by providing a “stopping” mechanism in order to compare disparate value signals. The emotion view cannot account for the role of the vmPFC in value processing, comparing, or prediction in tasks that are void of affective content and instead must embrace the information processing view. In fact, in light of the growing evidence that implicates the vmPFC in value assessment rather than emotion, researchers who have been avid supporters of the emotion view of vmPFC functionality (Greene, Sommerville et al. 2001, Greene, Nystrom et al. 2004, Greene, Morelli et al. 2008) have now adopted the information processing perspective. Specifically, Shenhav and Greene (2010) recently found that the vmPFC (as well as the ventral striatum) is active when individuals judge the expected value of saving versus sacrificing lives in moral dilemmas. Likewise, Shenhav and Greene (2014) also found that the vmPFC acts as a valuation center, proposing an “integrative judgment theory” of vmPFC functionality for both emotion and utilitarian (i.e., here synonymous with reason (Greene, Sommerville et al. 2001)) considerations that mimics value comparison theories of vmPFC functionality. Other researchers have since reinterpreted these findings, proposing that the vmPFC may act as an valuation center but also have a role in the emotional regulation of the amygdala to
prevent exaggerated emotional responses (Hu and Jiang 2014). Similar to this latter reinterpretation, the information processing view embraces vmPFC functionality as being both an evaluation center as well as responsible for regulating emotion.

Second, the information processing perspective can explain why the populations have both diminished and exaggerated emotional reactivity. As described in Manuscript 1 (Chapter 2), if individuals are missing relevant information because they are not attending to it (i.e., attention) or have difficulties learning from it (i.e., value), then subjective expressions of emotion would be abnormal. Especially as this relates to embodied emotion and behavioral expression, individuals would display diminished emotional reactivity because they are literally missing crucial information necessary for such affective computations necessary for physiological and behavioral reactions. Likewise, exaggerated emotional reactivity could also be caused by deficient processing in value assessment. As described in Manuscript 1 (Chapter 2), if the vmPFC has a functional role in value integration (Montague and Berns 2002, Grabenhorst and Rolls 2011, O'Doherty 2011, Levy and Glimcher 2012), then individuals with vmPFC disruption would display impulsive and outwardly emotive behaviors and an overall lack of emotion regulation. Specifically, without a functional value integration center of the brain that compares values from multiple regions, including affective value signals from the amygdala, whichever signal travels fastest may likely cause the resulting behavior due to not having the vmPFC acting as a “stopping” mechanism for value comparison. The value signals that are temporally computed first are often ones that are relayed from reward and emotion centers of the brain, that being the ventral striatum and amygdala (Decety and Cacioppo 2012, O'Doherty, Cockburn et al. 2017), and typically result in poor choices and impulsive behaviors (Steinberg 2007). Alternatively, deficits in attention can also account for deficits in value (Lim, O'Doherty et al. 2011), including how value can be used for emotion
regulation (Ochsner and Gross 2005, Kanske, Heissler et al. 2011). Specifically, while attention is needed in order to adequately process information about value in the first place, attention is also needed in order for an individual to know what information is relevant for regulation and comparison.

Third, the information processing perspective can also explain why the populations display empathy deficits. Empathy requires ToM, whether it be affective (e.g., their feelings) or cognitive (e.g., intentions) objective identification (Baron-Cohen and Wheelwright 2004, Blair 2005). ToM, in turn, relies on the abilities to detect relevant stimuli regarding the situation or object being assessed, which arguably are the basic information processes of attention and value assessment. If an individual is not paying attention to certain regions of a face, as found with vmPFC patients (Wolf, Philippi et al. 2014), they will make different judgments about the facial expression than individuals who are. In other words, lacking the capability to objectively recognize the emotional states of others does not necessary mean that the populations themselves lack emotional experience. Instead, deficits in attention can alternatively explain why the populations fail tasks that are meant to infer empathetic capabilities.

Fourth, the information processing perspective can explain why the populations’ deficits are especially pronounced in situations that involve affect. While it assumed that affective significance directs attention (Compton 2003, Bless and Fiedler 2006, Grabenhorst and Rolls 2008, Huebner, Dwyer et al. 2009, Huebner 2015) and that the populations may have pronounced deficits in affective content because they have specific deficits in attending to affective (Wolf, Philippi et al. 2014) or social (Vecera and Rizzo 2004) information, not all evidence supports this view. First, psychopathy is associated with overall attentional deficits, regardless of whether the task composes of affective content. Second, as evidenced in Manuscript 3 (Chapter 4), both populations fail
simple tasks that are void of affective content that measured attention. While the ability to process affective information may depend on attention (Erthal, de Oliveira et al. 2005, Mitchell, Nakie et al. 2007, Glass and Newman 2009), deficits in attention and not affective information is what seems to be driving the populations aberrant behavior and abnormal cognition. Specifically, vmPFC patients fail objective emotion recognition tasks because they do not attend to the eye region of faces (Wolf, Philippi et al. 2014). Likewise, psychopaths miss pertinent information about the world because they fail to attend to stimuli as time passes (Zeier, Maxwell et al. 2009, Newman, Curtin et al. 2010). Therefore, an alternative reason for why the populations’ deficits are especially pronounced in situations that involve affect is needed.

As proposed in Manuscript 1 (Chapter 2), it is suggested that content may inherently be more complex. Interestingly, both attention and value assessment deficits seem to be especially pronounced in situations that are complex, measured through task demand of information overload or temporal pressure. vmPFC patients have marked difficulty with abstraction and complexity in the real world (Anderson, Barrash et al. 2006), especially when measured in laboratory tasks in which reinforcement contingencies continually change (Bechara, Damasio et al. 1994, Bechara, Tranel et al. 1996, Bechara, Damasio et al. 1997, Fellows and Farah 2003, Fellows and Farah 2005) or when too many options are present (Fellows 2006). Psychopaths also display difficulties with complexity, as their attention span diminishes over time (Levenston, Patrick et al. 2000, Baskin-Sommers, Curtin et al. 2011, Larson, Baskin-Sommers et al. 2013) and they have difficulty making decisions when there is enforced time pressure (Kiehl 2007, Chen, Muggleton et al. 2008). Likewise, as evidenced in Manuscript 3 (Chapter 4), certain executive functioning tasks in which the populations fail are in fact tasks that measure complex reasoning processes, evidence that the populations have deficits in reason as well as emotion, especially when task complexity increases.
Specifically, the populations display deficits in tasks that require complex processes such as planning, organization, flexibility adapting to changing environments, understanding abstraction, and goal direction. Therefore, it is possible that the pronounced deficits of the populations in affective paradigms is likely a result of complexity rather than emotion. In other words, the information processing deficits of the populations become apparent when complexity increases, not whether emotion is present.

In support of this view, there is some evidence that the populations display relatively normal physiological reactivity and behaviors in simple paradigms. While both populations overwhelmingly display deficits in subjective expressions of emotion when exposed to emotionally salient stimuli, vmPFC patients do have normal physiological responses to simple, and not anticipatory, emotional startle responses (Anderson, Bechara et al. 1999) and that psychopaths display normal physiological (Lorber 2004) and behavioral responses to information that occurs early (in time) relative to task demands (Levenston, Patrick et al. 2000, Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011, Newman and Baskin-Sommers 2011, Larson, Baskin-Sommers et al. 2013).

More so, there are indications that once these information processing deficits are accounted for during laboratory testing, the stereotypical observed behavioral deficits diminish. Specifically, Manuscript 1 (Chapter 2) highlights two studies in which the behavior of vmPFC patients mimic that of controls once information processing deficits of value have been controlled. Specifically, when Fellows and Farah (2005) created a shuffled version of the IGT, vmPFC patients’ performance was no longer abnormal. In addition, Moretti, Dragone et al. (2009) demonstrated that vmPFC patients have difficulty comprehending value predictions and computations in a behavioral economic game known as the ultimatum game (where offers from one player are
deemed fair or unfair by a second player; both vmPFC patients and psychopathic individuals have performed abnormally in this and other economic games (Koenigs and Tranel 2007, Krajbich, Adolphs et al. 2009, Moretti, Dragone et al. 2009, Koenigs, Kruepke et al. 2010, Camille, Griffiths et al. 2011, Vieira, Almeida et al. 2014)). However, when Moretti, Dragone et al. (2009) made the information of the value associated with the options more apparent and easier to comprehend (i.e., by decreasing complexity), vmPFC patients performed similarly to controls. In other words, once the patient’s information processing deficits were compensated for by reducing complexity, the abnormal behavior of the patients went away. A similar observation highlighted in Manuscript 2 (Chapter 3) has also been made in psychopathic individuals regarding attention. Studies that measured startle responses of fear to threatening stimuli found that psychopaths demonstrated intact emotional responses in task conditions that demanded explicit attention to threat-relevant stimuli (Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011). Likewise, psychopathy IGT performance has been found to be mediated by attention span (Losel and Schmucker 2004). This evidence suggests that not only do these populations perform similarly to controls once their basic information processing deficit is controlled, but that their so-called deficient emotion processing may be due to deficits in the basic information processes of attention and value assessment and not the higher-order process of emotion. Therefore, complexity may be what is driving the populations’ aberrant behavior and abnormal cognition and not deficits in the ability to specifically process affective information.

5.3. Populations Similarities and Differences

While both populations are similar in that vmPFC patients have been described as having “pseudopsycopath” (Blumer and Benson 1975) and/or “acquired sociopathy” (Eslinger and Damasio 1985, Barrash, Tranel et al. 2000, Blair and Cipolotti 2000) and psychopathy is strongly
associated with vmPFC damage with both populations having similar deficits, the populations are in fact different. In addition, within each of the populations, deficits in diagnoses (Manuscript 2, Chapter 3), neurocognitive function (Manuscript 3, Chapter 4), and performance on laboratory measures vary. Therefore the question is, why do some individuals within each population pass certain emotion or reasoning type tasks (e.g., vmPFC patient E.V.R.’s normal moral reasoning performance in Saver and Damasio (1991)) and others do not (e.g., the differing responses of two vmPFC patients in neuropsychological testing in Anderson, Bechara et al. (1999)). Further, why are results extremely variable in studies that measure psychopathic capability?

One reason could be that there is not the same damage or dysfunction between individuals within the same population. Regarding vmPFC patients, one reason for this may be because of individual differences in lesion formation. Across patients, damage to the vmPFC is rarely in the exact same locations within the vmPFC or consist of the exact same extent of damage as evidence by overlapping comparisons. In addition, the vmPFC is a large region encompassing many different neural structures, each of which has been individually associated with specific functionality. For instance, the OFC alone has specific functionality when distinguishing between medial and lateral sections (Noonan, Walton et al. 2010). Therefore, which areas are affected may significantly alter the results when comparing individuals within a population. In addition, time of recovery post lesion onset also matters, in that over time, patients are often able to regain some degree of initial functionality due to neural plasticity. Therefore, a patient who is being tested 1 year after lesion onset may very well have more extreme behavioral abnormalities than a patient who is tested 10 years after lesion onset (Rorden and Karnath 2004).

Likewise, psychopathy is notoriously a heterogeneous group of individuals (Karpman 1946, Lykken 1957, Lykken 1995, Zuckerman 1995, Porter 1996, Schmitt and Newman 1999,
Brinkley, Newman et al. 2004, Poythress and Skeem 2006, Skeem, Johansson et al. 2007, Blackburn, Logan et al. 2008), meaning that not all psychopaths have the exact same type of deficits. This heterogeneity can be assessed using the multidimensional categories within psychopathy diagnoses (i.e., interpersonal, affective, lifestyle, and antisocial facets). Therefore, because of the multidimensional nature of psychopathy, one should not automatically assume that every psychopath has the exact same deficits across dimensions. Further, psychopathy research relies on diverse populations ranging from adult to adolescent, male to female, and criminal to general populations of students, adults or random online communities. Thus, demographic differences could likely contribute to these mixed results. More so, because of these diverse demographics, psychopathy assessment is also widely varied, from the standardized PCL-R for adult criminal populations to the PPI for the general population. Worse, some of the criteria to include individuals in psychopathic groups is not standardized, such as not using the same cut-off criteria for inclusion in the psychopathy group. This results in including individuals who have moderate psychopathy scores (which are usually excluded for group comparisons) in groups labeled as being psychopathic. Taken together, there are multiple potential causes for differential findings within psychopathy studies which are all potential confounds (Koenigs, Baskin-Sommers et al. 2011).

Lastly, moral cognition tasks rarely use the exact same methodology (Christensen and Gomila 2012). Especially within psychopathic exploration of moral cognition using Greene, Sommerville et al. (2001)’s battery of dilemmas, the exact same scenario stimuli are not necessary used nor are the exact same questions asked. Particularly, there is evidence that has shown that psychopathic individuals respond differently to choice of action questions (i.e., “Would you X”) than to questions that measure moral judgment (i.e., “Is it appropriate to do X”). Specifically,
psychopathic individuals are more likely to endorse moral choice of action questions but not moral judgment questions (Tassy, Deruelle et al. 2013, Tassy, Oullier et al. 2013). Because of these methodological differences of task questions, it is not surprising that there would be differential findings.

5.4. Future Directions

The work in this dissertation first aims to advance the field by suggesting new and improved ways to explore the moral capabilities of these populations based on this alternative explanation and by highlighting methodological confounds. Specifically, research using these populations should control for these information processing deficits using a variety of methods before conclusions are made regarding whether the populations have specific deficits in emotion.

For instance, instructions in tasks as well as task design can be constructed to better focus the attention of the populations as well as better call attention to value information, as has been done in Adolphs, Gosselin et al. (2005), Fellows and Farah (2005), Moretti, Dragone et al. (2009), Newman, Curtin et al. (2010), and Baskin-Sommers, Curtin et al. (2011). It would be interesting to see if SCR, especially anticipatory SCR, is observed in the populations once value information is made clear to the participants.

Further, basic neuropsychological tasks that measure attention, such as Flanker and oddball tasks, should be included as standard neuropsychological tests to measure whether the participants from the populations have attention deficits. Likewise, while participants are doing tasks that require visual processing, adding eye-tracking measurement as in Wolf, Philippi et al. (2014) while they perform the task will be highly beneficial in order to discern to what the participants are attending. In addition to eye-tracking, measuring the strategies participants use when making judgments and decisions, similar to Fellows (2006), will also be beneficial in determining how and
why the populations’ responses may be different from controls. Likewise, neuropsychological tests
of attention, memory, and executive functioning (specifically measurements of reason) should also
be given to the participants, especially psychopathic individuals who are rarely administered a
battery of these tests, in order to see if other, non-affective, deficits are observed.

In addition, complexity should also be measured and controlled. Giving participants tasks
that measure emotion and reason that are both simple and complex can perhaps parse complexity
confounds. Complexity can also be controlled by taking measurements about how complicated
stimuli is, specifically through objective measurements or subjective reports by the participants
themselves. As evidenced in Chapter 2 (Manuscript 1), even Greene, Sommerville et al. (2001)
battery of dilemmas differed in complexity as measured in an objective word count analyses
between personal and impersonal moral dilemmas. Interestingly, this complexity mimics the
emotional saliency rating differences between these two dilemma categories, as measured in
Greene, Sommerville et al. (2001)’s pilot study. Therefore, it is important to investigate if stimuli
that is emotionally salient are also more complex.

Further, using the exact same methodology between populations and studies is also key.
For instance, making sure methods used across studies within populations would reduce
differential results and provide clearer comparisons between populations (e.g., using the same
version of Greene, Sommerville et al. (2001)’s battery of dilemmas and/or standard criteria for
inclusion in psychopathy groups (Koenigs, Baskin-Sommers et al. 2011)). Further, it would be
interesting to see how psychopaths perform on tasks that have only been measured with vmPFC
patients and vice versa. To date, psychopaths have not been measured on preference judgment and
multi-attribute tasks similar to Fellows and Farah (2007) and Fellows (2006). In order to better
understand and compare the populations, similar testing and methodology needs to be used.
Lastly, attempting to make the populations as homogenous as possible is also important, though understandably difficult to control. Lesion spread as well as time of lesion onset are important factors when comparing and collapsing vmPFC patient data. In addition, psychopathy groups should be categorized based on how they score on each facet of diagnoses in order to better group individuals. Along this line of thinking, every psychopathy study should measure facet dimensions and correlate performance results with these detailed dimensional divides, which relatively few studies have done. As evidenced by Manuscript 2, Chapter 3, factor divides are not enough. It is likely that once these populations are as tightly controlled as possible, then true effects will be observed.

In addition, the work in this dissertation implies that therapeutic approaches can be applied to both populations. If the populations truly have deficits in basic information processing of attention and value, these processing deficits can then be corrected. As evidenced throughout this dissertation and highlighted in this Conclusion, once certain deficits in attention and value have been controlled in experimental testing, the abnormal behavioral deficits of the populations diminish, even in affective paradigms. This evidence provides hopeful remedies for the populations’ aberrant moral behaviors. If successful, accounting for these information processing deficits could be a more accessible form of therapy in contrast to emotional or moral rehabilitation.

In conclusion, the work in this dissertation contributes to the fields of philosophy, psychology, and neuroscience by questioning the status quo of using these populations to further support the claim that emotion is necessary for moral cognition within the framework of the Emotion-Reason debate. Specifically, this dissertation highlights that data from these populations cannot assert that emotion deficits cause abnormal moral cognition because the populations have basic information
processing deficits that affect all other processes, including the higher-order processes of both emotion and reason. Therefore, using the terms “emotion” and “reason” inaccurately describes the deficits of the populations. In fact, because of this, the information processing perspective of the populations’ deficits cannot shed light on what is required for the moral cognition of normal populations because normal populations typically do not have these types of deficits. Therefore, data from populations should not be used to support the claim that emotion is necessary for moral cognition.

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· For the psychopathic population, tasks demands manipulated attention (Newman, Curtin et al. 2010, Baskin-Sommers, Curtin et al. 2011); for the amgydala patient population, the instruction to the participants was to specifically pay attention to the eye region of faces (Adolphs, Gosselin et al. 2005).

· Specifically, if the vmPFC acts as a valuation center alone, then vmPFC disfunction would result in hyper-, not hypo- emotional reactively from vmPFC patients due to its connectivity with the amygdala, contradicting findings from lesion research in which vmPFC patients make hypo-emotional moral judgments when faced with highly emotional moral dilemmas (Hu and Jiang 2014).
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