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ARTICLE

Emotional reactions in moral decision-making are influenced by empathy and alexithymia

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ABSTRACT

The role of emotional processes in driving moral choices remains debated. In particular, diminished emotional processing and reduced empathy have been associated with unusual high rates of utilitarian responses in moral judgments while, to date, the effects of diminished emotional processing and empathy on moral decision-making have been only partially considered. In this study, we investigated the influence of empathy and alexithymia on behavior and emotional responses while participants performed a moral decision task. Self-report (valence and arousal ratings) and physiological (skin conductance and heart rate) measures were collected during the task. Results showed that empathy and alexithymia shaped emotional reactions to moral decisions but did not bias moral choices. The more empathic the participants, the more dilemmas were perceived as unpleasant and arousing, and the greater the increase in skin conductance. Conversely, alexithymia was characterized by a reduced physiological activation during moral decisions, but normal self-report ratings. Heart rate was not modulated by empathy or alexithymia. These results add new evidence to the field of moral decision showing that empathy and alexithymia modulate emotional reactions to moral decision.

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Moral decision-making; alexithymia; empathy; skin conductance; heart rate variability

Introduction

Imagine walking down the street alone and finding a wallet, which is filled with money. Will you give the wallet back to the police, even though you could really use the money? How will you reach this decision? Moral decision-making is the ability to choose an optimal course of action among multiple alternatives within a system of norms and values that guides our behavior in a community (Rilling & Sanfey, 2011).

Over the course of the past decade, a large amount of studies has focused on the role of emotions in morality. Greene and collaborators provided one of the most influential theoretical contributions in this domain (Greene & Haidt, 2002; Greene, Morelli, Lowenberg, Nystrom, & Cohen, 2008; Greene, Nystrom, Engell, Darley, & Cohen, 2004; Greene, Sommerville, Nystrom, Darley, & Cohen, 2001). According to their dual-process model, moral decisions are driven by the interaction between two competing processing systems mediated by partially dissociable neural networks: a fast, automatic emotional system engaging mainly the medial prefrontal cortex, and a slow, controlled cognitive system engaging mainly the dorsolateral prefrontal cortex and the inferior parietal lobe (Greene & Haidt, 2002; Greene et al., 2004, 2001). In this view, cognitive processes drive *utilitarian* choices, which lead to violation of societal norms and values for what the agent thinks is a greater good (e.g., to keep the wallet to pay your overdue bills), whereas emotional processes prompt *deontological* (nonutilitarian) choices, which instead follow societal norms (e.g., hand the wallet to the police).

During the presentation of hypothetical scenarios involving moral violations, emotions are also thought to be differently engaged depending on the nature of the dilemma. *Personal* dilemmas tend to elicit strong emotional responses. They describe a situation in which personal harm is caused to another person directly by the agent. For instance, in the footbridge dilemma, the agent can push a man from a bridge, if he wants to stop a trolley running underneath and save the lives of five workers on the tracks (Greene et al., 2004, 2001; Thomson, 1976). In contrast, in *impersonal* dilemmas, physical harm is only caused indirectly and, as such, elicits weaker emotional responses. An example is the trolley dilemma, in which the agent has the possibility to hit a switch to divert a trolley on another track to

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save five people's lives, while sacrificing the life of one person (Foot, 1967; Greene et al., 2004, 2001). *Self-beneficial* dilemmas, in which the agent has to harm another person to save herself, are judged as more arousing and more negative than *other-beneficial* dilemmas, in which benefit recipients are other persons (Bloomfield, 2007; Christensen, Flexas, Calabrese, Gut, & Gomila, 2014; Moore, Clark, & Kane, 2008). Finally, *instrumental* dilemmas, in which the harm is deliberate and instrumentally used, are rated as significantly more unpleasant than *incidental* (also called *accidental*) dilemmas, in which the harm is just a side effect of the action (Sarlo et al., 2012; Sarlo, Lotto, Rumiati, & Palomba, 2014).

Compared to controls, clinical populations with a deficit in emotion processing make significantly more utilitarian choices in moral dilemmas, thus confirming the role of emotions in moral decisions as described in Greene's model. This is the case of patients with lesions in the ventromedial prefrontal cortex (Ciaramelli, Muccioli, Làdavas, & Di Pellegrino, 2007; Koenigs et al., 2007; Moretto, Làdavas, Mattioli, & Di Pellegrino, 2009; Thomas, Croft, & Tranel, 2011), as well as of patients with frontal traumatic brain injury (Martins, Faísca, Esteves, Muresan, & Reis, 2012) or with frontotemporal dementia (Mendez, Anderson, & Shapira, 2005).

Similar results have also been observed in nonclinical populations with emotional deficiencies, such as those with a lack of empathy or with high levels of alexithymia. Empathy, which generally motivates pro-social behavior, is defined as the ability to understand what others feel (Batson, 2014; Eisenberg, 2000; Singer & Lamm, 2009). According to current theories, empathy is composed of three components (Blair, 2005; Decety & Jackson, 2004; Hein & Singer, 2008; Singer & Lamm, 2009). "Motor empathy" (Blair, 2005) is the capacity to become affectively aroused by emotions of others – and it likely involves mimicry of other people's emotional expressions (Neufeld, Ioannou, Korb, Schilbach, & Chakrabarti, 2016; Wood, Rychlowska, Korb, & Niedenthal, 2016). "Affective empathy" corresponds to the urge to care for another's welfare. It includes two key aspects: *empathic concern* (EC), that is the tendency of experiencing sympathy and concern for unfortunate others, and *personal distress* (PD) – the tendency of experiencing anxiety in response to others' distress. "Cognitive empathy," which encompasses both *fantasy* (FS) – the ability to imagine oneself into the feelings and actions of characters in books and movies, and *perspective taking* (PT) – the ability to adopt the psychological point of view of others, is the ability to attribute thoughts and intentions to oneself and to others (Decety & Cowell, 2014a; Singer & Lamm, 2009). In the past decade, empathy has been increasingly associated with morality both in theory (Decety & Batson, 2009; Decety & Cowell, 2014a, 2014b; Hoffman, 1994; Pizarro, 2000; Maibom, 2014) and empirically (Crockett, Clark, Hauser, & Robbins, 2010; Crockett et al., 2015; Gleichgerrcht & Young, 2013; Gleichgerrcht, Torralva, Roca et al., 2011; Patil & Silani, 2014b; Sarlo et al., 2014). In particular, greater percentages of utilitarian choices have been linked to the inability to fully experience affective empathy in healthy individuals (Choe & Min, 2011; Gleichgerrcht & Young, 2013; Patil & Silani, 2014b; Sarlo et al., 2014) and were described in psychopathy, a personality disorder characterized by a marked lack of affective empathy (Gao & Tang, 2013; Glenn, Koleva, Iyer, Graham, & Ditto, 2010; Langdon & Mackenzie, 2012; Tassy, Deruelle, Mancini, Leistedt, & Wicker, 2013a; Young, Koenigs, Kruepke, & Newman, 2012). This evidence suggests that in dilemmas requiring the decision to harm someone in order to save a greater number of lives, utilitarian choices are more common in participants lacking affective empathy and the experience (and understanding) of unpleasant emotions in response to other people's suffering (Choe & Min, 2011; Decety & Cowell, 2014a; Patil & Silani, 2014b; Sarlo et al., 2014).

Alexithymia – Greek for "no words for feelings" – is a psychological construct that describes individuals who have difficulties in identifying and describing their feelings to others (Bermond, Vorst, & Moormann, 2006; Larsen, Brand, Bermond, & Hijman, 2003; Nemiah, Freyberger, & Sifneos, 1976; Sifneos, 1973). Despite alexithymia being associated with a variety of psychiatric and neurological conditions (Sifneos, 1973; Sturm & Levenson, 2011; Taylor, Bagby, & Parker, 1999), a prevalence rate of 10% can also be observed in the general healthy population (Salminen, Saarijärvi, Äärelä, Toikka, & Kauhanen, 1999). Like empathy, alexithymia is not a unitary construct but comprises an affective and a cognitive dimension, each with its own neural substrates (Goerlich-Dobre, Bruce, Martens, Aleman, & Hooker, 2014; Goerlich-Dobre, Votinov, Habel, Pripfl, & Lamm, 2015). The affective dimension refers to the extent to which emotions are subjectively experienced, and it comprises *emotionalizing* (the degree to which someone is emotionally aroused by emotion-inducing events) and *fantasizing* (the degree to which someone is inclined to imagine, day dream etc.). The cognitive dimension implies difficulties in the conscious interpretation of emotions, and it comprises difficulties in *identifying* (the degree to which one is able to define one's arousal states), *analyzing* (the degree to which one seeks out explanations of one's own emotional reactions) and *verbalizing* feelings (the degree to which one

is able or inclined to describe or communicate about one's emotional reactions; Bermond et al., 2007). Furthermore, alexithymia may be associated with low empathy (Bird & Cook, 2013; Goerlich-Dobre, Lamm, Pripfl, Habel, & Votinov, 2015; Guttman & Laporte, 2002; Moriguchi et al., 2007; Neumann, Zupan, Malec, & Hammond, 2014) and with poor pro-sociality (Berthoz, Pouga, & Wessa, 2011).

A higher tendency to make utilitarian choices has been described also in alexithymic individuals (Brewer et al., 2015; Gleichgerrcht, Tomashitis, & Sinay, 2015; Koven, 2011; Patil & Silani, 2014b, 2014a). For instance, Patil and Silani (2014b) investigated the influence of alexithymia on moral judgments among more than 300 healthy participants in an online survey. Higher alexithymia scores were linked to a greater proportion of utilitarian choices in personal moral dilemmas, which are usually more emotionally aversive than impersonal ones. Moreover, two recent studies examining the relationship between alexithymia and utilitarian tendencies in both healthy and clinical populations (multiple sclerosis and autism) showed that in healthy individuals, but not in patients, moral acceptability judgments were predicted by higher alexithymia (Brewer et al., 2015; Gleichgerrcht et al., 2015). According to Koven (2011), individuals who are better at reasoning about their own emotions experience prolonged negative mood in response to moral dilemmas and tend to make deontological choices. On the other side, people who are confused about their emotional experiences (e.g., alexithymics) feel a less negative affect and therefore make more utilitarian choices. Therefore, alexithymia *per se* drives utilitarian judgments. On the other hand, Patil and Silani (2014b) proposed that utilitarian choices in alexithymics are driven by a lack of empathy since they observed that EC mediated the relation between alexithymia and acceptance of utilitarian choices.

To date, the influence of alexithymia on morality has only been investigated using moral judgment tasks (Koven, 2011; Patil & Silani, 2014b, 2014a). However, differences exist between moral decision and moral judgment (Szekely & Miu, 2014; Tassy, Oullier, Mancini, & Wicker, 2013b), while the former participants are asked to decide what *they* would do in a hypothetical moral dilemma, in the latter, they are asked to judge the appropriateness or moral permissibility of *somebody else*'s actions. When moral choice and judgment have been directly compared, responses to choices resulted more utilitarian than responses to judgments, thus suggesting that these two tasks may reflect different psychological constructs and rely on different neural underpinnings (Tassy et al., 2013b), an hypothesis that has recently been confirmed by a meta-analysis on 28 fMRI studies (Garrigan, Adlam, & Langdon, 2016). However, no study so far has jointly investigated the influence of both empathy and alexithymia on moral decision-making.

In the present study, we aimed at filling this gap. Furthermore, we examined the influence of empathy and alexithymia on participants' emotional reactions with both explicit and implicit measures by assessing arousal and valence – considered the core dimensions of the affective experience (Bradley, 2009; Lang, 1995).

First, we asked participants to rate the valence and arousal of emotions raised by the decision itself. These explicit measures were collected to clarify participant's perceived emotional reactions during the moral choice. Second, we measured skin conductance response (SCR) and instantaneous heart rate (IHR), which are implicit indexes of, respectively, arousal and valence (Bradley, 2009; Lang, 1995). In particular, psychophysiological measures are more reliable in providing insights into the individual's level of engagement and arousal since they overcome self-report limitation in emotional reports. This aspect may be particularly useful in the case of alexithymic individuals, which have difficulties in distinguishing and describing their emotions. Therefore, the use of both explicit and implicit indices of emotional reactions is helpful to elucidate whether empathy and alexithymia can affect both the conscious experience of emotion and the automatic physiological response (Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000).

Moreover, based on previous studies (Christensen et al., 2014; Greene et al., 2001; Lotto, Manfrinati, & Sarlo, 2014; Moore et al., 2008), the role of three conceptual factors was tested: personal force (the type of action), intentionality (whether the harm is intentional or not) and benefit recipient (who benefits from the action). To our knowledge, this is the first study that investigates the influence of alexithymia and empathy on these three factors.

Three main predictions were formulated. First, according to the dual-process theory, we expected the number of utilitarian responses to be low in people with high empathy and high in people with high alexithymia. Second, individuals with high, compared to low, empathy would consider more arousing and more unpleasant the dilemmas. In contrast, we predicted that individuals with high alexithymia will consider less arousing and less unpleasant dilemmas, due to the poor awareness of their own emotional experience. Third, we expected greater SCR and IHR deceleration in participants with high empathy and low alexithymia, while we foresaw lower SCR and less IHR

deceleration in participants with low empathy and high alexithymia (Bermond, Bierman, Cladder, Moormann, & Vorst, 2010a; Pollatos et al., 2011). In addition, we also anticipated that the type of decision (utilitarian vs. deontological) and the type of dilemma (personal/impersonal, accidental/instrumental, self/other) would influence emotional reactions in both explicit and implicit measures (Christensen et al., 2014; Lotto et al., 2014; Moretto et al., 2009; Sarlo et al., 2012).

It is important to keep in mind, however, that this is the first study to investigate the influence of alexithymia and empathy on three conceptual factors, and that the predictions described in the previous paragraph are based on studies that instead considered only one/or two conceptual factors at a time (Lotto et al., 2014; Moretto et al., 2009; Patil & Silani, 2014b, 2014a; Sarlo et al., 2012, 2014).

Methods

Participants

Forty-one right-handed healthy, native Italian speakers (21 females, age 19–35 years, M = 24.66, SD = 3.69; education 11–19 years, M = 16.19, SD = 2.06) were enrolled through online advertisement. Exclusion criteria were a history of neurological or psychiatric disorders and a score above 19 on the Beck Depression Inventory II (Beck, Steer, & Brown, 1996). The study was approved by SISSA's ethics committee.

Self-report questionnaires

Empathy and its components were assessed with the IRI (Interpersonal Reactivity Index; Davis, 1980), a self-report instrument using Likert scales ranging from 0 (*doesn't describe me at all*) to 4 (*describes me very well*). IRI's four components are FS (the proclivity to identify with fictitious characters), PT (the ability to adopt the perspective of others in common life), EC (the tendency to experience feelings of compassion and sympathy from others' misfortune) and PD (the proneness to feel uncomfortable about the distress of others). Each dimension contains 7 statements, giving 28 items, for a total maximum score of 112.

Alexithymia was assessed using the Bermond–Vorst Alexithymia Questionnaire, form B (BVAQ-B; Bermond & Oosterveld, 1994). The BVAQ-B consists of 20 items rated on a 5-point scale with total scores ranging from 20 to 100; participants with a score above 53 are considered alexithymic. The BVAQ was designed to measure the five dimensions of alexithymia: emotionalizing, fantasizing, identifying, analyzing and verbalizing (Vorst & Bermond, 2001). The BVAQ subscales produce the two orthogonal dimensions that constitute alexithymia: the affective dimension comprises the subscales emotionalizing and fantazising, while the cognitive dimension comprises the subscales verbalizing, identifying and analyzing (Bermond et al., 2007).

To increase the reliability of the screening, all participants were additionally assessed for alexithymia with the TAS-20 (Bressi et al., 1996), which consists of 20 items rated on a five-point scale with total scores ranging 20 to 100. It includes three subscales: difficulty in identifying feelings (F1), difficulty in communicating feelings (F2) and externally oriented thinking (F3). The international cutoff values are the following: 20–50 = non-alexithymic subjects, 51–60 = borderline alexithymic subjects and 61–100 = alexithymic subjects (Bressi et al., 1996). In contrast to the BVAQ, the TAS-20 scale focuses only on the cognitive dimension of the alexithymia (Bermond et al., 2010). See Table 1 for the summarized results of the IRI, BVAQ and TAS-20 questionnaires and their subscales.

Table 1. Summary table of empathy and alexithymia questionnaires.

	Mean (SD)	Range
IRI	61.32 (14.28)	19–88
PT	16.73 (4.45)	5–26
FS	17.00 (5.13)	5–27
EC	17.24 (4.82)	5–25
PD	10.27 (5.48)	0–22
BVAQ	51.76 (12.09)	21–82
B1	12.54 (4.09)	4–19
B2	8.93 (3.41)	4–18
B3	10.00 (3.18)	4–17
B4	10.83 (3.62)	5–19
B5	9.44 (3.13)	4–17
Affective component	19.76 (5.74)	9–37
Cognitive component	31.98 (8.74)	12–53
TAS-20	48.44 (12.92)	25–82
F1	14.34 (4.47)	7–23
F2	14.80 (5.63)	5–25
F3	19.19 (6.22)	10–34

BVAQ: Bermond–Vorst Alexithymia Questionnaire; B1: verbalizing, B2: fantasizing; B3: identifying; B4: emotionalizing; B5: analyzing; TAS-20: 20-items Toronto Alexithymia Scale; F1: difficulty in identifying feelings; F2: difficulty in communicating feelings; F3: externally oriented thinking; IRI: Interpersonal Reactivity Index; PT: perspective taking; FS: fantasy; EC: empathic concern; PD: personal distress.

Stimuli

Forty-six dilemmas of the 4CONFiDE moral set were used (Cecchetto, Rumiati, & Parma, in press). This set of dilemmas is validated for the Italian population and is based on four conceptual factors (personal force, intentionality, benefit recipient and evitability). For the present study, we considered three of the four proposed conceptual factors, since they have been used

most frequently in previous studies (Christensen et al., 2014; Christensen & Gomila, 2012): Personal force (personal, impersonal), intentionality (accidental, instrumental) and benefit recipient (self, other). Importantly, each dilemma contains a combination of all three factors.

Each dilemma was presented on two subsequent screens. The first screen described the scenario: the life of a group of people is in danger, and they can be saved through a hypothetical action, which however simultaneously causes the death of another person. The second screen presented the question *Do you … [action verb] so that…?* A direct question was used to emphasize the consequences of the choice made by the agent. Participants had to choose between four options: "I definitely do it", "I may do it", "I may not do it" and "I definitely do not do it". The first two options are considered utilitarian choices, as they maximize overall utility (i.e., saving more lives), whereas the last two are counted as deontological choices. Dilemmas were presented using black font color (font: Calibri, size: 24) against a white background on a 19-inch computer screen at a viewing distance of 60 cm. Stimulus presentation was accomplished with E-prime 2.0 software (Psychology Software Tools, Pittsburgh, PA).

Moral decision-making task

Before starting the task, participants performed two practice trials. The instructions were similar to the ones used by Christensen et al. (2014). Each trial included the scenario (36 s), the question slide (with the four choices displayed below) and a rating slide (Figure 1). Participants were instructed to make their choice as fast as possible and then to rate on two 10-point scales the valence (unpleasantness/pleasantness) and arousal (calmness/activation), felt during the decision. Higher scores indicated higher pleasantness/arousal. Each trial ended with a blank screen shown for 10 s. Dilemmas were presented in three blocks of 16 trials. In each block, dilemmas were matched for factors personal force, intentionality and benefit recipient. The order of the three blocks was randomized across participants. Participants were allowed to take a short break at the end of each block.

Procedure

Upon arrival, participants signed informed consent, sat in a quiet room and had electrodes attached for HR and SCR recording. Following a 10-min adaptation period, psychophysiological measures were recorded during a 1-min baseline and throughout the moral decision-making task. At the end of the experiment, participants completed the three self-report questionnaires.

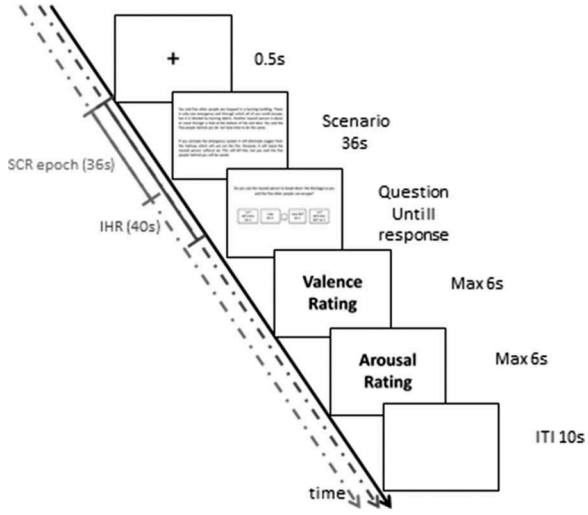

Figure 1. Sequence of events in the experiment. Psychophysiological measures were recorded time-locked to the scenario onset. ITI: Intertrial interval.

Psychophysiological data acquisition and analysis

SCR and HR were recorded during the moral decision-making task with a *PROCOMP infiniti system* (Thought Technology, Montreal, Canada). After a 10-minutes adaptation period, and before starting the task, 1 min of baseline was recorded.

SCR was measured according to guidelines (Boucsein, 2012; Schulte-Mecklenbeck, Kühberger, & Ranyard, 2011), using two 8-mm Ag/AgCl electrodes, attached to the medial phalanx surfaces of the index and ring finger of the left hand. Conductive gel was used to reduce impedance. The electrode pair was excited with a constant voltage of 0.5 V and conductance was recorded using a DC amplifier with a low-pass filter set at 64 Hz. A photoplethysmographic probe (3.2 cm/1.8 cm, photodetector LED type), placed on the middle finger of the nondominant hand, was used to assess HR at a sample rate of 2048 Hz. SC and HR data were analyzed with Matlab using in-house scripts partially using the EEGLAB toolbox (http://sccn.ucsd.edu/eeglab/). Data from five participants were removed due to a lack of sufficient physiological responsiveness or to technical problems during the recording.

SCR data were filtered with a 10-Hz low-pass filter and epoched over the 36 s of scenario presentation. The 2 s before the scenario-screen presentation served as baseline. The following SC parameters were analyzed: (1) *peak amplitude*, defined as the difference in μSiemens between the mean value during baseline and the peak after stimulus onset and (2) *rise time*, defined as milliseconds between scenario onset and the time of the peak. Trials with peak amplitudes below 0.01 μS

were excluded from the SC analysis and peak amplitudes were log transformed to improve interpretability (Boucsein, 2012).

HR data were filtered with a 1-Hz high-pass filter and resampled to 256 Hz. Beat detection was performed automatically, verified visually and corrected, if necessary. Frequency was computed as beats per minute. The 40 s from the dilemma presentation were divided in 10 time windows of 4 s. Interbeat intervals were computed, transformed to HR values and averaged for each 4-s window. Each time window was then corrected by subtracting the 4 s before scenario presentation to obtain the IHR (Palomba, Sarlo, Angrilli, Mini, & Stegagno, 2000). As to the trial design, the dilemma was presented from time window one and nine, while the question slide appeared at the beginning of the 10th time window.

Statistical analysis

Linear mixed-effects models (LMMs) with intercepts for participants as *random effect* were performed to account for the high variability across individuals. This type of analysis reduces Type I errors and makes possible the generalization of findings to other samples of participants (Judd, Westfall, & Kenny, 2012; McCulloch, 1997). LMMs were fitted and analyzed using R (version 2.10.1; http://www.r-project.org/) and in particular using the lme function from the nlme package (https://cran.r-project.org/web/packages/nlme/nlme.pdf) for continuous variables and the glmer function from the lme4 package (http://cran.r-project.org/web/packages/lme4/index.html) for the binary variable. To avoid derivative calculation, an optimizer (bobyqa) was chosen. Estimates on the choice between utilitarian and deontological responses were based on an adaptive Gaussian Hermite approximation of the likelihood with 10 integration points. For each dependent variable (type of moral choice, reaction times (RTs) of utilitarian answers, valence and arousal ratings, SCR peak amplitude, rise-time of SCR, IHR), we compared different LMMs, with and without interactions among conceptual factors and between conceptual factors and empathy and alexithymia scales, to find the best models fitting with the data. Models were compared with the log-likelihood ratio test using the *Anova* function, the higher the log likelihood, the better model fit of the data. As a measure of goodness of fit of the chosen LMMs, we also report *conditional* R^2, which describes the proportion of variance explained by both the fixed and random factors (Johnson, 2014; Nakagawa & Schielzeth, 2013) but remains debated (Orelien & Edwards, 2008). For *post-hoc* comparisons of significant interactions, the *lsmeans* package was used. Since for all dependent variables, no significant differences were found between models including total scores of IRI and BVAQ and the models including their subscales, it was decided to refer to the models including the subscales to better identify the role of each subcomponent. Only the total score of the TAS-20 was inserted in the models because this questionnaire refers solely to the cognitive dimension of alexithymia (Bermond et al., 2010). Best models are described in detail in the "Results" section. Trials with RTs more than two SDs above or below the individual mean were discarded from analyses. Finally, Pearson's correlations were performed across BVAQ, TAS-20 and IRI scores, to investigate the relationship between alexithymia questionnaires and its subcomponents, and between alexithymia and empathy. See Supplemental material for results of RTs, rise time of SCR and Pearson's correlations.

Results

Moral choice was explained by the three conceptual factors but not by alexithymia or empathy

The best fitting model for the moral choice data included as predictor's gender, affective and cognitive dimensions of the BVAQ, the TAS-20, the four subscales of the IRI and the three conceptual factors (see Table 2 for β, z, p values and CIs). A significant main effect of personal force was found ($z(1885) = 6.54$, $p < 0.001$), which was due to more utilitarian responses occurring when the agent was only indirectly (impersonal dilemma) compared to directly (personal dilemma) involved in the harm-causing process. A significant main effect of benefit recipient ($z(1885) = 2.97$, $p = 0.003$) was explained by more utilitarian choices when decision maker's life was at risk (self-beneficial dilemmas compared to other-beneficial dilemma). Finally, a significant main effect of intentionality ($z(1885) = -4.07$, $p < 0.001$) reflected more utilitarian choices when the victim of the dilemma died as a non-desired side effect of the action (accidental dilemmas compared to instrumental dilemmas).

Higher scores at FS and EC subscales increased unpleasantness

The best model for valence ratings included gender, the affective and cognitive dimensions of the BVAQ, the TAS-20, the four subscales of the IRI, the three conceptual factors and type of moral choice (see Table 3). Lower valence ratings were linked to higher scores on the FS ($t(34) = -2.52$, $p = 0.02$; see Figure 2(a)) and the EC ($t(34) = -2.11$, $p = 0.04$; see Figure 2(b)) subscales of

Table 2. Summary of the best fitting LMM for moral (number of utilitarian) choices.

Moral choice						95%CI	
Fixed effects	*β*	*SE*	*z Value*	*p Value*	*β Exp*	*Lower*	*Upper*
Gender (*male*)	0.254	0.448	0.568	0.570	1.290	0.536	3.104
Affective component (BVAQ)	0.025	0.047	0.546	0.585	1.026	0.936	1.124
Cognitive component (BVAQ)	0.000	0.035	−0.014	0.989	1.000	0.933	1.071
TAS-20	−0.017	0.028	−0.610	0.542	0.983	0.930	1.039
PT (IRI)	−0.041	0.059	−0.695	0.487	0.960	0.855	1.077
PD (IRI)	0.027	0.039	0.708	0.479	1.028	0.953	1.109
EC (IRI)	−0.063	0.054	−1.165	0.244	0.939	0.844	1.044
FS (IRI)	0.042	0.054	0.780	0.435	1.043	0.938	1.160
Personal force (*impersonal*)	0.709	0.108	6.536	**<0.001**	2.031	1.642	2.512
Benefit recipient (*self*)	0.318	0.107	2.973	**0.003**	1.374	1.114	1.694
Intentionality (*instrumental*)	−0.479	0.118	−4.072	**<0.001**	0.619	0.492	0.780
Random effects	StdDev	Residual					
Subjects (*intercept*)	1.154	1.074					
LogLik = −1113.2, R^2 = 0.32							

β: estimate; SE: standard error; 95% CI: confidence interval; BVAQ: Bermond–Vorst Alexithymia Questionnaire; TAS-20: 20-items Toronto Alexithymia Scale; IRI: Interpersonal Reactivity Index; PT: perspective taking; FS: fantasy; EC: empathic concern; PD: personal distress; LogLik: log likelihood; *β* exp: exponential of *β* coefficient. Significant *p* values are in bold. Reference condition for categorical factors is reported in italic inside bracket.

Table 3. Summary of the best fitting LMM for valence rating.

Valence rating					95%CI	
Fixed effects	*β*	*SE*	*t Value*	*p Value*	*Lower*	*Upper*
Gender (*male*)	0.456	0.337	1.350	0.186	−0.206	1.117
Affective component (BVAQ)	−0.048	0.035	−1.374	0.178	−0.117	0.021
Cognitive component (BVAQ)	0.043	0.026	1.619	0.115	−0.009	0.095
TAS-20	−0.036	0.021	−1.695	0.099	−0.078	0.006
PT (IRI)	−0.052	0.044	−1.177	0.248	−0.139	0.035
FS (IRI)	−0.103	0.041	−2.524	**0.016**	−0.182	−0.023
PD (IRI)	−0.048	0.029	−1.657	0.107	−0.105	0.009
EC (IRI)	−0.087	0.041	−2.116	**0.042**	−0.167	−0.006
Personal force (*impersonal*)	0.125	0.061	2.040	**0.041**	0.005	0.244
Benefit recipient (*self*)	−0.197	0.060	−3.277	**0.001**	0.315	−0.079
Intentionality (*instrumental*)	0.219	0.065	3.342	**0.001**	0.090	0.347
Moral choice (*utilitarian*)	−0.250	0.068	−3.682	**<0.001**	−0.383	−0.117
Random effects	StdDev	Residual				
Subjects (*intercept*)	0.833	1.283				
LogLik = −3251.503; R^2 = 0.47						

β: estimate; SE: standard error; 95% *CI*: confidence interval; BVAQ: Bermond–Vorst Alexithymia Questionnaire; TAS-20: 20-items Toronto Alexithymia Scale; IRI: Interpersonal Reactivity Index; PT: perspective taking; FS: fantasy; EC: empathic concern; PD: personal distress; LogLik: log likelihood. Significant *p* values are in bold. Reference condition for categorical factors is reported in italic inside bracket.

the IRI. Moreover, lower valence ratings were found when dilemmas were personal ($t(1851) = 2.04$, $p = 0.04$), self-beneficial ($t(1851) = -3.28$, $p = 0.001$) or accidental ($t(1851) = 3.34$, $p < 0.001$), and when participants chose utilitarian compared to deontological options ($t(1851) = -3.68$, $p < 0.001$).

Higher scores at EC subscale increased level of arousal

The model fitting best the arousal ratings was the same as for valence ratings gender, affective and cognitive dimensions of BVAQ, the TAS-20, the four subscales of IRI, type of moral choice and the three conceptual factors (see Table 4). Significantly, higher arousal ratings were associated with higher scores on the EC subscale ($t(34) = 2.36$, $p = 0.02$; see Figure 3) and were found for self-beneficial ($t(1851) = 3.50$, $p < 0.001$) and accidental dilemmas ($t(1851) = -2.79$, $p = 0.005$), as well as when participants chose utilitarian responses ($t(1851) = 3.36$, $p < 0.001$).

Higher score at PD and TAS-20 biased SCR in opposite directions

The best model for SCR during dilemma presentation included as predictors gender, age, education, affective and cognitive dimensions of the BVAQ, the TAS-20, the four subscales of the IRI, type of moral choice and the interaction among the three conceptual factors (see Table 5). Two significant main effects revealed that a greater SCR occurred in participants with high PD ($t(27) = 2.95$, $p = 0.006$) and low TAS-20 scores ($t(27) = -2.09$, $p = 0.04$; see Figure 4). Moreover, a significant interaction was found between personal force and benefit recipient ($t(1015) = 2.14$, $p = 0.03$). *Post-hoc* comparisons revealed that SCR was greater during the impersonal, self-beneficial dilemmas compared to the

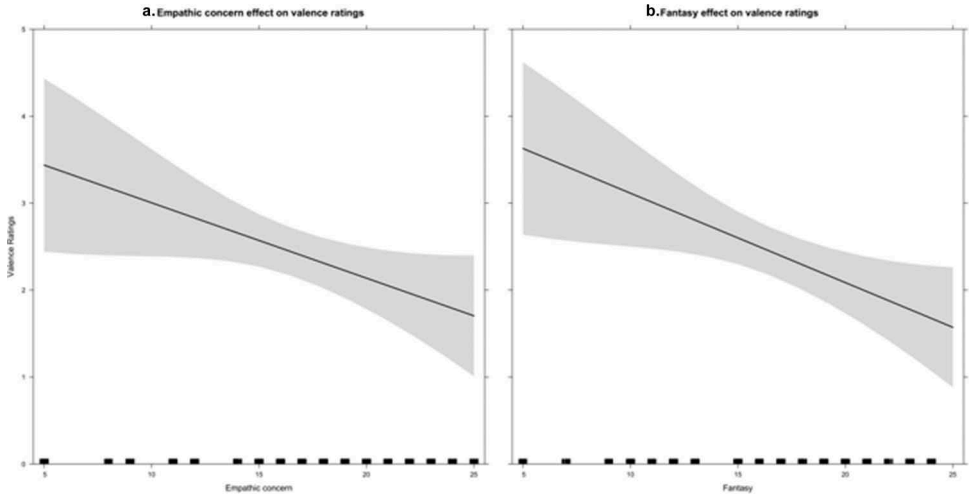

Figure 2. (a) Effect of empathic concern and (b) effect of fantasy on valence ratings. Gray areas represent the simulated 95% confidence interval of the coefficients.

Table 4. Summary of the best fitting LMM for arousal rating.

Arousal rating					95%CI	
Fixed effects	*β*	*SE*	*t Value*	*p Value*	*Lower*	*Upper*
Gender (*male*)	−1.198	0.691	−1.734	0.092	−2.552	0.156
Affective component (BVAQ)	0.073	0.072	1.007	0.321	−0.069	0.214
Cognitive component (BVAQ)	−0.020	0.054	−0.376	0.709	−0.126	0.086
TAS-20	0.047	0.043	1.091	0.283	−0.038	0.133
PT (IRI)	0.021	0.091	0.233	0.817	−0.157	0.199
FS (IRI)	0.096	0.083	1.157	0.255	−0.067	0.259
EC (IRI)	0.198	0.084	2.357	**0.024**	0.033	0.362
PD (IRI)	0.106	0.060	1.776	0.085	−0.011	0.223
Personal force (*impersonal*)	−0.098	0.078	−1.249	0.212	−0.251	0.056
Benefit recipient (*self*)	0.270	0.077	3.501	**<0.001**	0.119	0.421
Intentionality (*instrumental*)	−0.234	0.084	−2.791	**0.005**	−0.398	−0.069
Moral choice (*utilitarian*)	0.293	0.087	3.359	**0.001**	0.122	0.464
Random effects	StdDev	Residual				
Subjects (*intercept*)	1.733	1.644				
LogLik = −3734.306; R^2 = 0.63						

β: estimate; SE: standard error; 95% CI: confidence interval; BVAQ: Bermond–Vorst Alexithymia Questionnaire; TAS-20: 20-items Toronto Alexithymia Scale; IRI: Interpersonal Reactivity Index; PT: perspective taking; FS: fantasy; EC: empathic concern; PD: personal distress; LogLik: log likelihood. Significant *p* values are in bold. Reference condition for categorical factors is reported in italic inside bracket.

impersonal, other-beneficial dilemmas ($t(1015) = -3.34$, $p = 0.005$) and to the personal, self-beneficial dilemmas ($t(1015) = -2.76$, $p = 0.029$).

IHR was affected by dilemma conceptual factors and type of choice

The best fitting model included time windows 2–10, the affective and cognitive dimensions of the BVAQ, the TAS-20, the four subscales of the IRI, type of moral choice and the three conceptual factors (see Table 3SI of Supplemental materials). First, IHR was affected by the type of dilemma, as shown by (1) a significant main effect of benefit recipient ($t(46,512) = -6.45$, $p < 0.001$), with lower IHR for self versus other benefit dilemmas, (2) a significant main effect of intentionality ($t(46,512) = -7.94$, $p < 0.001$), with lower IHR during instrumental compared to accidental dilemmas, and (3) a marginal effect of personal force ($t(46,512) = 1.80$, $p = 0.07$), due to lower IHR for personal compared to impersonal dilemmas. Second, IHR was affected by the type of Moral choice ($t(46,512) = -2.08$, $p = 0.04$) and decelerated when participants chose utilitarian responses. Third, a time effect was present (see Figure 5). The IHR was decelerated during the entire trial (relative to the first time window). However, two phases could be distinguished. An initial deceleration peaked 16 s after dilemma onset (time window 4) and was followed by another acceleration toward the end of the dilemma presentation and throughout the question slide (time windows 7–10), as shown by exploratory *t*-tests (Time 4 vs. 7: $t(46,512) = -3.57$, $p = 0.01$; Time 4 vs. 8: $t(46,512) = -5.69$, $p < 0.001$; Time 4 vs. 9: $t(46,512) = -4.60$, $p = 0.002$; Time 4 vs. 10: $t(46,512) = -5.99$, $p < 0.001$).

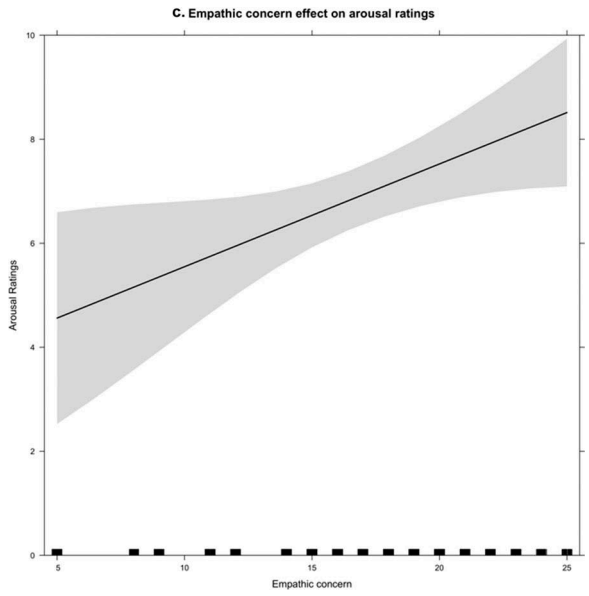

Figure 3. Effect of empathic concern on arousal ratings. Gray areas represent the simulated 95% confidence interval of the coefficients.

Discussion

The present study investigated the influence of empathy and alexithymia on choices and emotional reactions in a moral decision task. It was found that empathy and alexithymia did not bias participants' moral choices, but both influenced their emotional reactions to moral decisions. However, while the influence of several empathy components was evident in both explicit and implicit measures of emotional reactions, alexithymia influenced, in the opposite direction, only SCR. These results confirm the nature of both the empathy and the alexithymia constructs, and add new evidence to the field of moral decision-making.

Our first relevant result is that empathy and alexithymia were not significant predictors of moral choices. This unexpected result is in contrast with our hypotheses and with the existent literature (Crockett et al., 2010, 2015; Gleichgerrcht & Young, 2013; Koven, 2011; Patil & Silani, 2014b, 2014a; Sarlo et al., 2014). One source of such inconsistencies could be that previous studies used task paradigms that differed in terms of instructions provided to the participants. For instance, in the majority of the studies that investigated the influence of alexithymia on morality, participants were asked to rate the appropriateness of an action (Koven, 2011; Patil & Silani, 2014b, 2014a). However, as argued in the introduction, some differences could exist between the tasks tested in the current and previous experiments. Although it has been suggested that emotional involvement may be higher in moral decision compared to moral judgment (Szekely & Miu, 2014; Tassy et al., 2013a), the question is far from being understood. For instance, a recent meta-analysis did not find a specific involvement of the ventromedial prefrontal cortex – an area associated with emotional processing (Öngür & Price, 2000; Rolls, 2000) – in moral decision-making tasks (Garrigan et al., 2016). Importantly, the results of the only study in which a moral decision-making task was used to investigate

Table 5. Summary of the best fitting LMM for SCR.

SCR					95%CI	
Fixed effects	*β*	*SE*	*t Value*	*p Value*	*Lower*	*Upper*
Gender (*male*)	0.019	0.028	0.659	0.516	−0.036	0.074
Age	−0.002	0.003	−0.560	0.580	−0.007	0.004
Education	0.003	0.006	0.435	0.667	−0.009	0.014
Affective component (BVAQ)	−0.003	0.003	−1.017	0.318	−0.006	0.003
Cognitive component (BVAQ)	0.003	0.002	1.315	0.200	−0.007	0.007
TAS-20	−0.003	0.001	−2.099	**0.045**	0.002	−0.001
PT (IRI)	−0.001	0.003	−0.298	0.768	−0.007	0.005
PD (IRI)	0.007	0.002	2.953	**0.006**	−0.011	0.012
FS (IRI)	−0.001	0.003	−0.292	0.772	−0.008	0.006
EC (IRI)	−0.005	0.003	−1.795	0.084	−0.001	0.001
Personal force (*impersonal*)	−0.045	0.029	−1.538	0.124	−0.103	0.012
Benefit recipient (*self*)	−0.035	0.030	−1.158	0.247	−0.093	0.024
Intentionality (*instrumental*)	−0.023	0.025	−0.881	0.378	−0.074	0.028
Moral choice (*utilitarian*)	−0.006	0.012	−0.495	0.621	−0.029	0.017
Personal force × Benefit recipient	0.081	0.038	2.139	**0.033**	0.007	0.156
Personal force × Intentionality	0.026	0.026	0.762	0.446	−0.041	0.094
Benefit recipient × Intentionality	0.024	0.034	0.697	0.486	−0.043	0.091
Personal force × Benefit recipient × Intentionality	−0.014	0.046	−0.302	0.763	−0.104	0.076
Random effects	StdDev	Residual				
Subjects (*intercept*)	0.050	0.168				
LogLik = 297.487; R^2 = 0.10						

β: estimate; SE: standard error; 95% CI: confidence interval; BVAQ: Bermond–Vorst Alexithymia Questionnaire; TAS-20: 20-items Toronto Alexithymia Scale; IRI: Interpersonal Reactivity Index; PT: perspective taking; FS: fantasy; EC: empathic concern; PD: personal distress; LogLik: log likelihood. Significant *p* values are in bold. Reference condition for categorical factors is reported in italic inside bracket.

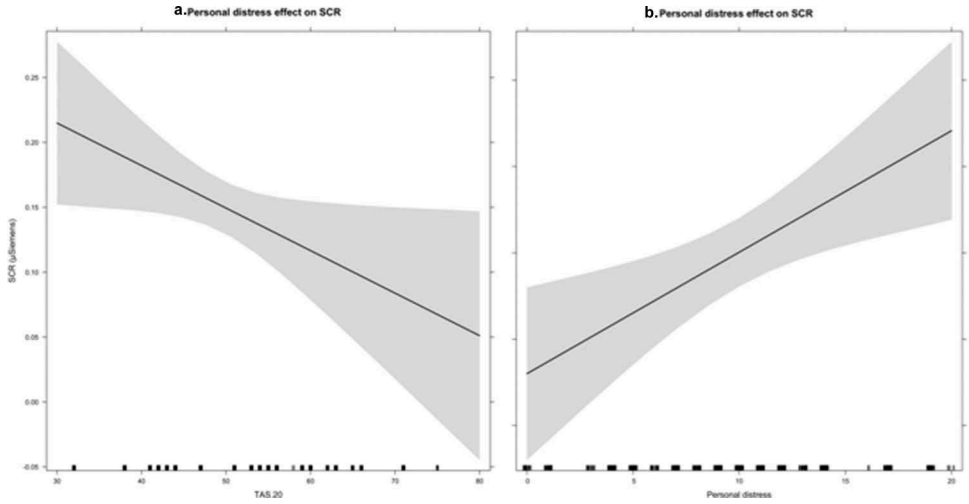

Figure 4. (a) Effect of personal distress and (b) effect of TAS.20 on SCR. Gray areas represent the simulated 95% confidence interval of the coefficients.

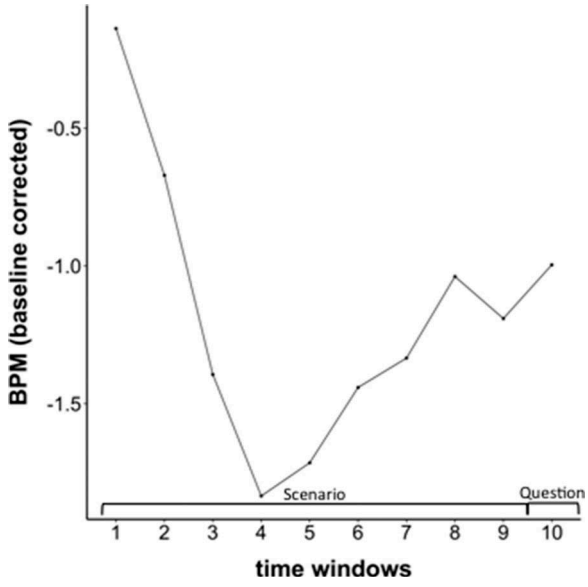

Figure 5. IHR per time windows.

alexithymia in morality (Patil, Melsbach, Hennig-Fast, & Silani, 2016) are consistent with the here presented evidence. Patil et al. (2016) enrolled participants with Autistic spectrum disorders and healthy participants. Even though autistic individuals showed higher alexithymia scores compared to healthy participants, they did not show differences in moral choices. Moreover, they did not report significant correlations between alexithymia and moral behavior in healthy participants (Patil et al., 2016).

Only one study investigated the influence of empathy on moral decision-making in healthy participants (Sarlo et al., 2014). The authors found that PD, measuring the state of anxiety and discomfort prompted by others in need, was negatively associated with the number of utilitarian decisions. However, it should be noted that PD scores in Sarlo et al. (2014) were higher than in our sample (range 6–30 compared to 0–22 in our study), and this aspect may explain the contrasting results. Future studies should carefully consider participants' distribution in both alexithymia and empathy scores.

Second, while the influence of several empathy components was evident in both explicit and implicit measures of emotional reactions, the influence of alexithymia, going in the opposite direction, emerged only in the SCR. Moreover, even though individual differences in empathy did not bias moral choices, empathy subcomponents affected emotional reactions during the moral decision-making task, independently of the type of dilemma. In particular, the more participants showed a propensity to experience compassion and concern for others (empathy concern), the more they considered moral dilemmas arousing and unpleasant. Interestingly, valence ratings were also influenced by FS scores – an empathy component that measures the propensity of identifying with characters of books or movies. Even though this subscale was not correlated with valence or arousal ratings in a previous study (Sarlo et al., 2014), the here reported finding is in line with prior hypotheses. Indeed, participants were explicitly asked to *try to identify yourself with the characters of the stories*, thus it was expected that the more they are able to imagine themselves in the described situation, the more they perceive the situation as unpleasant. These data confirm the dissociation between cognitive and affective empathy, proposed by Sarlo et al. (2014), in modulating emotional reactions during moral decision-making. Furthermore, the influence of empathy on emotional reactions to moral decision

was also evident considering implicit measures, in particular SCR. The arousal measured through SCR revealed that individuals presenting higher PD and higher EC, both affective components of empathy, presented greater and slower SCR, indicating higher bodily arousal, than individuals with lower PD and EC. This evidence confirms that the intensity of emotional reactions evoked by moral decision is biased by the individuals' urge to care for another's welfare.

Conversely, the influence of alexithymia was evident only when we considered an implicit measure of arousal. Participants with higher alexithymia showed lower SCR compared to those with lower alexithymia scores. This result is in line with previous studies and suggests that alexithymia is characterized by limited affective reactivity or a condition of hypoarousal (Franz, Schaefer, & Schneider, 2003; Bermond et al., 2010a; Pollatos et al., 2011; Neumann, Sollers, Thayer, & Waldstein, 2004). No influence of alexithymia was observed in the valence and arousal ratings. This unexpected result is nevertheless in line with the reported discordance between physiological responses and self-report measures in alexithymia (Peasley-Miklus, Panayiotou, & Vrana, 2016). This suggests that alexithymics' reports of emotional experience after moral choices may be based on what they know is socially acceptable (e.g., one should feel sorry for a certain type of situation) rather than on their psychophysiological reactions. As discussed by Peasley-Miklus et al. (2016), the inability of alexithymics' to describe their feelings may only become evident when they are requested to spontaneously describe their own emotional experiences, in which case it is more difficult to rely on external information.

Neither empathy nor alexithymia influenced IHR. However, a pattern of generalized deceleration was found during the first part of the dilemma presentation, probably due to the negative emotional state induced by the moral dilemmas (Bradley, 2009; for an alternative perceptual-attentional explanation, see Palomba et al., 2000) followed by a slight IHR acceleration. This pattern characterizes all type of dilemmas.

Results concerning the influence of the conceptual factors are in line with the previous literature. Participants provided more deontological responses when the moral dilemma was personal (Christensen et al., 2014; Greene et al., 2009, 2008; Moore et al., 2008, 2004; Koenigs et al., 2007; Mendez et al., 2005; Moretto et al., 2009), instrumental (Christensen et al., 2014; Greene et al., 2009; Hauser, Cushman, Young, Kang-Xing Jin, & Mikhail, 2007; Lotto et al., 2014; Sarlo et al., 2012) and/or self-beneficial (Moore et al., 2008; Christensen et al., 2014; Lotto et al., 2014). Generally, the more arousing and unpleasant a dilemma was perceived, as shown by the arousal and valence ratings and by the IHR modulation, the fewer utilitarian choices it induced. Personal dilemmas were considered more arousing and less pleasant than impersonal dilemmas and were characterized by less utilitarian responses (Christensen et al., 2014; Ciaramelli et al., 2007; Greene et al., 2008, 2004, 2001; Koenigs et al., 2007; Moretto et al., 2009; Shenhav & Greene, 2014; Thomas et al., 2011). Similarly, self-beneficial dilemmas were considered more arousing and less pleasant and resulted in fewer utilitarian responses than other-beneficial dilemmas (Bloomfield, 2007; Moore et al., 2008).

This study also provides new information about different cardiac modulations as depending on the moral conceptual factors: personal, self and instrumental dilemmas evoked greater deceleration in cardiac activity, a pattern that has been associated with negative emotional states (Bradley, 2009). In line with results of arousal and valence ratings, the analysis of IHR also confirms that utilitarian choices are those characterized by higher negative emotional reactions (Moretto et al., 2009), as they evoke greater deceleration in cardiac activity as well as higher unpleasantness and arousal ratings. These negative emotional reactions are those that discourage the selection of utilitarian options in future decisions.

In contrast with previous studies, in which the intentionality factor was considered in relation to arousal and valence (Sarlo et al., 2012), we found that participants considered dilemmas in which the harm was a side effect (accidental dilemmas) as more arousing and less pleasant compared to dilemmas in which the harm was deliberate and used instrumentally (instrumental dilemmas). Nevertheless, instrumental dilemmas evoked greater IHR deceleration, an index for unpleasant stimuli, and they resulted in a higher percentage of utilitarian responses than accidental dilemmas. This unexpected pattern in affective ratings for the intentionality factor has been found also in other studies (Christensen et al., 2014; Lotto et al., 2014). In Lotto et al. (2014), accidental dilemmas were rated as more arousing than instrumental dilemmas even though participants gave more utilitarian responses for accidental than instrumental dilemmas. Lotto et al. (2014) argued that during the evaluation of accidental dilemmas, participants are focused on the computation of the ratio between costs and benefits of the harmful action instead of the emotional conflicts typical of the instrumental dilemmas. The more arousing the dilemmas are, the greater the effects of the attentional processing (Lotto et al., 2014). In the second study (Christensen et al., 2014), the accidental harm was rated as more

unpleasant and more arousing than instrumental harm only when the dilemma was self-beneficial. According to the authors, this is due to a consequence of the less conflicting experience that characterizes the self-benefit dilemmas. Our result clearly supports the theory proposed by Lotto et al. (2014), pointing out a peculiar characteristic of the intentionality factor: since the instrumental dilemmas evoke very strong emotional reactions, participants choose deontological responses; on the other hand, as accidental dilemmas do not lead to strong emotional engagement, participants are freer to think about the consequences of the actions. Arousal and valence ratings reflect a greater cognitive effort.

In conclusion, the evidence that empathy and alexithymia did not bias moral decisions seems to suggest that participants, when asked to perform a moral decision-making task, rely less on the perception of their own emotions than previously suggested for moral judgment and more on reasoning about the information provided by the dilemmas. However, individual differences in empathy or alexithymia influence emotional reactions to moral dilemma, in both self-report measures of arousal and valence and implicit arousal (in the case of empathy) or only in implicit arousal (in the case of alexithymia). These findings reinforce the view that interactions between individual differences in emotional awareness and moral decision-making are very complex and need to be addressed further and taken in consideration in future studies on moral decision-making.

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Disclosure statement

Authors have no conflicts of interest to declare.

References

Batson, C. D. (2014). *The altruism question: Toward a social-psychological answer*. Hillside, NJ: Psychology Press.

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *Beck depression inventory-II*. San Antonio, TX: Psychological Corporation.

Bermond, B., Bierman, D. J., Cladder, M. A., Moormann, P. P., & Vorst, H. C. (2010). The cognitive and affective alexithymia dimensions in the regulation of sympathetic responses. *International Journal of Psychophysiology*, *75*(3), 227–233. doi:10.1016/j.ijpsycho.2009.11.004

Bermond, B., Clayton, K., Liberova, A., Luminet, O., Maruszewski, T., Ricci Bitti, P. E., … Wicherts, J. (2007). A cognitive and an affective dimension of alexithymia in six languages and seven populations. *Cognition and Emotion*, *21*(5), 1125–1136. doi:10.1080/02699930601056989

Bermond, B., & Oosterveld, P. (1994). *Bermond-vorst alexithymia questionnaire; construction, reliability, validity and uni-dimensionality: Internal report*. Amsterdam, University of Amsterdam: Faculty of Psychology. Department of Psychological Methods.

Bermond, B., Vorst, H. C. M., & Moormann, P. P. (2006). Cognitive neuropsychology of alexithymia: Implications for personality typology. *Cogntive Neuropsychiatry*, *11*(3), 332–360. doi:10.1080/13546800500368607

Berthoz, S., Pouga, L., & Wessa, M. (2011). Alexithymia from the social neuroscience perspective. In Decety, J., & Cacioppo, J. T. (Eds.), *The Oxford handbook of social neuroscience*. Oxford University Press, (pp. 906–934).

Bird, G., & Cook, R. (2013). Mixed emotions: The contribution of alexithymia to the emotional symptoms of autism. *Translational Psychiatry*, *3*, e285. doi:10.1038/tp.2013.61

Blair, R. J. R. (2005). Responding to the emotions of others: Dissociating forms of empathy through the study of typical and psychiatric populations. *Consciousness and Cognition*, *14*(4), 698–718. doi:10.1016/j.concog.2005.06.004

Bloomfield, P. (2007). *Morality and self-interest*. New York: Oxford University Press.

Boucsein, W. (2012). *Electrodermal activity*. US: Springer Science & Business Media.

Bradley, M. M. (2009). Natural selective attention: Orienting and emotion. *Psychophysiology*, *46*(1), 1–11. doi:10.1111/psyp.2008.46.issue-1

Bressi, C., Taylor, G., Parker, J., Bressi, S., Brambilla, V., Aguglia, E., … Bucca, M. (1996). Cross validation of the factor structure of the 20-item toronto alexithymia scale: An Italian multicenter study. *Journal of Psychosomatic Research*, *41*(6), 551–559. doi:10.1111/1468-5914.00135

Brewer, R., Marsh, A. A., Catmur, C., Cardinale, E. M., Stoycos, S., Cook, R., & Bird, G. (2015). The impact of autism spectrum disorder and alexithymia on judgments of moral acceptability. *Journal of Abnormal Psychology*, *124*(3), 589. doi:10.1037/abn0000076

Cacioppo, J. T., Berntson, G. G., Larsen, J. T., Poehlmann, K. M., & Ito, T. A. (2000). The psychophysiology of emotion. *Handbook of Emotions*, *2*, 173–191.

Cecchetto, C., Rumiati, R., & Parma, V. (in press). *Promoting cross-culture research on moral decision-making through the use of standardized*. culturally-equivalent dilemmas: The validation of the 4CONFiDe set.

Choe, S. Y., & Min, K.-H. (2011). Who makes utilitarian judgments? The influences of emotions on utilitarian judgments. *Judgment and Decision Making*, *6*(7), 580–592.

Christensen, J. F., Flexas, A., Calabrese, M., Gut, N. K., & Gomila, A. (2014). Moral judgment reloaded: A moral dilemma validation study. *Emotion Science*, *5*, 607.

Christensen, J. F., & Gomila, A. (2012). Moral dilemmas in cognitive neuroscience of moral decision-making: A principled review. *Neuroscience & Biobehavioral Reviews*, *36*(4), 1249–1264. doi:10.1016/j.neubiorev.2012.02.008

Ciaramelli, E., Muccioli, M., Làdavas, E., & Di Pellegrino, G. (2007). Selective deficit in personal moral judgment following damage to ventromedial prefrontal cortex. *Social Cognitive and Affective Neuroscience*, *2*(2), 84–92. doi:10.1093/scan/nsm001

Crockett, M. J., Clark, L., Hauser, M. D., & Robbins, T. W. (2010). Serotonin selectively influences moral judgment and behavior through effects on harm aversion. *Proceedings of the National Academy of Sciences*, *107*(40), 17433–17438. doi:10.1073/pnas.1009396107

Crockett, M. J., Siegel, J. Z., Kurth-Nelson, Z., Ousdal, O. T., Story, G., Frieband, C., … Dolan, R. J. (2015). Dissociable effects of serotonin and dopamine on the valuation of harm in moral decision making. *Current Biology*, *25*(14), 1852–1859. doi:10.1016/j.cub.2015.05.021

Davis, M. H. (1980). A multidimensional approach to individual differences in empathy. *JSAS Catalog of Selected Documents in Psychology*, *10,* 85.

Decety, J., & Batson, C. D. (2009). Empathy and morality: Integrating social and neuroscience approaches. In *The moral brain* (pp. 109-127). Springer Netherlands.

Decety, J., & Cowell, J. M. (2014a). The complex relation between morality and empathy. *Trends in Cognitive Sciences*, *18*(7), 337–339. doi:10.1016/j.tics.2014.04.008

Decety, J., & Cowell, J. M. (2014b). Friends or foes is empathy necessary for moral behavior? *Perspectives on Psychological Science*, *9*(5), 525–537. doi:10.1177/1745691614545130

Decety, J., & Jackson, P. L. (2004). The functional architecture of human empathy. *Behavioral and Cognitive Neuroscience Reviews*, *3*(2), 71–100. doi:10.1177/1534582304267187

Eisenberg, N. (2000). Emotion, regulation, and moral development. *Annual Review of Psychology*, *51*(1), 665–697. doi:10.1146/annurev.psych.51.1.665

Schulte-Mecklenbeck, M., Kühberger, A., & Ranyard, R. (Eds.). (2011). *A handbook of process tracing methods for decision research: A critical review and user's guide.* Psychology Press.

Foot, P. (1967). *Theories of ethics*. Oxford: Oxford University Press.

Franz, M., Schaefer, R., & Schneider, C. (2003). Psychophysiological response patterns of high and low alexithymics under mental and emotional load conditions. *Journal of Psychophysiology*, *17*(4), 203–213. doi:10.1027/0269-8803.17.4.203

Gao, Y., & Tang, S. (2013). Psychopathic personality and utilitarian moral judgment in college students. *Journal of Criminal Justice*, *41*(5), 342–349. doi:10.1016/j.jcrimjus.2013.06.012

Garrigan, B., Adlam, A. L., & Langdon, P. E. (2016). The neural correlates of moral decision-making: A systematic review and meta-analysis of moral evaluations and response decision judgements. *Brain and Cognition*, *108*, 88–97. doi:10.1016/j.bandc.2016.07.007

Gleichgerrcht, E., Tomashitis, B., & Sinay, V. (2015). The relationship between alexithymia, empathy and moral judgment in patients with multiple sclerosis. *European Journal of Neurology*, *22*, 1295–1303. doi:10.1111/ene.2015.22.issue-9

Gleichgerrcht, E., Torralva, T., Roca, M., Pose, M., & Manes, F. (2011). The role of social cognition in moral judgment in frontotemporal dementia. *Social Neuroscience*, *6*(2), 113-122. doi:10.1080/17470919.2010.506751

Gleichgerrcht, E., & Young, L. (2013). Low levels of empathic concern predict utilitarian moral judgment. *Plos One*, *8*(4), e60418. doi:10.1371/journal.pone.0060418

Glenn, A. L., Koleva, S., Iyer, R., Graham, J., & Ditto, P. H. (2010). Moral identity in psychopathy. *Judgment and Decision Making*, *5*(7), 497–505.

Goerlich-Dobre, K. S., Bruce, L., Martens, S., Aleman, A., & Hooker, C. I. (2014). Distinct associations of insula and cingulate volume with the cognitive and affective dimensions of alexithymia. *Neuropsychologia*, *53*, 284–292. doi:10.1016/j.neuropsychologia.2013.12.006

Goerlich-Dobre, K. S., Lamm, C., Pripfl, J., Habel, U., & Votinov, M. (2015). The left amygdala: A shared substrate of alexithymia and empathy. *NeuroImage*, *122*, 20–32. doi:10.1016/j.neuroimage.2015.08.014

Goerlich-Dobre, K. S., Votinov, M., Habel, U., Pripfl, J., & Lamm, C. (2015). Neuroanatomical profiles of alexithymia dimensions and subtypes. *Human Brain Mapping*, *36*, 3805–3818. doi:10.1002/hbm.22879

Greene, J., & Haidt, J. (2002). How (and where) does moral judgment work? *Trends in Cognitive Sciences*, *6*(12), 517–523. doi:10.1016/S1364-6613(02)02011-9

Greene, J., Nystrom, L., Engell, A., Darley, J., & Cohen, J. (2004). The neural bases of cognitive conflict and control in moral judgment. *Neuron*, *44*(2), 389–400. doi:10.1016/j.neuron.2004.09.027

Greene, J., Sommerville, R., Nystrom, L., Darley, J., & Cohen, J. (2001). An fMRI investigation of emotional engagement in moral judgment. *Science (New York, N.Y.)*, *293*(5537), 2105–2108. doi:10.1126/science.1062872

Greene, J. D., Cushman, F. A., Stewart, L. E., Lowenberg, K., Nystrom, L. E., & Cohen, J. D. (2009). Pushing moral buttons: The interaction between personal force and intention in moral judgment. *Cognition*, *111*(3), 364–371. doi:10.1016/j.cognition.2009.02.001

Greene, J. D., Morelli, S. A., Lowenberg, K., Nystrom, L. E., & Cohen, J. D. (2008). Cognitive load selectively interferes with utilitarian moral judgment. *Cognition*, *107*(3), 1144–1154. doi:10.1016/j.cognition.2007.11.004

Guttman, H., & Laporte, L. (2002). Alexithymia, empathy, and psychological symptoms in a family context. *Comprehensive Psychiatry*, *43*(6), 448–455. doi:10.1053/comp.2002.35905

Hauser, M., Cushman, F., Young, L., Kang-Xing Jin, R., & Mikhail, J. (2007). A dissociation between moral judgments and justifications. *Mind & Language*, *22*(1), 1–21. doi:10.1111/j.1468-0017.2006.00297.x

Hein, G., & Singer, T. (2008). I feel how you feel but not always: The empathic brain and its modulation. *Current Opinion in Neurobiology*, *18*(2), 153–158. doi:10.1016/j.conb.2008.07.012

Hoffman, M. L. (1994). The contribution of empathy to justice and moral judgment. *Reaching Out: Caring, Altruism, and Prosocial Behavior*, *7*, 161–194.

Johnson, P. C. (2014). Extension of Nakagawa & Schielzeth's R2GLMM to random slopes models. *Methods in Ecology and Evolution*, *5*(9), 944–946. doi:10.1111/2041-210X.12225

Judd, C. M., Westfall, J., & Kenny, D. A. (2012). Treating stimuli as a random factor in social psychology: A new and comprehensive solution to a pervasive but largely ignored problem. *Journal of Personality and Social Psychology*, *103* (1), 54. doi:10.1037/a0028347

Koenigs, M., Young, L., Adolphs, R., Tranel, D., Cushman, F., Hauser, M., & Damasio, A. (2007). Damage to the prefrontal cortex increases utilitarian moral judgements. *Nature*, *446* (7138), 908–911. doi:10.1038/nature05631

Koven, N. (2011). Specificity of meta-emotion effects on moral decision-making. *Emotion (Washington, D.C.)*, *11*(5), 1255–1261. doi:10.1037/a0025616

Lang, P. J. (1995). The emotion probe: Studies of motivation and attention. *American Psychologist*, *50*(5), 372. doi:10.1037/0003-066X.50.5.372

Langdon, R., & Mackenzie, C. (2012). *Emotions, imagination, and moral reasoning*. Psychology Press.

Larsen, J. K., Brand, N., Bermond, B., & Hijman, R. (2003). Cognitive and emotional characteristics of alexithymia. *Journal of Psychosomatic Research*, *54*, 533–541. doi:10.1016/S0022-3999(02)00466-X

Lotto, L., Manfrinati, A., & Sarlo, M. (2014). A new set of moral dilemmas: Norms for moral acceptability, decision times, and emotional salience. *Journal of Behavioral Decision Making*, *27*(1), 57–65. doi:10.1002/bdm.v27.1

Martins, A. T., Faísca, L., Esteves, F., Muresan, A., & Reis, A. (2012). *Atypical moral judgment following traumatic brain injury*. *Judgment and Decision Making, 7*(4), 478.

McCulloch, C. E. (1997). Maximum likelihood algorithms for generalized linear mixed models. *Journal of the American Statistical Association*, *92*(437), 162–170. doi:10.1080/01621459.1997.10473613

Mendez, M. F., Anderson, E., & Shapira, J. S. (2005). An investigation of moral judgement in frontotemporal dementia. *Cognitive and Behavioral Neurology*, *18*(4), 193–197. doi:10.1097/01.wnn.0000191292.17964.bb

Moore, A. B., Clark, B. A., & Kane, M. J. (2008). Who shalt not kill? Individual differences in working memory capacity, executive control, and moral judgment. *Psychological Science*, *19*(6), 549–557. doi:10.1111/j.1467-9280.2008.02122.x

Moretto, G., Làdavas, E., Mattioli, F., & Di Pellegrino, G. (2009). A psychophysiological investigation of moral judgment after ventromedial prefrontal damage. *Journal of Cognitive Neuroscience*, *22*(8), 1888–1899. doi:10.1162/jocn.2009.21367

Moriguchi, Y., Decety, J., Ohnishi, T., Maeda, M., Mori, T., Nemoto, K., … Komaki, G. (2007). Empathy and judging other's pain: An fMRI study of alexithymia. *Cerebral Cortex*, *17*(9), 2223–2234. doi:10.1093/cercor/bhl130

Nakagawa, S., & Schielzeth, H. (2013). A general and simple method for obtaining R2 from generalized linear mixed-effects models. *Methods in Ecology and Evolution*, *4*(2), 133–142. doi:10.1111/j.2041-210x.2012.00261.x

Nemiah, J., Freyberger, H., & Sifneos, P. (1976). Alexithymia: A view of the psychosomatic process. *Modern Trends in Psychosomatic Medicine*, *3*, 430–439.

Neufeld, J., Ioannou, C., Korb, S., Schilbach, L., & Chakrabarti, B. (2016). Spontaneous facial mimicry is modulated by joint attention and autistic traits. *Autism Research, 9 (7), 781–789*.

Neumann, D., Zupan, B., Malec, J., & Hammond, F. (2014). Relationships between alexithymia, affect recognition, and empathy after traumatic brain injury. *The Journal of Head Trauma Rehabilitation, 29*(1), E18-E27.

Neumann, S. A., Sollers, J. J., Thayer, J. F., & Waldstein, S. R. (2004). Alexithymia predicts attenuated autonomic reactivity, but prolonged recovery to anger recall in young women. *International Journal of Psychophysiology*, *53*(3), 183–195. doi:10.1016/j.ijpsycho.2004.03.008

Öngür, D., & Price, J. L. (2000). The organization of networks within the orbital and medial prefrontal cortex of rats. *Monkeys and Humans. Cerebral Cortex*, *10*(3), 206–219. doi:10.1093/cercor/10.3.206

Orelien, J. G., & Edwards, L. J. (2008). Fixed effect variable selection in linear mixed models using statistics. *Computational Statistics & Data Analysis*, *52*, 1896–1907. doi:10.1016/j.csda.2007.06.006

Palomba, D., Sarlo, M., Angrilli, A., Mini, A., & Stegagno, L. (2000). Cardiac responses associated with affective processing of unpleasant film stimuli. *International Journal of Psychophysiology*, *36*(1), 45–57. doi:10.1016/S0167-8760(99)00099-9

Patil, I., Melsbach, J., Hennig-Fast, K., & Silani, G. (2016). Divergent roles of autistic and alexithymic traits in utilitarian moral judgments in adults with autism. *Scientific Reports*, *6*, 23637. doi:10.1038/srep23637

Patil, I., & Silani, G. (2014a). Alexithymia increases moral acceptability of accidental harms. *Journal of Cognitive Psychology*, *26*(5), 597–614. doi:10.1080/20445911.2014.929137

Patil, I., & Silani, G. (2014b). Reduced empathic concern leads to utilitarian moral judgments in trait alexithymia. *Frontiers in Psychology*, *5*. doi:10.3389/fpsyg.2014.00501

Peasley-Miklus, C. E., Panayiotou, G., & Vrana, S. R. (2016). Alexithymia predicts arousal-based processing deficits and discordance between emotion response systems during emotional imagery. *Emotion*, *16*(2), 164. doi:10.1037/emo0000086

Pizarro, D. (2000). Nothing more than feelings? The role of emotions in moral judgment. *Journal for the Theory of Social Behaviour*, *30*(4), 355–375. doi:10.1111/jtsb.2000.30.issue-4

Pollatos, O., Werner, N. S., Duschek, S., Schandry, R., Matthias, E., Traut-Mattausch, E., & Herbert, B. M. (2011). Differential effects of alexithymia subscales on autonomic reactivity and anxiety during social stress. *Journal of Psychosomatic Research*, *70*(6), 525–533. doi:10.1016/j.jpsychores.2010.12.003

Rilling, J. K., & Sanfey, A. G. (2011). The neuroscience of social decision-making. *Annual Review of Psychology*, *62*, 23–48. doi:10.1146/annurev.psych.121208.131647

Rolls, E. T. (2000). The orbitofrontal cortex and reward. *Cerebral Cortex*, *10*(3), 284–294. doi:10.1093/cercor/10.3.284

Salminen, J. K., Saarijärvi, S., Äärelä, E., Toikka, T., & Kauhanen, J. (1999). Prevalence of alexithymia and its association with sociodemographic variables in the general population of Finland. *Journal of Psychosomatic Research*, *46*(1), 75–82. doi:10.1016/S0022-3999(98)00053-1

Sarlo, M., Lotto, L., Manfrinati, A., Rumiati, R., Gallicchio, G., & Palomba, D. (2012). Temporal dynamics of cognitive-emotional interplay in moral decision-making. *Journal of Cognitive Neuroscience*, *24*(4), 1018–1029. doi:10.1162/jocn_a_00146

Sarlo, M., Lotto, L., Rumiati, R., & Palomba, D. (2014). If it makes you feel bad, don't do it! Egoistic rather than altruistic empathy modulates neural and behavioral responses in moral dilemmas. *Physiology & Behavior*, *130*, 127–134. doi:10.1016/j.physbeh.2014.04.002

Shenhav, A., & Greene, J. (2014). Integrative moral judgment: Dissociating the roles of the amygdala and ventromedial prefrontal cortex. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience*, *34*(13), 4741–4749. doi:10.1523/JNEUROSCI.3390-13.2014

Sifneos, P. E. (1973). The prevalence of 'alexithymic'characteristics in psychosomatic patients. *Psychotherapy and Psychosomatics*, *22*(2–6), 255–262. doi:10.1159/000286529

Singer, T., & Lamm, C. (2009). The social neuroscience of empathy. *Annals of the New York Academy of Sciences*, *1156*(1), 81–96. doi:10.1111/j.1749-6632.2009.04418.x

Sturm, V., & Levenson, R. (2011). Alexithymia in neurodegenerative disease. *Neurocase*, *17*(3), 242–250. doi:10.1080/13554794.2010.532503

Szekely, R. D., & Miu, A. C. (2014). Incidental emotions in moral dilemmas: The influence of emotion regulation. *Cognition & Emotion*, *29*(1), 64-75.

Tassy, S., Deruelle, C., Mancini, J., Leistedt, S., & Wicker, B. (2013a). High levels of psychopathic traits alters moral choice but not moral judgment. *Frontiers in Human Neuroscience*, *7*. doi:10.3389/fnhum.2013.00229

Tassy, S., Oullier, O., Mancini, J., & Wicker, B. (2013b). Discrepancies between judgment and choice of action in moral dilemmas. *Frontiers in Psychology*, *4*. doi:10.3389/fpsyg.2013.00250

Taylor, G. J., Bagby, R. M., & Parker, J. D. (1999). *Disorders of affect regulation:Alexithymia in medical and psychiatric illness*. Cambridge: Cambridge University Press.

Thomas, B. C., Croft, K. E., & Tranel, D. (2011). harming kin to save strangers: Further evidence for abnormally utilitarian moral judgments after ventromedial prefrontal damage. *Journal of Cognitive Neuroscience*, *23*(9), 2186–2196. doi:10.1162/jocn.2010.21591

Thomson, J. (1976). *Aristotle: Ethics*. Harmondsworth, UK: Penguin.

Maibom, H. L. (Ed.). (2014). *Empathy and morality*. Oxford: Oxford University Press.

Vorst, H. C., & Bermond, B. (2001). Validity and reliability of the Bermond–Vorst alexithymia questionnaire. *Personality and Individual Differences*, *30*(3), 413–434. doi:10.1016/S0191-8869(00)00033-7

Wood, A., Rychlowska, M., Korb, S., & Niedenthal, P. (2016). Fashioning the face: sensorimotor simulation contributes to facial expression recognition. *Trends in Cognitive Sciences*, *20*(3), 227–240. doi:10.1016/j.tics.2015.12.010

Young, L., Koenigs, M., Kruepke, M., & Newman, J. P. (2012). Psychopathy increases perceived moral permissibility of accidents. *Journal of Abnormal Psychology*, *121*(3), 659. doi:10.1037/a0027489