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Neural processing of moral content reflects moral identity in 10-year-old children

Carolina Pletti[1,2] | Jean Decety[3] | Markus Paulus[1,2]

[1] Department of Psychology, LMU Munich, München, Germany

[2] Munich Center for Neurosciences – Brain & Mind, Munich, Germany

[3] College of the University of Chicago, Chicago, USA

Correspondence
Carolina Pletti, Department of Psychology, LMU Munich, Leopoldstraße 13, München 80802, Germany.
Email: carolina.pletti@lmu.de

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Abstract

Middle childhood seems to be crucial for the emergence of a moral identity, that is, an evaluative stance of how important it is for someone's sense of self to be moral. This study investigates the effects of moral identity on the neural processing of moral content in 10-year-old children. Participants were presented with scenes portraying prosocial and antisocial behavior, while electroencephalographic responses were collected. Analyses of event-related potentials (ERPs) showed that, for children with a strong moral identity, antisocial scenes elicited a greater early posterior negativity (EPN) as compared to prosocial scenes. Thus, for children with a strong moral identity, antisocial scenes capture more attentional resources than prosocial ones in early processing stages. In contrast to previous findings with adults, the implicit moral self-concept was not related to any ERP differences. Overall, the results show that, even in its developmental emergence, moral identity relates to the neurocognitive processing of third-party moral content. Together, the study supports the social-cognitive model of the development of moral identity, according to which moral identity is based on a chronical activation of moral schemas that guide a person's perception of the social world.

KEYWORDS
EEG, middle childhood, moral cognition, moral identity, neural processing

1 | INTRODUCTION

Moral identity is defined as how important it is for someone's identity or sense of self to be moral (Hardy & Carlo, 2011). This construct was introduced by Augusto Blasi in 1983 to explain why some people behave according to their moral judgments, while some others do not. According to Blasi, if morality is central to someone's identity, then this person will be motivated to behave morally, because not doing so would cause a feeling of dissonance (Blasi, 1983). According to Colby and Damon (1992), if a person has a strong moral identity, their personal goals coincide with moral goals. That is, these people do not have a conflict between personal and moral interests, and by behaving morally they also fulfill their personal interests. In line with these theories, empirical findings showed how moral identity is positively associated with various forms of prosocial behavior measured through experimental tasks, self-reports and observations (see Hertz & Krettenauer, 2015, for a meta-analysis). How morality becomes part of the self-concept is thus a crucial area of research for understanding moral cognition and prosocial behavior and the relationship between the two. From a developmental perspective, a key question concerns how and when moral identity develops – and how it affects children's processing of information about the social world.

According to classical theories (e.g., Blasi, 1983; Frimer & Walker, 2009), moral identity emerges in adolescence, because it is only at this time that moral values can be integrated in the newly forming sense of identity. Yet, according to other developmental accounts, there is a moral self-concept, which is interpreted as precursor of a full-fledged moral identity, already in early childhood. Such a moral self-concept is initially very rudimentary and may consist of interiorization of parental norms (Kochanska, 2002; Kochanska et al., 2010). It becomes more refined as children start describing themselves as people who prefer carrying out prosocial actions and avoiding antisocial action (Sengsavang & Krettenauer, 2015; Sticker et al., 2021). However, the moral self-concept one can observe in children is not a full-fledged moral identity. In particular, moral identity requires the ability to take an evaluative stance towards oneself (Kingsford et al., 2018), which is supposed to emerge in middle childhood (Harter, 2012; Rholes & Ruble, 1984). For this reason, middle childhood would be a crucial period for the moral self-concept to evolve in an outright moral identity, thanks to children's emerging abilities to evaluate themselves and to form desires about which kind of person they want to be (Kingsford et al., 2018; Tomasello, 2019).

These developmental considerations are complemented by a different approach on moral identity, which focusses on the cognitive processes underlying the moral self and moral identity, and how this relates to the processing of the external word: the social-cognitive model of moral identity (Lapsley, 2015; Lapsley & Narvaez, 2004). According to this model, moral self-concept and moral identity are both based on the chronical activation of moral schemas and scripts that guide not only a person's actions, but also a person's perception and interpretation of the world. Thus, according to this model, moral identity is not only based on rational thought and explicit reasoning, as suggested by Blasi and other classical theorists (Blasi, 1983; Colby & Damon, 1992; Frimer & Walker, 2009), but additionally on the implicit, automatized activation of schemas and scripts. This theory predicts that people with a strong moral identity should process moral information differently as compared to people with a weak moral identity. Evidence in line with this theory comes from a study with adults (Pletti et al., 2019), which used event-related potentials (ERPs) of the electroencephalogram (EEG) to investigate how people with a strong moral identity process social interactions involving prosocial and antisocial behavior. Results showed that moral identity was specifically related to differential processing of prosocial scenes: People with strong moral identity showed reduced processing of prosocial scenes at a very early stage (starting from 200 ms) after stimulus onset. These results, which reflect reduced attentional capture and higher expectation of prosocial scenes, support the social-cognitive model: if people with a strong moral identity have chronically active prosocial schemas, they will anticipate prosocial actions to happen and thus, following a predictive coding logic, will require less resources to process them.

These results open a fascinating theoretical question. Building on proposals that moral identity emerges in middle childhood (Kingsford et al., 2018; Tomasello, 2019), the social-cognitive model of moral identity would predict that it relates to how children perceive the social world. More concretely, can we expect children's moral identity to relate to the processing of pro- and antisocial actions? According to the social-cognitive model, moral identity is indicative of chronic and deeply entrenched social schemas (Lapsley, 2015; Lapsley & Narvaez, 2004). If such schemas are already chronically active in middle-late childhood, one should find that children with a higher moral identity process morally relevant behavior differently than children will a lower moral identity. Yet, since moral identity is just about to emerge and consolidate in middle childhood (Kingsford et al., 2018; Tomasello, 2019), moral schemas might not be automatically and chronically active yet, but rather deliberately activated. If this were true, we might still expect a difference in processing morally relevant content, but this might appear in a later time window as compared to adults.

Another theoretical question regards the extent to which moral identity in children affects only the processing of prosocial scenes, as is the case in adults, or whether also the processing of antisocial behaviors would be affected. Moral identity theories (Aquino & Reed, 2002; Walker & Frimer, 2007) suggest that an adult's moral identity mostly revolves around the so-called positive duties of morality (see Belliotti, 1981; Lichtenberg, 2010): to be a moral person, one needs to regularly and consistently carry out moral, prosocial actions. The avoidance of antisocial and immoral actions alone is not sufficient for someone to consider themselves particularly moral: for well-integrated adults, the avoidance of antisocial actions is expected, and it is not considered exemplary. Yet, avoidance of antisocial behavior has been proposed as a central part of the moral self-concept in children (Sengsavang & Krettenauer, 2015). In childhood, refraining from behaviors such as fighting (Boulton, 1993) and unfair sharing (Smith et al., 2013) is an important challenge and plays a crucial role in moral development (Dahl, 2016; Hay et al., 2021). Furthermore, in middle childhood, the moral self-concept was found to specifically relate to negative emotions associated with not sharing (the higher the moral self-concept, the more children anticipated to feel bad if they would not share), rather than to the positive emotions elicited by sharing (Christner et al., 2020). This suggests that antisocial actions could be especially relevant for children with a strong moral identity. Thus, one might hypothesize that

Research Highlights

- Moral identity has been proposed to emerge in middle childhood.
- Assessment of 10-year-old children's moral identity and neural processing of moral content.
- In children with strong moral identity, antisocial scenes elicited a greater early posterior negativity as compared to prosocial scenes.
- Children having a strong moral identity means having chronically active moral schemas that affect information processing.

children with a strong moral identity also differentially process antisocial scenes.

Importantly, some recent literature (Perugini & Leone, 2009) suggests that next to an explicit moral identity, an implicit moral self-concept exists. The explicit moral identity includes what persons report to think of themselves, what they strive to be, and how they want to present themselves to others (e.g., Aquino & Reed, 2002). The implicit moral self-concept is based on implicit associations between oneself and moral characteristics, which is built in the course of one's life through repetition (Perugini & Leone, 2009). Implicit moral self-concept and explicit moral identity seem to be different constructs: they usually do not correlate (Christner et al., 2020; Johnston et al., 2013; Perugini & Leone, 2009; Pletti et al., 2019), and they relate to different types of moral behavior. For instance, the explicit moral identity seems to relate especially to self-report behavior and hypothetical moral decisions, whereas the implicit moral self relates more strongly to deception (inversely) and moral outrage (Johnston et al., 2013; Perugini & Leone, 2009). The implicit moral self-concept has been scarcely investigated in childhood. Some studies suggest the presence of implicit attitudes in young children (e.g., Dunham et al., 2016; Rae & Olson, 2018), even concerning identity-related issues (e.g., Cvencek et al., 2016). Interestingly, implicit shame-prone self-concept was found to relate to borderline personality features in girls aged 10–14 years (Hawes et al., 2013), and implicit aggressive self-concept was found to predict aggressive behavior in middle childhood (Grumm et al., 2011). However, two studies found no relation between the implicit moral self-concept in childhood and prosocial behavior, even in middle childhood (Christner et al., 2020; Sticker et al., 2021). This could either suggest that its relation to actual behavior is rather weak or that the implicit moral self-concept might only emerge in adulthood.

One line of developmental theorizing stressed the ontogenetic priority of implicit compared to explicit social-cognitive processes, resembling an "intuitive difference between an inchoate earlier and more robust later understanding" (Low & Perner, 2012, p. 1). Yet, recent investigations cast doubt on the generality of this developmental framework. For some phenomena, an earlier or improved functioning in explicit, verbal contexts could be observed compared to so-called implicit processes (e.g., Paulus et al., 2017). From that perspective, more complex cognitive abilities may first emerge on an explicit, verbal level and may become automatized and implicit in the course of further development. Relying on our neurocognitive approach enabled us to explore whether in middle childhood the implicit moral self-concept and the explicit moral identity likewise relate to the processing of pro- and antisocial behavior, or if one form takes priority over the other. If we were to find relations with the implicit moral self-concept, we would obtain clear evidence for the existence of a meaningful implicit moral self. Yet, one could hypothesize that the moral self-concept first emerges in terms of explicit reasoning about oneself and only later becomes an automatized, implicit scheme of the self. If this were true, relations between implicit moral self and the processing of moral content would be weaker as compared to the effects that would emerge for explicit moral identity, or even absent.

1.1 | Current study

To investigate our central hypotheses, we assessed moral identity and the implicit moral self in 10-year-old children. We examined the extent to which these constructs relate to the neural processing of prosocial and antisocial scenes. We measured ERPs, focusing on three different time windows, representing three distinct information processing stages: (1) an early window reflecting automatic attentional capture (EPN, Cowell & Decety, 2015b; Gui et al., 2016; Pletti et al., 2019; Yoder & Decety, 2014b); (2) an intermediate window reflecting violation of expectation and allocation of attentional resources to salient stimuli (N2, Cowell & Decety, 2015b; Gui et al., 2016; Pletti et al., 2019); and (3) a late time window reflecting more deliberate allocation of processing resources to motivationally relevant stimuli (LPP, Cowell & Decety, 2015b; Gui et al., 2016; Pletti et al., 2019; Yoder & Decety, 2014b). One recent EEG study with adult participants (Pletti et al., 2019) found the implicit moral self to be related to reduced automatic attentional capture by prosocial stimuli (lower EPN) and moral identity to be related to reduced allocation of attentional resources and reduced violation of expectation for prosocial stimuli (N2). In 10 years old, since the chronicization of moral schemas might not be as consolidated yet, we expect to find effects especially on the later time window (LPP), which reflects more top-down controlled processing. Building on theoretical considerations pointing towards the importance of avoiding antisocial action for the moral self-concept in childhood (Christner et al., 2020; Sengsavang & Krettenauer, 2015), we expect such effects to emerge for both prosocial and antisocial actions. Furthermore, we examine such relations for both moral identity and the implicit moral self, as we can hypothesize the latter to also emerge at this age.

Finally, an additional goal of this study was to compare the neural processing of third-party prosocial and antisocial actions in middle childhood, irrespective of moral identity and moral self-concept. Since the current literature only focused on adults (Pletti et al., 2019; Yoder & Decety, 2014a) or younger children (Cowell & Decety, 2015b), this fills a gap in the study of the development of moral cognition.

2 | MATERIALS AND METHODS

2.1 | Participants

Fifty-six 10-year-olds (21 females, mean age: 10.45 years, SD: 0.33 years) were recruited through letters directed to the parents in a large German city. Participants had no history of psychiatric or neurological disorders, were right-handed and native German speakers. In exchange for their participation, they received a small gift, and the parents received a reimbursement for travel costs. The study was approved by the local Ethics Committee.

We determined the sample size through a power analysis, planning a mixed model ANOVA, setting the effect size to $f = 0.40$ (based on studies investigating the effect of interindividual differences on ERPs related to social cognition, e.g., Sarlo et al., 2014;

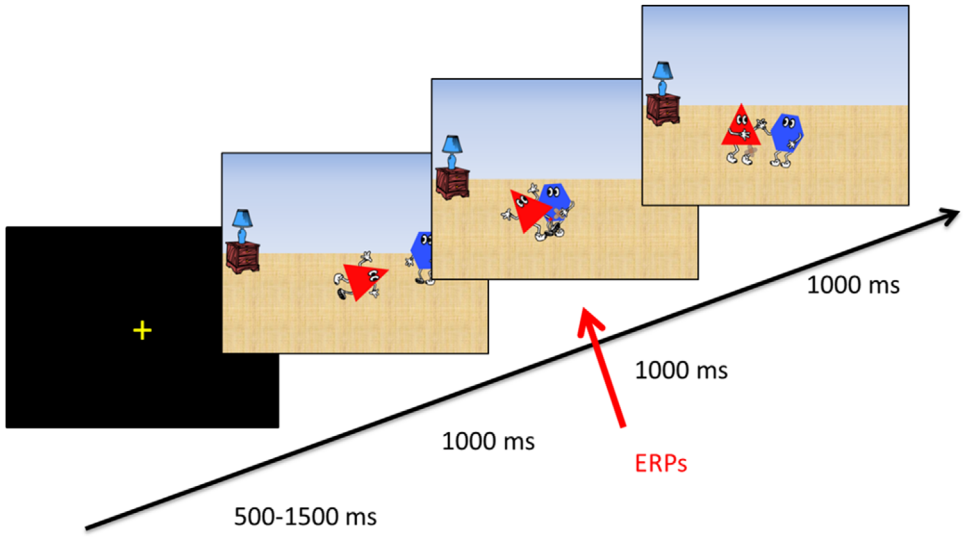

FIGURE 1 Depiction of an example trial of the Chicago moral sensitivity task (a prosocial action). The red arrow indicates the event to which the ERPs were time-locked to

Yoder & Decety, 2014a, 2014b), the alpha level to .05 and the power level to .80. The estimated sample size was $N = 25$ per group. To account for attrition, we collected data from 56 participants. Of these, we excluded four from all analyses because of equipment failure or too many EEG artifacts (final sample size for ERP data analyses: 52 (20 F), mean age 10.447, SD = 0.338). Additional seven were excluded from the analyses regarding the implicit moral self, one because of equipment failure and six because of lack of understanding of most of the words included in the Implicit Association Task (IAT). The final sample size for the analyses including the IAT was 45 (18 F) with a mean age of 10.45 (SD = 0.349) years.

2.2 | Stimuli and measures

2.2.1 | CMST

The Chicago Moral Sensitivity Task (CMST, Cowell & Decety, 2015, 2015a) is a task that allows for an assessment of children's processing of pro- and antisocial behavior. It consists of a set of scenarios depicting prosocial and antisocial interactions. The set comprises a total of 60 prosocial and 60 antisocial actions, each consisting of three pictures portraying two characters (geometric shapes) interacting with each other. The first picture of each scenario introduces the situation, the second depicts the crucial pro-or anti-social action, and the third the resolution of the situation (see Figure 1).

We presented the scenarios in a random order, with a duration of one second for each picture, and a jittered inter-trial interval of 500–1000 ms. As in previous studies (Cowell & Decety, 2015b; Pletti et al., 2019), the ERPs were time-locked to the onset of the second picture, where the quality of the interaction (antisocial vs. prosocial) becomes clear. The task was administered using Presentation® software (Version 19.0, Neurobehavioral Systems, Inc., Berkeley, CA, www.neurobs.com).

2.2.2 | Moral self IAT

To measure the implicit moral self-concept, we adapted the Moral Self Implicit Association Task (Moral Self IAT, Perugini & Leone, 2009). In this task, participants categorize a series of words into four categories (moral, immoral, related to the self, related to others – see Table 1 for a list of stimuli). The words for our adaptation of the Moral Self IAT were chosen after a pilot study, conducted to select only words which are suitable for 10-year-olds. Additionally, to ensure word understanding, before beginning the IAT an experimenter read each word to the participants, asking them what they mean. All words unknown to the children were noted down. Children that did not know at least five of the 10 moral words were excluded from this task ($n = 6$). During the IAT, the words were presented singularly at the center of the screen, with the categories presented on the top left and right corner. Participants had to categorize them by pressing one of two keys (one on the left, one on the right), as quickly and accurately as possible. The task consisted of seven blocks: in the first block (*moral/immoral discrimination* – 20 trials), participants categorized adjectives as moral or immoral. In the second (*self/other discrimination* – 20 trials), they categorized pronouns as pertaining to the self or to others. In the third and fourth blocks (*first paired* – 20 trials and *second paired* – 40 trials), the two pairs of labels were shown at the same time, with one side corresponding to two categories (e.g., moral and self on the right and immoral and others on the left. See Figure 2 for two example trials of a *paired* block). The task was administered using Presentation® 19.0.

TABLE 1 Words used in the moral self IAT (original German, English translation in brackets)

Moral	Immoral	Self	Others
Ehrlich (honest)	Betrüger (cheater)	Ich (ich)	Andere (others)
Zuverlässig (reliable)	Unehrlich (dishonest)	Mein (my)	Sie (they)
Aufrichtig (sincere)	Täuschend (deceptive)	Mich (me)	Ihnen (them)
Bescheiden (modest)	Arrogant (arrogant)		
Selbstlos (selfless)	Eingebildet (conceited)		

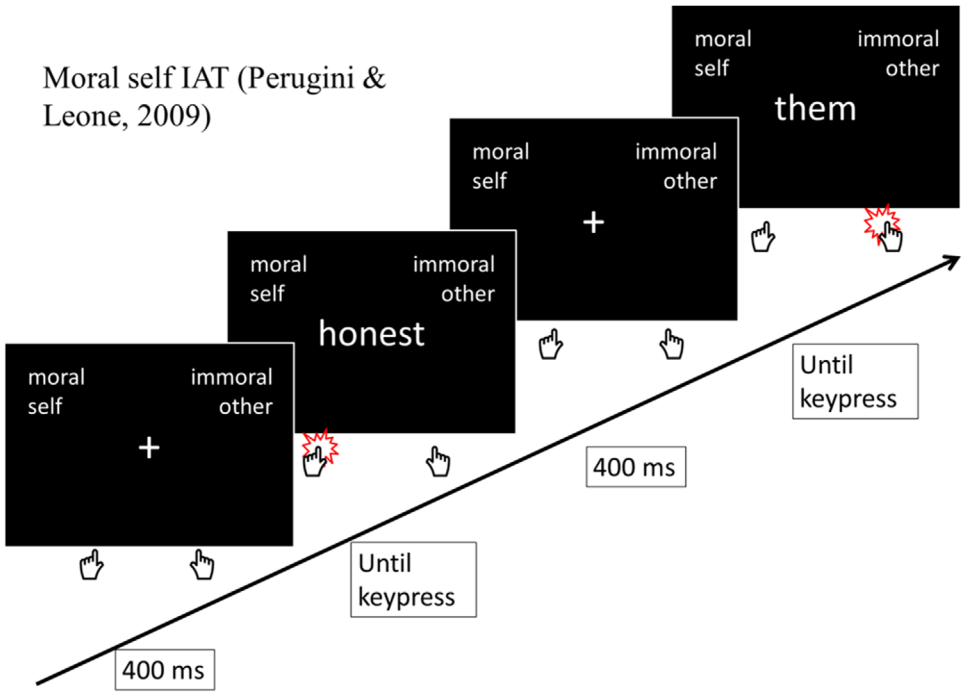

FIGURE 2 Two example trials of a paired block of the IAT. Here, participants are asked to click the left key to categorize the word as self-related or moral, and the right key to categorize the word as other-related or immoral

2.2.3 | Self-importance of moral identity questionnaire

We adapted this measure from the adult version created and validated by Aquino and Reed (2002). Participants were asked to imagine a boy or girl (gender-matched to the participant) named Carla or Carlo, who is friendly, kind, honest, eager to help, empathic, generous and hardworking. These characteristics were described either directly through adjectives, or through examples (e.g., "Carlo/a likes to share his toys or candies with other children", to indicate generosity). After reading this description together with the experimenter, participants were left alone and were asked to respond to a list of items referring to how much being like Carla/o was important to them and something that they strived to be (Internalization scale) and to how much they tried to appear to others like such a person (Symbolization scale). The response scales for each item ranged from 1 (not at all) to 7 (completely). See Supplementary material for the full questionnaire. With this sample, the questionnaire showed a good reliability (Cronbach's alpha for the whole questionnaire: $\alpha = 0.88$; for the internalization scale: $\alpha = 0.78$; and for the symbolization scale: $\alpha = 0.86$.

2.3 | EEG recordings

We recorded EEG signals using a 64-channels active electrode set (ActiCap, Brain Products GmbH, Gilching, Germany), referenced to Cz. The signal was amplified through a BrainAmp MR amplifier and recorded through the software Brainvision recorder (Brain Products GmbH). The recording parameters were: 0.016 Hz high-pass filter, 1000 Hz low-pass filter, 500 Hz sampling rate, and 0.1 μV resolution per least significant bit. Impedances were kept below 25 KOhm (as recommended by Brain Products for the ActiCap).

2.4 | Procedure

At their arrival, children were familiarized with the lab and with the EEG procedure, while their parents read and signed the informed

consent form. Subsequently, children sat in a dimly lit, sound-attenuated EEG cabin, 90 cm from the presentation monitor (19″, 60 Hz refresh rate). After applying the EEG cap, the experimenter left the cabin, and the participants started the CMST. Subsequently, the experimenter gave them instruction for the moral self IAT and left the cabin again. Finally, the experimenter gave participants the instructions for the Self-Importance of Moral Identity Questionnaire, which participants completed on their own. The tasks were administered in this order, because we wanted to avoid priming participants on moral content before starting the CMST, or having them focus on their self-concept before completing the IAT. At the end of the procedure, participants and their parents were debriefed and compensated for their participation. During the whole procedure, accompanying caregivers remained in the lab, but outside of the EEG cabin. Children and their parents were not told that we were interested in morality, identity and the self-concept until the end of the procedure.

3 | DATA ANALYSIS

3.1 | EEG data preprocessing

The EEG signal was resampled to 250 Hz, and visually scored for gross artifacts and bad channels, which were removed from further processing. The data were then re-referenced to the average reference and high-pass filtered at 0.1 Hz. Afterwards, an ICA was used to identify and remove eye movements and blink. Then, the data were low-pass filtered at 30 Hz, the missing channels were interpolated, and the data were epoched in 1200 ms epochs, starting 200 ms before and ending 1000 ms after the onset of the second picture. The epochs were baseline corrected, using the signal starting from 200 ms before the picture as baseline. Finally, all epochs in which the signal amplitude in any channel exceeded a threshold of $\pm 70\ \mu V$ were excluded. All remaining epochs were averaged separately per condition. For the analyses, we used EEGlab 14_1_1b (Delorme & Makeig, 2004) and ERPlab 7.0 (Lopez-Calderon & Luck, 2014) on Matlab 2017a (The MatWorks®, Inc).

Based on the theoretical considerations as reviewed in the introduction section and based on findings with adults (Pletti et al., 2019), we examined the EPN, N2 and LPP components. However, as children show different ERP latencies and distributions as compared to adults, we adapted the clusters of electrodes to be analyzed and the time windows of interest based on the inspection of the grand average. We choose to calculate clusters instead of performing the analyses on single channels, in order to maximize the signal-to-noise ratio and to minimize potential differences between participants in the scalp distribution of the components. We quantified the EPN as the peak amplitude between 150 and 250 ms in two lateralized parietal clusters (Parietal Left: P5, P3, P1; Parietal Right: P2, P4, P6); the N2 as the peak amplitude between 270 and 370 ms in three midline fronto-central clusters (Frontal: Fz, F1, F2; Frontocentral: FCz, FC1, FC2; Central: Cz, C1, C2); the LPP as the mean amplitude between 600 and 1000 ms in three midline centro-parietal and parieto-occipital clusters (Centroparietal: CPz, CP1, CP2; Parietal: Pz, P1, P2, Parietooccipital: PO3, POz, PO4).

3.2 | Moral self measures data reduction

We used the improved algorithm by Greenwald et al. (2003) to score the IAT (See Supplementary materials for a detailed description). We scored The Self-Importance of Moral Identity Questionnaire in the two subscales Internalization and Symbolization.

3.3 | Statistical analyses

To assess association between moral identity and the implicit moral self-concept, we performed correlations between IAT scores and questionnaire scores divided by scales. To analyze the effect of moral identity, we assigned participants to a high moral identity and a low moral identity group based on a median split of the internalization scale (high moral identity group: 26 children, 12 females, mean age = 124.5 months, SD = 3.636; low moral identity group: 26 children, eight females, mean age = 126.2 months, SD = 4.340). Then, for each ERP component, we applied a repeated measure ANOVA with cluster, condition, and group as factors. To analyze the effect of implicit moral self, we used the same procedure, but participants were assigned to different groups based on a median split of the IAT score (high implicit moral self group: 22 children, eight females, mean age = 126.571, SD = 3.472; low implicit moral self group: 23 children, 10 females, mean age = 124.143, SD = 4.564). Originally, we had also planned to conduct similar analyses based on the symbolization score. However, group assignment based on symbolization or internalization would have only differed for few participants, due to the high correlation between the two scales (see results section below). Thus, repeating the analyses for both variables would not have been meaningful. Previous studies showed that internalization is more robustly associated with prosocial behavior as compared to symbolization (Hertz & Krettenauer, 2015; Pohling et al., 2018), and that only internalization relates to the processing of moral content in adults (Pletti et al., 2019). Furthermore, the internalization scale is more representative of theoretical definitions of moral identity (Hardy & Carlo, 2011). For these reasons, and in line with other studies (Hardy et al., 2014), we chose internalization only as measure of moral identity.

4 | RESULTS

4.1 | Association between moral identity and implicit moral self

Descriptive statistics concerning moral identity and implicit moral self measures are reported in Table 2. The internalization and symbolization scales correlated positively ($r = 0.63$, $p < 0.001$). The implicit

TABLE 2 Means and standard deviations for moral identity and implicit moral self measures

Variable	Mean (s.d.) and range				
	All participants (*N* = 52)	High internalization (*N* = 26)	Low internalization (*N* = 26)	High IAT (*N* = 22)	Low IAT (*N* = 23)
Self-importance of moral identity - internalization	27.788 (5.154) Range: 16–35	32.154 (2.395) Range: 28–35	23.423 (2.969) Range: 16–27	28.864 (4.465) Range: 18–35	28 (5.161) Range: 19–35
Self-importance of moral identity – symbolization	20.586 (6.420) Range: 5–34	24.327 (5.213) Range: 14–34	16.846 (5.274) Range: 5–26	21.727 (6.280) Range: 5–34	20.543 (6.058) Range: 5–33
Moral self IAT	0.295 (0.268) Range: −0.424–0.982	0.364 (0.248) Range: −0.109–0.982	0.197 (0.285) Range: −0.424–0.801	0.511 (0.161) Range: 0.334–0.982	0.077 (0.174) Range: −0.424–0.311

Higher scores indicate a higher moral identity or a higher implicit moral self-concept. The internalization and symbolization scores are calculated by summing up the scores given to each item in the scale. Every scale is composed of 10 items with scores ranging from 1 to 7. The IAT score is calculated as adjusted reaction time difference following Greenwald et al. (2003). Positive numbers indicate that participants were faster to respond when moral adjectives were associated to the self. Negative numbers indicate that they were faster to respond when immoral adjectives were associated to the self.

measure did not correlate significantly with any of the measures (all *r*s > 0.22, all *p*s > 0.15).

4.2 | ERP analyses

4.2.1 EPN

Figure 3 shows the grand-averaged waveform on the parietal right and parietal left cluster, where the EPN is visible. The ANOVA ran to investigate the effect of moral identity yielded a significant Group x Condition interaction ($F(1,50) = 5.041$, $p = 0.029$, $\eta^2_G = 0.010$, see Figure 4). The interaction was due to a significant higher (more negative) amplitude for the antisocial as compared to the prosocial condition in the high moral identity group ($t(51) = -2.812$, $p = 0.007$, $d = 0.390$). Conversely, no difference between condition was found for the low moral identity group ($t(51) = 1.178$, $p = 0.244$, $d = 0.163$). No other main effect nor interactions from the ANOVA were significant.

To investigate the effect of implicit moral self, we ran another ANOVA using the IAT score to define the groups. This ANOVA did not yield any significant main effects nor interactions.

4.2.2 N2

There was no significant main effect nor interaction involving the group in the moral identity ANOVA, nor in the implicit moral self ANOVA. Both ANOVAs yielded a significant Cluster main effect and a Cluster × Condition interaction. We will report the effects obtained in the moral identity ANOVA, since it included a larger sample: main effect of Cluster, $F(2,100) = 3.749$, $p = 0.027$, $\eta^2_G = 0.013$; Cluster × Condition interaction, $F(2,100) = 6.444$, $p = 0.002$, $\eta^2_G = 0.006$. The interaction was driven by a significant difference between prosocial and antisocial scenes on the frontal cluster ($t(51) = 2.038$, $p < 0.047$, $d = 0.283$), with greater negativity for prosocial scenes (see Figure 5 for the grand-averaged waveform on the frontal cluster). This difference was not significant on the frontocentral or central cluster (*p*s > 0.2).

4.2.3 LPP

In both ANOVAs, no effect involving the Group was significant. Both ANOVAs yielded significant Cluster effects and significant Cluster × Condition interactions. Due to the larger sample size, we will report the effects obtained in the moral identity ANOVA: Cluster main effect, $F(2,100) = 230.023$, $p < 0.001$, $\eta^2_G = 0.374$; Cluster × Condition interaction, $F(2,100) = 4.658$, $p = 0.012$, $\eta^2_G = 0.003$. This interaction was driven by a significant difference between prosocial and antisocial scenes in the parieto-occipital cluster ($t(51) = 2.150$, $p = 0.036$, $d = 0.298$), with greater positivity for antisocial vs prosocial scenes (see Figure 6 for the grand-averaged waveform on the parietooccipital cluster). This comparison was not significant for the other clusters (all *p*s > 0.2).

5 | DISCUSSION

Moral identity, that is, how important it is for someone's identity or sense of self to be moral, has been proposed to be a unique characteristic of human morality (Korsgaard, 1996). It is a crucial predictor of prosocial behavior in both adults and children (Hardy & Carlo, 2011; Hertz & Krettenauer, 2015; Sticker et al., 2021). Yet, its development remains hotly debated and virtually nothing is known on the neurocognitive processes that relate to its developmental emergence. Our study was based on the proposal that moral identity emerges in middle childhood (Kingsford et al., 2018, 2021; Tomasello, 2019). We aimed at investigating the hypotheses that, already in middle childhood, moral identity affects the neurocognitive processing of moral content. According to the social-cognitive model, having a strong moral identity means having chronically active moral schemas that guide action and are used for social information processing (Lapsley, 2015; Lapsley & Narvaez, 2004).

Results confirmed our main hypothesis that in 10-year-old children moral identity is related to differential processing of moral content. For children with a strong moral identity only, antisocial scenes elicited a greater early posterior negativity (EPN) as compared to prosocial

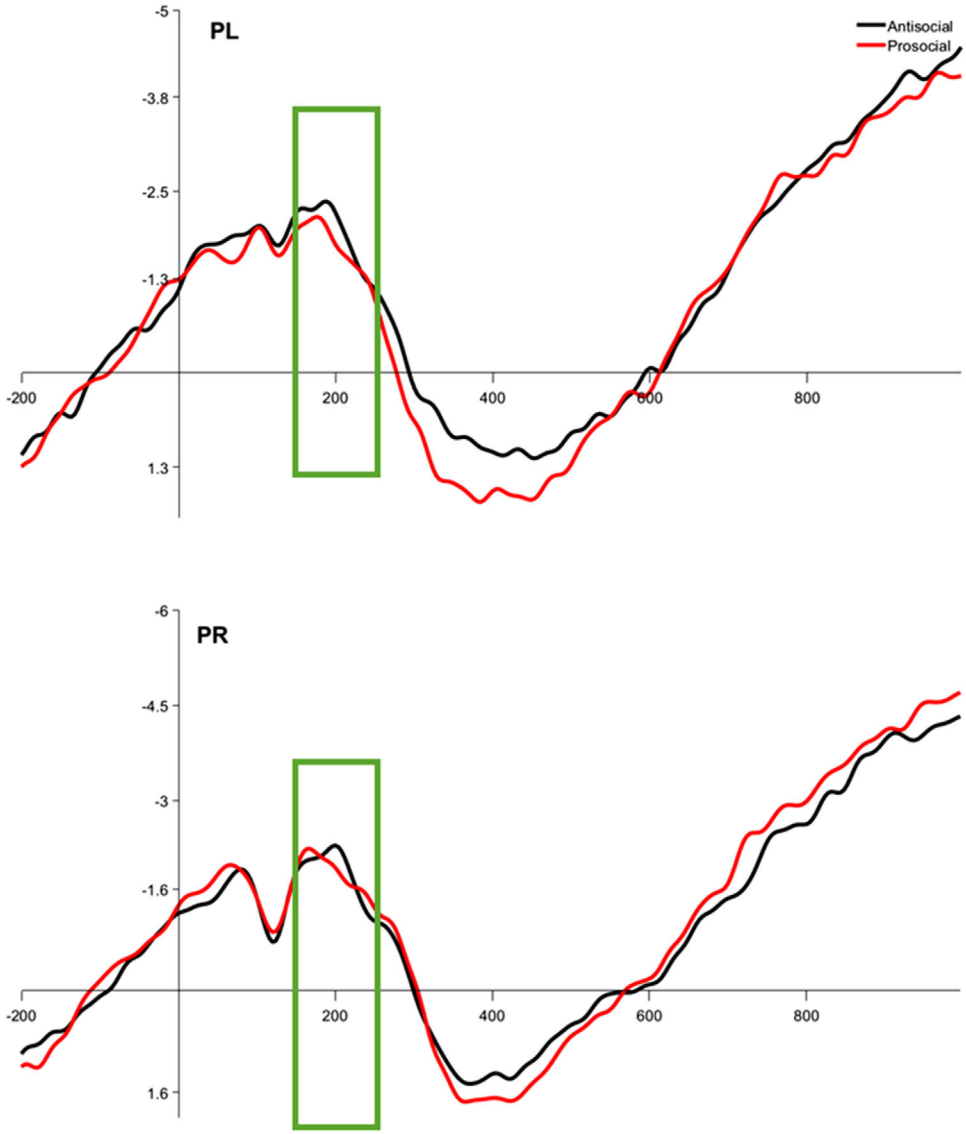

FIGURE 3 Grand averaged waveform on the right and left parietal clusters. The *x* axes represent time in milliseconds, the *y* axes represent the amplitude in microvolt. Negative values are plotted upwards. The EPN time window is marked by the green rectangle

scenes. However, contrary to what was hypothesized, the effect did not emerge in a late processing time window but rather in an early time window (EPN). Furthermore, also in line with our hypotheses, this effect did not emerge for prosocial behavior only, but rather for the difference in processing third-party prosocial and antisocial behaviors. Specifically, we found that, for participants with a strong moral identity only, antisocial scenes elicited a greater EPN as compared to prosocial scenes. The EPN reflects attentional capture by salient and emotional stimuli (Codispoti et al., 2006; Schupp et al., 2003, 2004). In the moral domain, a similar negative deflection has been related to quick detection of moral content in a scene (Gui et al., 2016). Thus, our results could indicate that, for children with a strong moral identity, antisocial scenes capture more attention than the prosocial ones, and that children with a strong moral identity more quickly detect the difference in moral content between prosocial and antisocial behavior as compared to children with a weaker moral identity. This effect supports the existence of chronically active moral schemas as proposed by the social-cognitive model (Lapsley, 2015; Lapsley & Narvaez, 2004). However, since this component is also sensitive to emotional content, an alternative explanation would be that participants with a high moral identity perceive antisocial scenes as more emotionally salient as compared to prosocial scenes (which again can be ascribed to the moral content). In order to distinguish between these two explanations, future research should add an evaluation of scenarios' valence and arousal. In any case, on a more general level, this finding demonstrates how in children the emerging moral identity relates to differences in neurocognitive processes even at an early stages of information processing.

Interestingly, there are differences concerning what has been observed in adults and in children. In particular, in adults, only the EPN elicited by prosocial scenes has been found to relate to the implicit moral self (the higher the implicit moral self, the lower the EPN amplitude for prosocial scenes, Pletti et al., 2019). In a later time window,

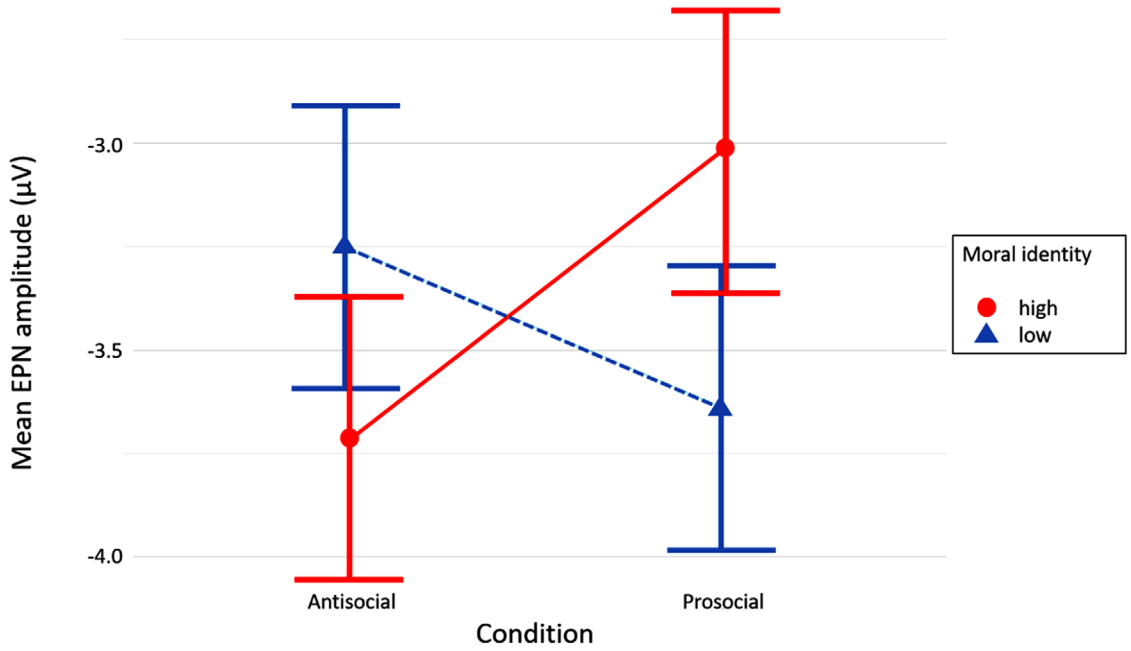

FIGURE 4 Interaction effect of condition × group on the EPN amplitude. The plot shows how, for participants high in moral identity (internalization) only, antisocial scenes elicit a more negative EPN as compared to prosocial scenes. The two conditions do not significantly differ for participants low in moral identity

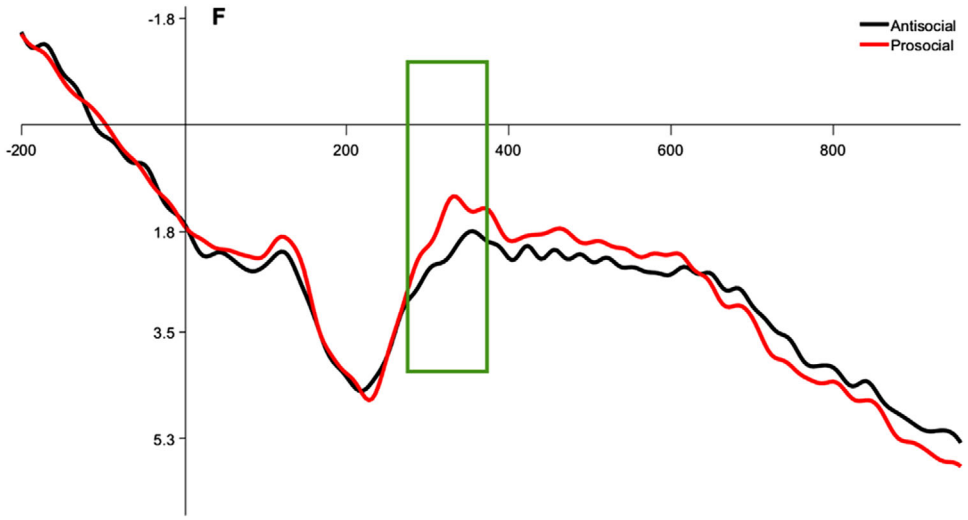

FIGURE 5 Grand averaged waveform on the frontal clusters. The *x* axes represent time in milliseconds, the *y* axes represent the amplitude in microvolt. Negative values are plotted upwards. The N2 time window is marked by the green rectangle

moral identity related in a similar way to the N2 elicited by prosocial scenes (the higher the moral identity, the lower the N2 elicited by prosocial scenes). In children, on the other hand, moral identity related to the EPN and specifically to a greater difference between the amplitude elicited by prosocial and antisocial scenes. We can only speculate on the underlying reasons. It is possible that in children moral identity relates to an enhanced moral sensitivity, that is, the ability to differentiate good from bad. Potentially, in the course of development, moral identity may become more internalized and integrated (Krettenauer & Victor, 2017), leading to genuine positive emotions when acting in line with one's moral self (Krettenauer, 2020), and being therefore more strongly related to the processing of prosocial behavior (Pletti et al., 2019). It would be valuable to explore this developmental path in greater detail.

Concerning the implicit moral self, we did not find any effect on the ERPs nor any correlation with the moral identity measures. The lack of correlation between explicit and implicit measures is in line with what reported in previous studies in both adults and children (Christner et al., 2020; Johnston et al., 2013; Perugini & Leone, 2009; Pletti et al., 2019; Sticker et al., 2021). The lack of effects of the implicit moral self

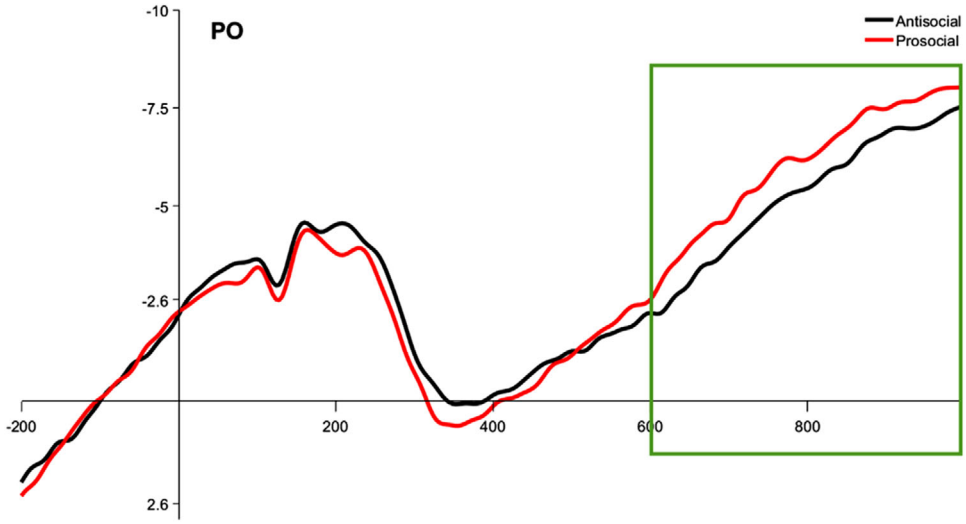

FIGURE 6 Grand averaged waveform on the parietooccipital clusters. The *x* axes represent time in milliseconds, the *y* axes represent the amplitude in microvolt. Negative values are plotted upwards. The LPP time window is marked by the green rectangle

on ERPs might be due to the implicit moral self not being consolidated yet in 10 years old. This finding also relates to recent work reporting limits in children's acquisition of implicit attitudes (Charlesworth et al., 2020). As we found relations to the explicit moral identity, our findings are in line with a developmental model according to which the moral self-concept is first acquired on an explicit and deliberative level before it becomes automatized and implicit.

These results taken together might seem contradictory: how is it possible that the explicit moral identity relates to implicit processes, but the implicit moral self does not? This can neatly be explained by the social-cognitive model, according to which, individuals with a strong moral identity (an explicit construct) rely on automatized, chronically activated moral schemas to process social situation. This is in line with our results, which show that such an activation of moral schemas is already in place by 10 years of age. The implicit moral self, on the other hand, is based on the formation of implicit associations between the self and moral characteristics. Our results indicate either that 10-year-olds have not formed such associations yet (similar to Christner et al, 2020), or that such implicit moral self is not associated to how one processes third party situations yet. The first possibility would tie in with a developmental account according to which more complex cognitive processes (such as a moral identity) might first emerge on an explicit level before becoming automatized and implicit in the course of development.

The current study also provided general information about how moral content is processed in middle/late childhood, irrespective of moral identity and the moral self-concept. We found that 10-year-old children process prosocial and antisocial scenes more similarly to adults than do younger children. In particular, in line with adults (Pletti et al., 2019; Yoder & Decety, 2014b) and opposed to younger children (Cowell & Decety, 2015b), we found a generally greater N2 for prosocial as compared to antisocial actions. The N2 is sensitive to violation of expectation (Folstein & Van Petten, 2008). Thus, these results indicate that, as compared to antisocial scenes, prosocial scenes are less expected for 10 year old children. This might depend on the specific characteristics of the task, since there was a greater variety concerning the prosocial behaviors depicted in the scenes (helping, sharing, consoling) as compared to the antisocial ones (mainly physical harm). Furthermore, a greater N2 could also indicate greater allocation of attentional resources to salient stimuli. Thus, the greater N2 for prosocial actions could indicate that such actions capture more attention (as compared to antisocial actions) in 10-year-olds as well as in adults in intermediate processing stage (Yoder & Decety, 2014b). Finally, we found a greater LPP for antisocial as compared to prosocial scenes. This result is also in line with previous findings in adults (Pletti et al., 2019) and in contrast with what found in younger children (Cowell & Decety, 2015b). The LPP indicates top-down allocation of resources to emotional stimuli, especially negatively valenced, highly arousing ones (Codispoti et al., 2006; Hajcak et al., 2010). The fact that younger children show a greater LPP for prosocial actions, and older children and adults for antisocial ones, might depend on the development of empathy, which increases greatly during middle childhood (Stern & Cassidy, 2018) and could contribute to make antisocial scenes more aversive and arousing.

An unexpected finding is the lack of a general difference between conditions in the EPN component. Previous studies both on children and adults reported a greater amplitude of this component for prosocial vs antisocial actions (Cowell & Decety, 2015b; Pletti et al., 2019; Yoder & Decety, 2014b). In the present study, such difference was not significant for children with a weak moral identity, and was inverted for children with a strong moral identity. Thus, these results seem to indicate that prosocial scenes, which are more salient than antisocial ones in early childhood, become equally salient in middle childhood (at least for children with a weak moral self) and then increase their saliency in adulthood again. Given the paucity of studies investigating the processing of moral content in middle childhood, such results would need further investigation in order for this interpretation to be clarified.

Overall, the current study is an important step in the investigation of the neurodevelopment of moral identity in childhood. It also adds

to the literature on the neural processing of third-party moral content during development. However, this study comes with some limitations. First of all, the use of cartoon stimuli instead of naturalistic ones might limit the ecological validity of the results (albeit increasing experimental control and limiting confounding variables). Furthermore, being the first study conducted on the neural correlates of moral identity and the implicit moral self-concept in middle childhood, and one of the few on the neural correlates of moral cognition in this age in general, it should be considered a first step and the results need replication before one can consider them solid. Finally, due to the cross-sectional design, our study does not allow us to exclude alternative interpretations. Although not predicted by theoretical models, our results could also indicate that those children who are more sensitive to the difference between prosocial and antisocial action at an early perceptual level can develop a stronger moral identity. Another consequence of our design is that the developmental conclusions are limited: we chose to test 10 years old children as moral identity has been proposed to emerge at this age. However, comparisons with younger samples would be necessary to directly test this hypothesis. This would be an exciting next step for research on the development of moral identity and the moral self-concept. Moreover, this is the first study using a verbal IAT to measure the implicit moral self in children (even though other studies used verbal IATs to measure other kinds of self-concept in 10 year olds, e.g. Grumm et al., 2011; Hawes et al., 2013). Notably, also other studies using pictorial versions of the IAT have not found relations between the implicit moral self and prosocial behavior, whereas they reported such relations for the explicit moral self-concept (Christner et al., 2020; Sticker et al., 2020). Our finding relates well to these studies. Nonetheless, further empirical work is necessary to explore this measure, and to investigate its measurement quality criteria in greater detail. Despite these limitations, this study sheds light on the development of moral identity in childhood, by underlying the importance of early information processing stages and by finding evidence in line with the social-cognitive model. Our results show that in middle childhood, moral identity relates to how moral content is processed, even in situations that do not require the active participation of the individual. This indicates that in children moral identity is not only relevant for moral behavior, but for moral cognition in general.

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CONFLICT OF INTEREST

The authors have no conflicts of interest.

ETHICS STATEMENT

The study obtained ethical approval by the local ethic committee.

DATA AVAILABILITY STATEMENT

The data are available on the Open Science Framework (ODF) at https://osf.io/ez2ja/.

ORCID

Markus Paulus https://orcid.org/0000-0003-0446-4956

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