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# On the Impact of the Genocide on the Intergroup Empathy Bias Between Former Perpetrators, Survivors, and Their Children in Rwanda

Emilie A. Caspar[1, 2], Guillaume P. Pech[2], Darius Gishoma[3], and Clémentine Kanazayire[3]
[1] Department of Experimental Psychology, Moral & Social Brain Lab, Ghent University
[2] Center for Research in Cognition and Neuroscience, Université Libre de Bruxelles
[3] Department of Mental Health, College of Medicine and Health Sciences, University of Rwanda



Studying what factors influence the ability to resonate with the pain of others in the aftermath of a genocide and how this extends to the following generation is critical to better understand the perpetuation of conflicts. In the present study conducted in Rwanda, we recruited former genocide perpetrators and survivors, and their respective children and investigated how their neural response to the pain of others is modulated when they visualized pictures of former perpetrators or survivors, or their offspring. We further evaluated how the impact of the genocide and psychological factors associated with trauma influenced the results. Results showed that the intergroup empathy bias—that is, a reduced neural response to the pain of the outgroup—is present for both individuals alive during the genocide and their offspring. We also observed that a higher number of stressors experienced during the genocide was associated with a higher reduction of the neural response to the pain of others, even toward the children of one's own ingroup. Finally, we observed that a deliberate and free decision to reconcile is associated with a higher neural response to the pain of others. The results may be central to encouraging reconciliation in peacebuilding programs and to fostering empathic repair after trauma.

***Public Significance Statement***
In the present research conducted on former genocide perpetrators, survivors, and their children in Rwanda, we showed that the intergroup empathy bias is still present 27 years after the genocide and that children display the same biases as their parents. These findings are important to better understand the perpetuation of conflicts.

*Keywords:* trauma, genocide, intergroup empathy bias, transmission

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Human societies must ensure peaceful relationships between groups in order to prevent conflicts. A key neural process impacted by intergroup tensions and which is linked to prosocial behaviors and to fostering forgiveness is empathy (Bruneau et al., 2017; Cehajic et al., 2008; McCullough et al., 1997; Stephan & Finlay, 1999; Worthington et al., 2000). Empathy is a psychological construct that refers to the ability to understand and imagine what others feel. In many studies, the intensity of the empathic experience has been measured through subjective reports, such as self-reported questionnaires on one's own estimated level of empathy or through scales measuring the empathic experience toward a

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All data are available on Open Science Framework (https://osf.io/md97v/). Analysis code and research materials are available upon request to the corresponding author. Data were analyzed using R and JASP. The study design and its analysis were preregistered on Open Science Framework (https://osf.io/wrbz9).

Correspondence concerning this article should be addressed to Emilie A. Caspar, Department of Experimental Psychology, Moral & Social Brain Lab, Ghent University, Henri Dunantlaan 2, 9000 Ghent, Belgium. Email: Emilie.Caspar@UGent.be

**Emilie A. Caspar**

specific stimulus (Gerdes et al., 2010). However, neuroscientists have progressively complemented these reports with measurements of the degree of activation in brain regions involved in pain experience when participants witness the pain of others. In the case of empathy for pain, extensive literature in neuroscience has shown that seeing another individual in pain triggers an empathic response in the brain of the observer, especially in the anterior cingulate cortex and the insula (Decety, 2011; Jauniaux et al., 2019; Keysers & Gazzola, 2014; Singer & Lamm, 2009; Timmers et al., 2018). Critically, when the individual experiencing pain is perceived as an outgroup member, be it based on ethnical, religious, or political differences, the neural empathic response is attenuated for the observer (Han, 2018; Hein et al., 2010). This so-called intergroup empathy bias (Cikara et al., 2014) mediates reduced prosocial behaviors for outgroup members compared to ingroup members (Bruneau et al., 2017; Hein et al., 2010), an effect thought to prevent reconciliation in the case of group conflict (Shnabel & Nadler, 2008).

The intergroup empathy bias in Western, healthy adults is relatively well documented (Amodio & Cikara, 2021). However, there are several gaps in the literature that prevent a full understanding of the implications of this bias on societies that experienced dramatic group conflicts and suffered from severe trauma and mental health issues. Rwanda is a critical example of how citizens of a divided society have nonetheless managed to preserve peaceful social interactions. Between April 1994 and July 1994, more than 1 million of Tutsis and some Hutus who were against genocide were mutilated and killed in a genocidal process. This dramatic event in the history of Rwanda seems unforgivable. However, Rwandan citizens have to learn to live together: Perpetrators of the genocide were not invaders from another country; those who were killed died at the hands of their neighbors. While the majority of people who experienced severe prejudices can avoid the group they were in conflict with in the past (McCullough, 2001), Rwandan citizens have to be able to manage their emotions and behaviors toward their former aggressors or victims. Can we expect individuals who have suffered such intense trauma, or who are descendants of the victims, to be able to resonate with the suffering of others and develop empathy toward them, especially if those others were their former aggressors? And if so, what factors prevent or support empathy toward the conflicting group? Answering these questions is at the core of the present study and has the potential to provide a better understanding of the perpetuation of conflicts (Bruneau et al., 2017) and the factors that foster "empathic repair" (Gobodo-Madikizela, 2008).

Surprisingly, there has been only little empirical research into the relationship between trauma and empathy, and to the best of our knowledge, no systematic research on how a human-caused trauma impacts empathy for the conflicting group and extends to their children. Past research, mostly based on testimonies and self-report measurements, indicates quite divergent results. Some previous work indeed indicated that past adversity and trauma can lead to increased compassion (Lim & DeSteno, 2016) and empathy (Greenberg et al., 2018), while other work indicated that experiencing a trauma impairs empathic abilities (Nietlisbach et al., 2010) and leads to a compassion deficit (Palgi et al., 2016). As these studies targeted populations with diverse backgrounds and ages and with different types of trauma, the reasons for such discordance are unclear. Further, none of those studies manipulated the identity of the person supposedly in pain to study empathy, thus precluding the possibility of knowing if the effect of trauma on empathy and compassion is specific to a group or is a general consequence. A former functional Magnetic Resonance Imaging (fMRI) study indicated that posttraumatic stress disorder (PTSD) patients showed impairments in implicit and explicit emotional empathy toward other humans, but not in cognitive empathy (Mazza et al., 2015). However, as the trauma in this study was due to a natural disaster and not due to human actions, it is still unclear if a human-caused trauma impacts emotional empathy similarly. Further, an extensive amount of work has shown that the effects of social trauma do not end with the victims, but often impact their children and grandchildren (Sangalang & Vang, 2017; Weingarten, 2004). However, the extent to which children adapt to their parents' attitudes and beliefs toward the outgroup is less clear as former studies confirmed this adaptation (Degner & Dalege, 2013; Meeusen & Dhont, 2015), while other studies showed that survivors' and genocide perpetrators' attitudes toward the outgroup did not influence the attitudes of their children toward the outgroup (Kang et al., 2022). This could be of importance to understanding how cycles of violence can be perpetrated by following generations (Bruneau et al., 2017).

**Guillaume P. Pech**

In the present study conducted in Rwanda, we investigated how the neural empathic response varies between former perpetrators and victims of the genocide and their children when they visualized former perpetrators or victims, or their offspring, receiving painful or nonpainful stimulations. Several research questions and predictions were formulated. First, according to past literature, we expected to observe a strong intergroup empathy bias between former genocide perpetrators and survivors, due to the history of conflict between these two groups (Vanman, 2016). Second, we evaluated to what extent the following generations are also affected by an intergroup empathy bias against them and if the children of former perpetrators or survivors also display an intergroup empathy bias toward the other group. If the intergroup empathy bias affects the next-generation individuals, then former genocide perpetrators or survivors should have a reduced neural response to the pain of the offspring of a survivor or a former genocide perpetrator, respectively. If the intergroup empathy bias is transferred to the next-generation individuals, we should observe that the children of former genocide perpetrators or survivors do display an intergroup empathy bias toward the other group. Observing an intergroup empathy bias in our groups composed of children could suggest that biases are transmitted to the next generations. Be this transmission a direct transmission from their parents or an indirect transmission made by the society at large would nonetheless remain a question. Third, past qualitative work suggested that being a victim of collective violence often inhibits empathy toward others (Mazza et al., 2015), especially toward the victims' aggressors (Chaitin & Steinberg, 2008; Gobodo-Madikizela, 2008). Overall, we could thus observe that people who have suffered from a more intense trauma are more likely to show more attenuated pain responses toward others. We could also expect a more attenuated empathic response from victims toward former perpetrators, an effect that could be accentuated by a more severe PTSD (Mazza et al., 2015), a lower resilience (Vinayak & Judge, 2018), and a lower capacity to regulate emotions (Lockwood et al., 2014). These effects could also be observed in the survivors' children as a consequence of the intergenerationality of the trauma (Sangalang & Vang, 2017). It is important to mention that a strong dehumanization process took place in Rwanda before the Genocide Against Tutsis. The radio station *Radio Télévision Libre Des Milles Collines*, members of the government, started to describe the Tutsis as cockroaches or snakes. By referring to the Tutsis as animals that are considered pests that must be killed, the promotors of the genocide removed humanity from their targets, a process which is known to alter empathy (Harris & Fiske, 2009). The remains of this dehumanization process could perhaps still be present, thus leading former perpetrators to feel no empathy for the pain of survivors. Fourth, as empathy is a motivated phenomenon (Zaki, 2014), we also investigated how the willingness to reconcile influenced the results. We expected a stronger willingness to reconcile to be associated with increased empathy, without ruling out the alternative directionality implying that individuals with a higher level of empathy could also be more willing to reconcile.

## Method

### Participants

We recruited 108 families ($N = 216$), which systematically included an individual who was either recognized as a genocide survivor or as a genocide perpetrator and one of their offspring (aged 16–35). To determine the sample size, we conducted the calculations with a power of 95%. No previous studies have examined the present research question, especially on non-Western individuals. We thus used a standard small-to-medium effect size f of .12. The calculation was realized on GPower based on a triple interaction generation (present during the genocide, offspring not present during the genocide) and individual (neutral, perpetrator, survivor) as within-subject factors and group (survivor of the genocide, former genocide perpetrator, child of a survivor of the genocide, child of a former genocide perpetrator). The estimated total sample size was $N = 164$ (i.e., $N = 41$/group). However, we recruited $N = 216$ to prevent the loss of data due to the conditions in which the testing had to take place and because our inclusion criteria (see below) had to be flexible. For the group of individuals exposed to the genocide, $N = 53$ were composed of genocide survivors and $N = 55$ were composed of former genocide perpetrators released from prison. To identify survivors and former perpetrators, we recruited our participants through Prison Fellowship Rwanda (PFR), a local community-based organization that works with former perpetrators and survivors in an attempt to promote

**Darius Gishoma**

reconciliation. By recruiting through PFR, we ensured that we recruited individuals officially recognized as genocide survivors or genocide perpetrators. To recruit participants, two volunteers working for PFR went door to door in rural villages of Rwanda to ask the families if they wanted to participate in our study. This process ensured that our participants would not only know about the study but also they would trust us. This aspect was critical for them to accept answering our questionnaires, doing the computer task, and wearing on their head a machine (i.e., the Electroencephalography [EEG]) that they had never seen before.

We also included an additional between-subject factor in our experimental design, which was not mentioned in the preregistration (https://osf.io/wrbz9/?view_only=8f3223410ad04c2d8b899baa38058ca9) of the present study as we could not predict in advance, due to the COVID-19 pandemic, if we would be able to take it into account. As part of the reconciliation process in Rwanda, several Reconciliation Villages, although in a limited number ($N = 8$) have been built across the country. Rwandese citizens officially recognized as survivors or former perpetrators can decide to live in those villages and participate in sociotherapy activities. The aim of those villages is thought to be to improve intergroup relations and to foster forgiveness between survivors and former perpetrators, as well as their children. When we arrived in Rwanda during the COVID-19 pandemic in 2021, we could not ensure that we would have access to those villages, as traveling between different districts in Rwanda was forbidden. Fortunately, some restrictions were lifted, and we were thus able to integrate this additional factor into our analyses. However, this analysis was not planed in the power calculation and was thus only exploratory.

We tested our volunteers directly in their villages by conducting the experiment in buildings that had at least two electrical plugs and relative quietness. Half of our sample was recruited and tested in the district of Kayonza and the other half in the district of Bugesera. For our recruitment criteria, we had to be much more flexible than in classical neuroscience projects conducted on the WEIRD (Western, Educated, Industrialized, Rich, Democratic). Here, half of our sample could not read Kinyarwanda, never went to school, and never saw or even used a computer in their entire life. In addition to those aspects, a quarter of our sample spent years in jail and was relatively old at the moment of the testing (i.e., the genocide perpetrators). We tried to have a relatively good gender balance (82/216 females). However, obtaining a gender balance was not possible for the group composed of former perpetrators. The first reason is that there were much fewer female perpetrators than male perpetrators (Verwimp, 2005). The second reason is that after the genocide, many men were put in jail but not women, which were not directly considered perpetrators. Many of the female perpetrators were judged and sentenced to jail during the Gacaca trials, which started in 2003. Most of those women were thus still in jail at the moment of the testing. We found two female perpetrators released from prison, but one refused to participate in the study, and the other one was mentally unstable. For the group composed of genocide survivors, there were more women than men (33/53). Men were indeed systematically killed during the genocide, while some women were left alive with lifelong bodily trauma or were raped by individuals knowingly having HIV to purposely let them live with lifelong sexual diseases. Our inclusion criteria were thus simply (a) being officially recognized as a genocide survivor or perpetrator and (b) coming with one offspring aged between 16 and 28. A priori exclusion criteria involved not understanding the task ($N = 3$), having haircuts (i.e., braided hairs attached in a ponytail) that prevent placing the EEG hat ($N = 2$), and having a bad signal-to-noise ratio ($N = 26$). As this population was never approached by neuroscience projects before, we could not plan all the exclusion criteria a priori. A posteriori exclusion criteria also included falling asleep during the task ($N = 2$), being drunk at the moment of the testing ($N = 3$), not willing to separate from their baby during the testing ($N = 1$), being younger than 16 or older than 28 despite our recruitment criteria ($N = 8$), when a storm happened, which forced us to stop the testing ($N = 2$), or when a low IQ was suspected ($N = 1$). The data of one participant were lost due to an issue with recording the EEG triggers, and the data of another participant were lost due to an alteration of the recorded file. In the case of trauma revival during the experiment, we followed a procedure decided in accordance with the Rwanda National Ethics Committee that involved a follow-up by a trained clinical psychologist. Two survivors could not complete the task because of trauma revival and were thus also excluded from the sample.

**Clémentine Kanazayire**

After applying the exclusion criteria, our final sample was composed of 164 individuals, which corresponds to the predetermined sample size with the power calculations. In the group of genocide survivors, 16/40 were males and the mean age was 50.85 ($SD$ = 9.76). 18/40 were living in a Reconciliation Village. In the group of former genocide perpetrators, 44/44 were males and the mean age was 58.95 ($SD$ = 8.12). Twenty-seven of 44 were living in a Reconciliation Village. In the group of children of genocide survivors, 24/41 were male and the mean age was 19.97 ($SD$ = 3.62). 16/41 were living in a Reconciliation Village. In the group of children of genocide perpetrators, 17/39 were male and the mean age was 19.79 ($SD$ = 3.67). Twenty-two of 39 were living in a Reconciliation Village. The study was approved by the Rwanda National Ethics Committee (Ref: 167/RNEC/2021) and preregistered before data collection on Open Science Framework (https://osf.io/wrbz9/?view_only=8f3223410ad04c2d8b899baa38058ca9).

## Materials and Procedure

Participants were invited to sit in front of a computer screen. As several buildings had no isolated rooms, we constructed isolation walls with wooden planks (see Figure 1) to reduce surrounding distractions (i.e., curious children, goats, etc.) and create relative quietness. More information about how the present study was planned and conducted can be found on https://emiliecaspar.home.blog/ in the section "Behind the paper—Rwanda." We used a 64-channel EEG system in order to record the participants' brain activity. Participants were told that they would witness pictures of six different individuals across four different experimental blocks, with three individuals alive during the genocide and three individuals not yet born when the genocide happened. Those six individuals included (a) a former perpetrator of the genocide, (b) the offspring of a former perpetrator of the genocide, (c) a genocide survivor, (d) the offspring of a genocide survivor, (e) an individual who was not present in Rwanda during the genocide, and (f) the offspring of an individual who was not present in Rwanda during the genocide. The last two individuals were used as controls in order to understand if our effects on the neural response to the pain of others were group specific (e.g., survivors toward former perpetrators only) or a general effect (e.g., survivors toward both former perpetrators and neutral individuals) after a social trauma. To control for gender, only males were displayed in those pictures as there was a higher percentage of male perpetrators during the genocide compared to female perpetrators (Verwimp, 2005).

To increase the ecology of the procedure, we told participants that the six individuals accepted to share their stories or the stories of their parents during the genocide for the sake of our study. Before starting an experimental block, participants were presented with a picture of an individual, and his story was presented in Kinyarwanda, both orally and written, see Figure 2B and Supplemental Material S1). Audio recordings were important for those who could not read, but also because Rwanda has a culture of oral transmission. The stories were created based on what really happened to some people during the genocide, such as hiding in the swamps to survive or having killed and been sentenced to prison during the *Gacaca* trials. Each Rwandan citizen is, in one way or in another, linked to the genocide. To create the control story for a Rwandese who would not have been present during the genocide and not have had his family killed or involved in the genocide, we explained that this person left Rwanda with his entire family before the genocide because of finding a job in Europe. To ensure that our participants really paid attention to the stories and remembered them before starting an experimental block, we presented after each story one out of four questions in which they had to rate how they felt about that individual (e.g., "I feel sad for what happened to this person," see Supplemental Material S2). Those data were not analyzed as they were not planned in the preregistration.

We also told our participants that we had to preserve the anonymity of the six individuals who had accepted to share their stories. As a consequence, pictures were centered on the hand of those individuals, with their bodies and the low part of their faces being blurred. To avoid creating physical distinctions between the different categories of individuals, which would not be ethically acceptable in Rwanda as the genocide has been committed in the name of ethnicity that were described as physically quite different, we ensured that the six individuals had a relatively similar skin color and body shape. To ensure that our participants would associate the hands receiving the painful or nonpainful

**Figure 1**

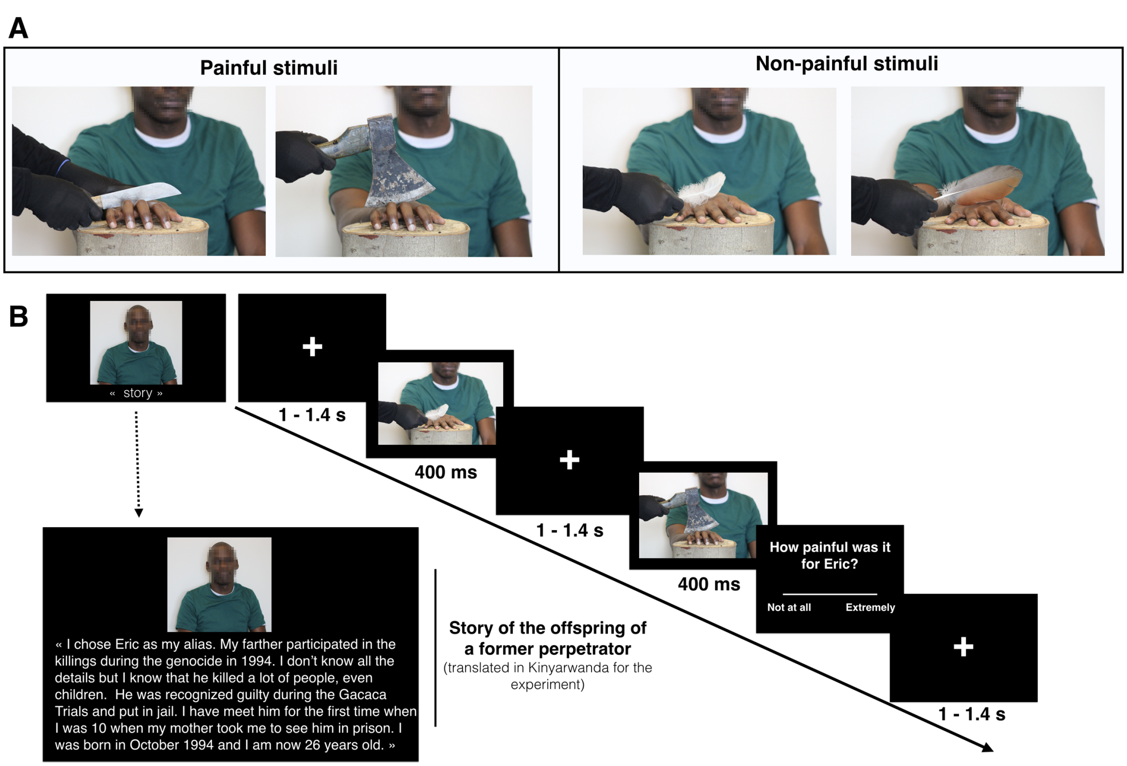
*Pictures of the Setup of the "Experimental Rooms" in One of the Testing Locations in Rwanda*

*Note*. See the online article for the color version of this figure.

stimuli with a specific individual whom they read and heard the story about, we ensured that the T-shirt and bottom part of the face were visible in the pictures, even if blurred (e.g., a blue T-shirt for one individual, and a kaki T-shirt and a bandanna for another individual). For each of the six individuals, we created eight pictures: Four with tools capable of causing painful physical harm (e.g., a knife) and four with tools not capable of inflicting pain or causing painful physical harm (i.e., a feather; see Figure 2A). In the pictures, someone was holding the tools in such a way as if they intended to hurt the individual, but the skin color of that person was hidden by gloves and a long shirt to avoid associating an ethnicity with the person holding the tools. Four experimental blocks displayed randomly the six individuals and their stories, with 20 painful and 20 nonpainful stimuli presented to each individual in a randomized

**Figure 2**

*(A) Examples of Painful and Nonpainful Stimuli and (B) Schematic Representation of the Task*




*Note*. The written and oral parts were in Kinyarwanda for our volunteer participants. See the online article for the color version of this figure.

order. The block design was decided in order to limit visual habituation to the stimuli presented. In total, there were 20 trials per category of tools, thus resulting in 160 trials per individual (80 painful and 80 nonpainful) across the four experimental blocks. The number of trials was decided based on the best ratio to obtain a good EEG signal-to-noise ratio but also to avoid too long a computer task for elderly participants. We also randomized the individuals and the stories. For instance, one individual was a former perpetrator for some participants and a control for other participants. Pictures were presented during 400 ms, with a jittered intertrial interval (ITI) lasting between 1 and 1.4 s. The 400-ms presentation of the pictures was decided based on several studies in EEG focusing on the same event-related potentials (ERPs), which used a presentation time between 250 ms (Vaes et al., 2016) and 500 ms (Suzuki et al., 2015). A fixation cross located at the center of the screen was displayed during the ITI.

To ensure that participants were paying attention to the stimuli, in 12/160 trials per individual, we randomly displayed a question appearing on the screen where participants were asked to estimate the pain of the individual on a scale ranging from 0 (*not painful at all*) to 10 (*very painful*) on the last picture presented on the screen. Participants were told that they had to focus on how painful the presented tools could be for the individual in order to target emotional empathy (Decety et al., 2018). We also wanted to ensure that our participants would keep in mind who the individual in the picture they were seeing was. Therefore, we also mentioned the chosen name of the individual in the question (e.g., "How was the intensity of the pain for Eric in the last trial?"). At the end of the experimental session, participants were asked to complete a series of questionnaires measuring: (a) the short version of the *PCL-C DSM-4* scale to assess the persistence of PTSD symptoms (Fodor et al., 2015; Pham et al., 2004), (b) resilience (Connor & Davidson, 2003), (c) a scale on the willingness to reconcile (see Supplemental Material S3), (d) a questionnaire on the impact of the genocide (Blanchette et al., 2019), (e) the Bogardus Social Distance scale (adapted to our different groups), and (f) a short version of the emotion regulation questionnaire (Garnefski & Kraaij, 2006). If participants could not read, an assistant was reading the sentences to them, and participants could circle their answers after having been explained the scales. In that case, to restrict any influence on their answer, the assistant simply read the sentences and did not look at the participant when s/he was circling the answer.

## EEG Recordings

Brain activity was recorded using a 64-channel electrode cap with the ActiveTwo system (BioSemi), and data were analyzed using the Fieldtrip software (Oostenveld et al., 2011). The activities from left and right mastoids and from horizontal and vertical eye movements were also recorded. Amplified voltages were sampled at 2048 Hz. Data were referenced to the average signal of the mastoids and filtered (bandpass filter: 0.01–40 Hz). The baseline was taken from 250 ms to 50 ms before the apparition of pictures. Artifacts due to eye movements were removed based on a visual inspection with the removal of epochs containing eye blinks or ocular saccades. Power line noise was strong as we tested in rural villages with generally a single electrical circuit for the entire village. We thus also used Zapline (de Cheveigné, 2020) to first clean the data from the line noise and then used a spectral interpolation around 50 Hz and its harmonics. All ERPs were analyzed across Cz, CPz, and Pz. The timing of the ERPs was decided based on a visual inspection of the grand averages. The N1 and the N2 were measured as the most negative peaks within the 110–160-ms time window and the 280–390-ms time window after the picture, respectively. The P2 was measured as the most positive peaks within the 190–250-ms time window and the 340–440-ms time window after the tone, respectively. The P3, the early Late Positive Potential (LPP), and the late LPP were measured as the mean amplitude between the 390–510-ms time window, the 520–770-ms time window, and the 790–1,000-ms time window after the picture, respectively. Source reconstruction was performed by first computing a filter with a covariance matrix taken between −400 ms and 1 s with the linearly constrained minimum variance (LCMV) beamformer method to reconstruct the sources of ERPs' components. A second covariance window was calculated on the period of interest for the pain response (390 ms–1 s, corresponding to the time windows of the P3, early Late Positive Potential [eLPP], and late Late Positive Potential [lLPP] combined), and the same LCMV beamformer method was applied based on the filter computed. The volume construction was based on the standard head model and source model downloaded through Fieldtrip. Source localization was determined with the Brainnetome Atlas (Fan et al., 2016).

# Results

Results were systematically analyzed with both the frequentist and the Bayesian approach (see Supplemental Material S4, for more information).

## Subjective Pain Ratings

The estimations reported by participants on the pain scale were analyzed as a sanity check to ensure that they paid attention during the task and to ensure that they rated painful stimuli as more painful than nonpainful stimuli. Participants who could not read numbers were excluded from the analysis ($N = 15$). We conducted a repeated-measures analysis of variance (ANOVA) with the six different individuals presented in pictures and pain (painful stimulation, nonpainful stimulation), as within-subject factors, on the pain ratings. We observed a main effect of pain, $F(1, 189) = 63.227$, $p < .001$, $\eta_p^2 = .251$, $BF_{incl.} = 1.525e^{+13}$, with higher pain ratings when painful stimuli were presented (6.35, $SD = 1.72$) than when nonpainful stimuli were presented (5.26, $SD = 2.28$). It thus indicates that participants indeed paid attention to the stimuli presented. Importantly, the interaction Pain × Individual was in favor of $H_0$($p > .07$; $BF_{incl.} = .003$), as well as the triple interaction Individual × Pain × Group ($p > .5$, $BF_{incl.} = 2.230e^{-6}$). It thus indicated that participants from all groups paid equal attention to the stimuli presented in all the experimental blocks. Other main effects or interactions are not reported as not part of our hypotheses regarding the sanity check.

## Electroencephalography

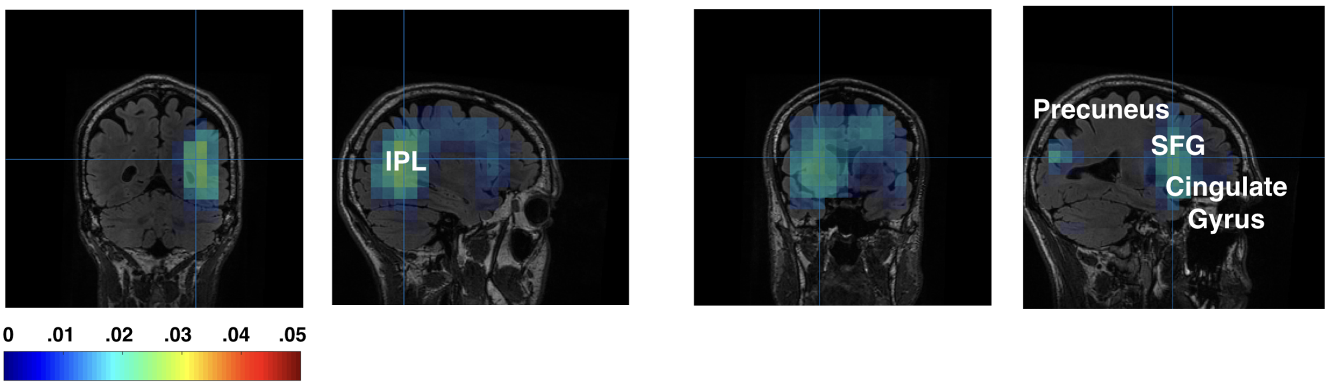
We first compared the amplitude of the P3, eLPP, and lLPP when participants witnessed pictures displaying painful stimuli versus pictures displaying nonpainful stimuli in order to confirm that these ERPs are sensitive to the visualization of pain, irrespective of the other independent variables. As expected, we observed very strong evidence in favor of $H_1$ for a higher amplitude for pain trials versus no-pain trials for the P3, $t(176) = 12.233$, $p < .001$, Cohen's $d = .919$, $BF_{10} = 1.419e^{+22}$, the eLPP, $t(176) = 16.454$, $p < .001$, Cohen's $d = 1.237$, $BF_{10} = 1.331e^{+34}$, and the lLPP, $t(176) = 14.936$, $p < .001$, Cohen's $d = 1.123$, $BF_{10} = 7.091e^{+29}$. We subtracted the amplitude of the pain response during no-pain trials to pain trials (i.e., pain– no pain) and performed our statistical analyses on this new variable. For the sake of clarity of the Results section, we computed a global pain response, which corresponded to the averaging of the P3, the eLPP, and the lLPP. Results for each ERP were also performed and overall, they do not differ from the results of the global pain response (hereinafter, referred to as "pain response"). We also reconstructed the sources of ERP components in order to ensure that our computed pain response originated in empathy-related brain regions. Results showed higher activation in the inferior parietal lobule, the precuneus, the superior frontal gyrus, and the cingulate gyrus (see Figure 3).

The repeated-measures ANOVA was conducted with generation (present during the genocide, offspring not present during the genocide) and Individual (neutral, perpetrator, survivor) as within-subject factors, and group (survivor of the genocide, former genocide perpetrator, child of a survivor of the genocide, child of a former genocide perpetrator) and Living in a Reconciliation Village (yes, no) as between-subject factors on the pain response. We found a strong evidence in favor of $H_1$ for a main effect of Group, $F(3, 156) = 4.380$, $p = .005$, $\eta_p^2 = .078$, $BF_{incl.} = 1.019e^{+10}$. Independent sample *t* tests revealed anecdotal to very strong evidence that the pain response was lower for the group of genocide survivors compared to the group of former genocide perpetrators, $t(82) = -3.260$, $p = .002$, Cohen's $d = -.712$, $BF_{10} = 19.974$, to the group of children of a genocide survivor, $t(79) = -3.671$, $p < .001$, Cohen's $d = -.816$, $BF_{10} = 61.429$, and to the group of children of a former perpetrator, $t(77) = -2.289$, $p = .025$, Cohen's $d = -.515$, $BF_{10} = 2.186$. The difference between the other groups was in favor of $H_0$(all *p*s ≥ .3, all $BFs_{10} \leq .354$).

We also observed strong evidence in favor of $H_1$ for a main effect of Individual, $F(2, 312) = 6.113$, $p = .002$, $\eta_p^2 = .038$, $BF_{incl.} = 2.124e^{+10}$, and an interaction Individual × Group, $F(6, 312) = 12.564$, $p < .001$, $\eta_p^2 = .195$, $BF_{incl.} = 4.898e^{+10}$. The main effect of generation was in favor of $H_0$($p > .3$, $BF_{incl.} = .019$) but the triple interaction Group × Individual × Generation was in favor of $H_1$ with the frequentist approach, $F(6, 312) = 2.910$, $p = .009$, $\eta_p^2 = .053$, but not with the Bayesian approach ($BF_{incl.} = .040$). For investigating the intergroup empathy bias predicted in our hypotheses, we conducted paired comparisons between the pain response when visualizing the pictures of an individual representing one's own group and the amplitude of the pain response when visualizing the pictures of the other individuals (see Figure 4). For the sake of clarity, tables with full statistics are available in Supplemental Material S5. For the group of survivors, we observed moderate to strong evidence in favor of $H_1$ that their pain response was higher when they visualized the pictures of a survivor compared to all the other individuals (all *p*s ≤ .015, all $BFs_{10} \geq 3.033$), except for the offspring of a neutral individual as this difference was inconclusive ($p = .047$, $BF_{10} = 1.117$). For the group of children of survivors, we observed moderate to strong evidence in favor of $H_1$ that their pain response was higher when visualizing pictures of the offspring of a survivor compared to visualizing pictures of a former perpetrator and the pictures of the offspring of a former perpetrator (all *p*s ≥ .006, all $BFs_{10} \leq 5.927$). Other comparisons were in favor of $H_0$ or inconclusive (all *p*s ≥ .025, all $BFs_{10} \leq 1.86$ and ≥.19). For the group of former perpetrators, we observed strong to very strong evidences in favor of $H_1$ that their pain response was higher when they visualized the pictures of a former perpetrator compared to all the other individuals (all *p*s ≤ .003, all $BFs_{10} \geq 13.063$), except for the offspring of a former perpetrator as this difference was inconclusive ($p = .061$, $BF_{10} = .875$). For the group of children of a former perpetrator, the pattern of the result was relatively similar to the one of their parents. We observed strong to very strong evidences in favor of $H_1$ that their pain response was higher when they visualized the pictures of the offspring of fa ormer perpetrator compared to all the other individuals (all *p*s ≤ .002, all $BFs_{10} \geq 16.910$), except for the pictures of a perpetrator as this difference was inconclusive ($p = .05$, $BF_{10} = 1.088$). Overall, those results revealed an ingroup effect for one's own group and an outgroup effect for the group of individuals they were in conflict with during the

**Figure 3**

*Source Reconstruction of the ERPs Associated With the Pain Response*




*Note*. IPL = inferior parietal lobule; SFG = superior frontal gyrus; ERP = event-related potential. See the online article for the color version of this figure.

genocide. Results also indicated that these effects extend to the subsequent generation, with similar ingroup and outgroup effects for their children.

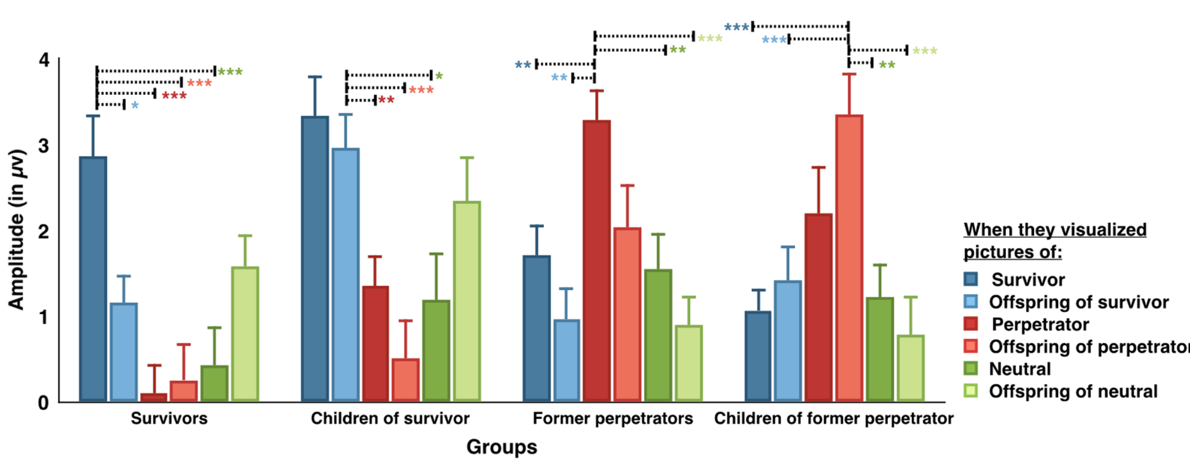
Supplemental Material S6 displays the same analysis conducted with a 2 Generation of the participant (parent, children) × 2 Group (survivors, perpetrators) between-subject design instead of a single-factor group with four levels. The results were similar and the lack of interaction with the factor generation of the participant confirmed that children display the same pattern of results as their parents. However, all the correlations between the pain response of survivors and the pain response of their child for each individual presented in the pictures were in favor of $H_0$ (all *ps* $\geq .5$, all $BFs_{10} \leq .253$). For the group of former perpetrators and their children, the same correlations were either in favor of $H_0$ or inconclusive (all *ps* $\geq .09$, all $BFs_{10} \leq .809$).

## Exploratory Analyses

We reported the results with the factor Living in a Reconciliation Village in a separate subsection dedicated to exploratory analysis as those analyses were not planned in the preregistration and thus were not taken into account in the power calculations. We found evidence for a triple interaction Group × Generation × Reconciliation Village with the frequentist approach, $F(3, 156) = 4.868$, $p = .003$, $\eta_p^2 = .086$, but not with the Bayesian approach ($BF_{incl.} = .034$), see Figure 5. We analyzed to what extent living or not living in a Reconciliation Village influenced the neural pain

**Figure 4**

*Graphical Representation of the Triple Interaction Group × Individual × Generation*

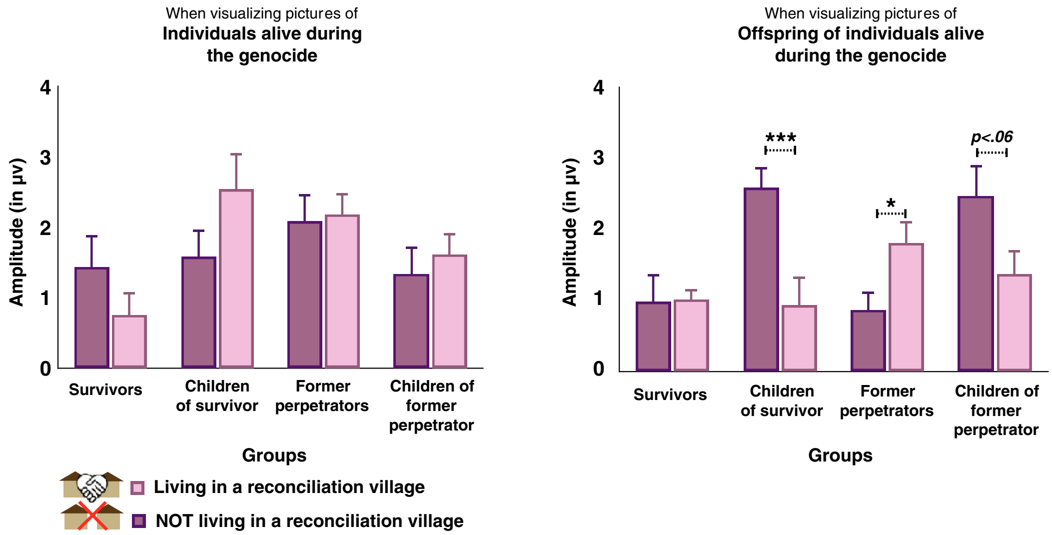



*Note*. The four groups of participants are displayed on the horizontal axis. The vertical axis represents the amplitude of the pain response (pain–no pain). All tests were two-tailed. Error bars represent standard errors. Graphical representation of the ERP waves is displayed in Supplemental Material S5, Figure S1. ERP = event-related potential. See the online article for the color version of this figure.

* $p \geq .01$ and $\leq .05$. ** $p \geq .001$ and $\leq .01$. *** $p \leq .001$.

**Figure 5**

*Graphical Representation of the Triple Interaction Group × Generation × Reconciliation Village*




*Note*. The four groups of participants are displayed on the horizontal axis. The vertical axis represents the amplitude of the pain response (pain–no pain). All tests were two-tailed. Error bars represent standard errors. See the online article for the color version of this figure.
* $p \geq .01$ and $\leq .05$. *** $p \leq .001$.

response when visualizing pictures of an adult or their child alive during the genocide. For the group of survivors, we observed evidence for $H_0$ that living in a Reconciliation Village did not influence their pain response when they visualized pictures of individuals present during the genocide ($p > .2$, $BF_{10} = .525$) or their offspring ($p > .9$, $BF_{10} = .311$). For the group of children of survivors, living in a Reconciliation Village did not reliably influence their pain response when they visualized pictures of individuals present during the genocide ($p > .1$, $BF_{10} = .760$). However, when they visualized pictures of the offspring of individuals present during the genocide, living in a Reconciliation Village reduced their pain response (.92 µv, $SD = 1.70$) compared to not living in a Reconciliation Village, 2.58 µv, $SD = 1.52$, $t(39) = 3.248$, $p = .002$, Cohen's $d = 1.040$, $BF_{10} = 15.245$. For the group of former perpetrators, living in a Reconciliation Village did not influence their pain response when they visualized pictures of individuals present during the genocide ($p > .8$, $BF_{10} = .308$). However, when they visualized pictures of the offspring of individuals present during the genocide, living in a Reconciliation Village slightly increased their pain response (1.81 µv, $SD = 1.57$) compared to not living in a Reconciliation Village, .87 µv, $SD = 1.05$, $t(42) = -2.183$, $p = .035$, Cohen's $d = -.676$, $BF_{10} = 1.940$. Finally, for the group composed of children of former perpetrators, living in a Reconciliation Village did not influence their pain response when they visualized pictures of individuals present during the genocide ($p > .5$, $BF_{10} = .353$). However, when they visualized pictures of the offspring of individuals present during the genocide, living in a Reconciliation Village marginally increased their pain response (2.47 µv, $SD = 1.81$) compared to not living in a Reconciliation Village, 1.36 µv, $SD = 1.66$, $t(37) = 1.986$, $p = .054$, Cohen's $d = .641$, $BF_{10} = 1.432$.

Results thus showed overall that living or not living in a Reconciliation Village has an effect on the pain response when visualizing pictures of the offspring of individuals present during the genocide, but not when visualizing the pictures of individuals present during the genocide. However, this effect differs between groups. Results indeed showed that living in a Reconciliation Village increased the pain response in the group of former perpetrators but decreased it for children of both survivors and former perpetrators.

Results also revealed a double interaction Individual × Reconciliation Village significant with the frequentist approach, $F(2, 312) = 4.043$, $p = .018$, $\eta_p^2 = .025$, but not with the Bayesian approach ($BF_{incl.} = .127$) and a significant triple interaction Generation × Individual × Reconciliation Village significant with the frequentist approach, $F(6, 312) = 3.065$, $p = .048$, $\eta_p^2 = .019$, but not with the Bayesian approach ($BF_{incl.} = .014$). However, as these interactions were not planned for answering our main research questions, they were not investigated further. Other main effects or interactions were in favor of $H_0$ or inconclusive (all $ps \geq .1$, all $BFs_{10} \leq .034$).

We also ran the same repeated-measures ANOVA with gender (male, female) as additional between-subject factors in exploratory analyses. As the group composed of former perpetrators only included male individuals, that group was excluded from the analysis. The main effect of gender was in favor of $H_0$($p > .8$, $BF_{incl.} < .016$), as well as the interaction Gender × Group ($p > .1$, $BF_{incl.} = .0012$), and the general pattern of results was unchanged.

## Questionnaires

In order to try quantifying what our participants experienced during the genocide in 1994 and its psychological consequences, they had to fill in several questionnaires (see the Method section). We systematically conducted univariate ANOVAs with group (survivor of the genocide, former genocide perpetrator, child of a survivor of the genocide, child of a former genocide perpetrator) and living in a Reconciliation Village (yes, no) as fixed factors on the scores of each questionnaire. Overall, we observed evidence in favor of $H_0$ that the main effect of group, the main effect of living in a Reconciliation Village or their interaction did not influence scores on the willingness to reconcile (all $ps \geq .1$, all $BFs_{10} \leq .233$), scores of PTSD (all $ps \geq .1$, all $BFs_{10} < .248$), on scores on resilience (all $ps \geq .08$, all $BFs_{10} \leq .446$), and scores on emotion regulation (all $ps \geq .1$, all $BFs_{10} \leq .337$). We observed a very strong evidence that the impact of the genocide was higher for the group of survivors than for all the other groups (all $ps < .003$, all $BFs_{10} \leq .12$, see Supplemental Material S7, for full results). Results also indicated that scores on social distance were higher toward former perpetrators, and, more moderately, toward children of former perpetrators, compared to the other group (see Supplemental Material S8, for full results). We also observed that for survivors, former perpetrators, and children of former perpetrators, living in a Reconciliation Village or not did not reliably influence the scores on social distance (all $ps \geq .1$, all $BFs_{10} \leq .9$). However, for the group of children of survivors, results revealed that when they were living in Reconciliation Villages, they scored higher on social distance toward former perpetrators and children of former perpetrator compared to those not living in Reconciliation Villages.

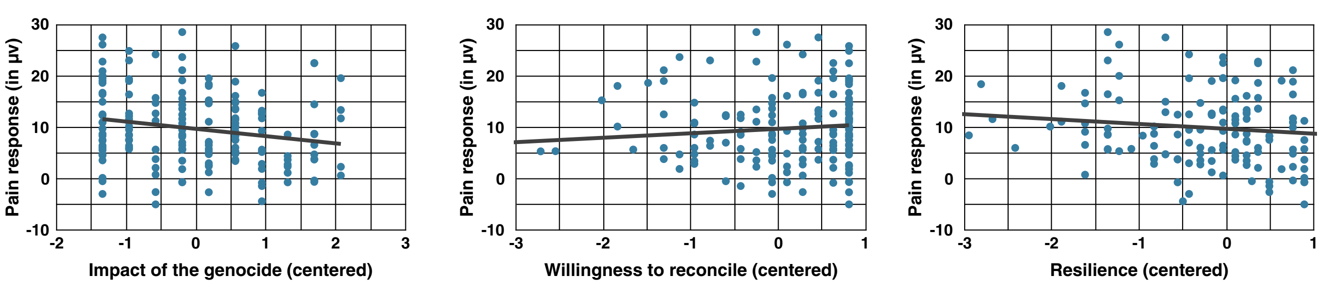
We also ran Pearson correlations between the different questionnaires. To correct for multiple comparisons with the frequentist statistics, we applied a false discovery rate (FDR) approach with the Benjamini and Hochberg method (Benjamini & Hochberg, 1995) to each $p$ value. We observed a positive correlation between the score on the PTSD scale and the number of stressors our participants endure during or after the genocide ($r = .260$, $p_{FDR} < .001$, $BF_{10} = 25.168$). We also observed positive correlations between the willingness to reconcile and scores on emotion regulation ($r = .232$, $p_{FDR} = .007$, $BF_{10} = 8.240$) and on resilience ($r = .262$, $p_{FDR} < .001$, $BF_{10} = 28.666$). Scores on emotion regulation also positively correlated with resilience scores ($r = .214$, $p_{FDR} = .012$, $BF_{10} = 4.221$). Finally, we observed a positive correlation between scores on the PTSD scale and emotion regulation ($r = .261$, $p_{FDR} < .001$, $BF_{10} = 27.606$). Other correlations were in favor of $H_0$(all $ps_{FDR} \geq .2$, all $BFs_{10} \leq .250$).

## Effect of the Trauma on the Neural Response to the Pain of Others

To assess if the impact of the genocide and the psychological profile in the aftermath of the genocide of our participants influence the pain response, a forced-entry regression method was used to fit a multiple linear regression model. We centered the overall score of all predictor variables (i.e., impact of the genocide, PTSD symptoms, resilience, emotion regulation, willingness to reconcile) before building the model. We ran a model with the pain response as the dependent variable and scores on the different questionnaires as predictor variables, all participants combined. Results indicated that the best predictor variable of the pain response was the score regarding the number of stressors our participants endured during or after the genocide, $F(5, 162) = 3.020$, $p = .018$, $\beta = -.190$, $BF_{incl.} = 2.760$, see Figure 6. The higher number of stressors our participants had to endured during or after the genocide, the more reduced their neural pain response was. We also observed an anecdotal evidence that the more participants indicated that

**Figure 6**

*Graphical Representation of the Correlations Between the Pain Response and the Impact of the Genocide (Right), the Willingness to Reconcile (Center), and Resilience (Left)*




*Note.* All tests were two-tailed. See the online article for the color version of this figure.

they were willing to reconcile, the higher their neural pain response was, $F(5, 162) = 2.184$, $p = .030$, $\beta = .176$, $BF_{incl.} = 1.303$. Further, the higher participants scored on the resilience subscale, the lower their neural pain response was, $F(5, 162) = -2.079$, $p = .039$, $\beta = -.167$, $BF_{incl.} = 1.248$. Other predictor variables were slightly in favor of $H_0$(all $p$s $\geq .5$, all $BFs_{10} \leq .538$).

As we were specifically interested in the intergroup empathy bias and how a human-related trauma influences it, we conducted separate linear regressions on the different groups with respect to their relative outgroup and the other outgroup generation.

For the group of survivors, the best predictor variable of the pain response toward the former perpetrator was the score regarding the number of stressors they endured during the genocide, $F(5, 39) = -2.732$, $p = .010$, $\beta = -.419$, $BF_{incl.} = 2.484$. The correlation indicated that the higher the number of stressors, the lower their pain response toward the former perpetrator was. Other predictor variables were inconclusive (all $p$s $\geq .1$, all $BFs_{10} \leq .711$). None of the questionnaires influenced the pain response toward the offspring of former perpetrators (all $p$s $\geq .3$, all $BFs_{10} \leq .238$). For the group of children of survivors, all predictor variables were in favor of $H_0$ or inconclusive regarding their pain response toward the former perpetrator (all $p$s $\geq .1$, all $BFs_{10} \leq .399$) and toward the offspring of former perpetrators (all $p$s $\geq .069$, all $BFs_{10} \leq .682$). For the group of former perpetrators, all predictor variables were in favor of $H_0$ or inconclusive regarding their pain response toward survivors (all $p$s $\geq .079$, all $BFs_{10} \leq .433$) and toward the offspring of survivors (all $p$s $\geq .5$, all $BFs_{10} \leq .177$). For the group of children of former perpetrators, all predictor variables were in favor of $H_0$ regarding their pain response toward survivors (all $p$s $\geq .6$, all $BFs_{10} \leq .180$). When visualizing pictures of the offspring of a survivor, we nonetheless observed evidence in favor of $H_1$ that a higher score on the PTSD scale, $F(5, 38) = -2.652$, $p = .012$, $\beta = -.410$, $BF_{incl.} = 3.220$, and a higher score on resilience, $F(5, 38) = -2.394$, $p = .023$, $\beta = -.410$, $BF_{incl.} = 3.603$, were associated with a reduced pain response. Other predictor variables were inconclusive (all $p$s $\geq .3$, all $BFs_{10} \leq .737$).

## Discussion

In the present study, we investigated how the neural empathic response varies between former perpetrators and victims of the Genocide Against Tutsis and their children when they visualized former perpetrators or victims, or their offspring, receiving painful or nonpainful stimulations. Different results tend to indicate that our study did target empathy for pain. First, our ERPs (P3, LPP) were sensitive to the visualization of pain. We indeed observed a higher amplitude of the P3 and the LPP when participants visualized painful compared to nonpainful stimuli, similar to several previous studies (Cheng et al., 2014; Coll, 2018; Vanman, 2016). Second, source reconstruction analyses showed a pattern of activation, including the inferior parietal lobule, the precuneus, the superior frontal gyrus, and the cingulate gyrus, which is consistent with the literature (Lamm et al., 2011; Timmers et al., 2018). Third, subjective pain ratings were in accordance with our ERPs as participants indicated that painful stimuli were more painful than nonpainful stimuli.

In accordance with our first hypothesis, we observed a strong intergroup empathy bias. The group of former genocide perpetrators indeed had a lower neural response to the pain of a survivor and survivors had a lower neural response to the pain of former genocide perpetrators. Each of these groups also had a higher neural response to the pain of their own group. This result is in line with previous studies showing that people tend to experience a reduced empathy toward outgroup individuals (Cikara et al., 2014; Vanman, 2016). Importantly, this result may not just be due to an attentional effect as participants in all groups correctly rated painful and nonpainful stimuli toward each individual presented.

Regarding our second hypothesis, we observed that the intergroup empathy bias seems to be transferred to the next-generation individuals. We indeed observed that children of survivors and children of former perpetrators both overall display an intergroup empathy bias toward, for example, their parents, suggesting that the intergroup empathy bias is transferred to the following generations. However, correlations between the pain response of parents and their children were not significant. This result supports a previous study conducted in Rwanda (Kang et al., 2022) showing that even if the intergroup empathy bias is found in the following generation and toward the offspring of the outgroup, this transmission is not direct and other factors, such as the number of voluntary interactions with the outgroup, can influence it. We also observed that the children of former genocide perpetrators and survivors were also impacted by the intergroup empathy bias. We indeed observed that the neural response to the pain of the child of a survivor or a former genocide perpetrator was as low as the pain response toward their parents when the pictures were visualized by a member of the other group. This result may suggest that children may also be affected by the actions or history of their parents, even though they were not alive during the conflicting events.

In accordance with our third hypothesis, we observed evidence of an association between the impact of the genocide and the neural response to the pain of others, with a higher number of stressors reported being associated with a lower pain response. This result is consistent with past literature showing that past traumatic or painful experiences impact the ability to resonate with the pain of others (Driscoll et al., 2012; Eidelman-Rothman et al., 2016;

Mazza et al., 2015). Results further revealed that this association appeared to be stronger for the group of survivors compared to the other groups. Expectedly and similar to past studies (Blanchette et al., 2019; Rieder & Elbert, 2013), survivors, as the primary targets of the atrocities that happened in 1994, were indeed the most impacted by the genocide compared to the other groups. Interestingly, we observed that the reduced pain response in the group of survivors was also present toward the pain of the child of a survivor. A first explanation is that a massive social trauma impacts so much empathy that even children of the ingroup are impacted, leaving survivors with the unique possibility to empathize with the pain of those who experienced similar life events. Second, many women were raped during the genocide. The children born from those rapes face stigmatization (Mukangendo, 2007) and have been called "children of bad memories" (Goodwin, 1997) or even "devil's children" (Nowrojee, 1996). In our story, the child of the survivor explicitly mentioned the rape of her mother during the genocide, which could have resulted in an attenuated pain response.

Although to a lower degree, genocide perpetrators also reported a high number of stressors, but those stressors were more frequently experienced after the genocide, during their prison time, similar to what was observed in past studies (Rieder & Elbert, 2013; Schaal et al., 2012). However, unlike survivors, former perpetrators did not display an overall reduction in the pain response compared to the other group. It may thus suggest that the type and origin of stressors experienced during a human conflict have a different impact on the ability to resonate with the suffering of others.

Our results also indicated that the impact of the genocide positively correlated with the number of persisting PTSD symptoms, similar to previous results (Blanchette et al., 2019). Interestingly, although we found that a higher impact of the genocide was statistically associated with a lower pain response, the number of persisting PTSD symptoms did not statistically correlate with the pain response. This result may indicate that PTSD symptoms in themselves are not what is associated with the reduction of the pain response. Rather, the type and origin of stressors experienced are the factors that influence the ability to resonate with the suffering of others.

It could be considered that survivors could display a higher level of PTSD symptoms than the rest of the population, as they experienced a higher number of stressors during the genocide. However, similar to past studies (e.g., Blanchette et al., 2019; Rieder & Elbert, 2013), we did not observe group differences in reported PTSD symptoms. Several reasons could account for this lack of difference. First, the PTSD scale assesses events and symptoms that happened over the last month, while the genocide happened 27 years before the testing. Thus, other events or factors could have influenced the responses of the participants. In this regard, some survivors have relatively low PTSD scores as they have been able to cope with their past traumatic experience and even forgive former perpetrators. On the contrary, some perpetrators have high scores of PTSD. They have spent years in overcrowded prisons, have been highly blamed publicly during the Gacaca trials for what they did, and some had to flee the country. Some of them also have to deal with what they did and experience feelings of shame and guilt (Kanyangara et al., 2014). Further, past research has shown that the offspring of survivors and perpetrators both display high levels of PTSD (Mutuyimana et al., 2019; Rieder & Elbert, 2013; Roth et al., 2014). This may explain why scores did not differ between groups, despite a higher number of stressors reported by survivors during the genocide.

Past research found a positive correlation between resilience and empathy (Grant & Kinman, 2014; Smith & Hollinger-Smith, 2015). However, in the present study, we observed that the higher our participants scored on the resilience scale, the lower their neural response to the pain of others was. A first critical difference with past studies is that we used EEG instead of self-report measurements, which are more biased to social desirability, especially for empathy (Neumann & Westbury, 2011). A second critical difference may be cultural, as the majority of previous research was conducted on Western individuals. A former study conducted in Rwanda indicated that deliberately forgetting about the actions of the other group, referred to by the author as "chosen amnesia," is essential for peaceful local coexistence (Buckley-Zistel, 2006) and to maintain harmony in the whole community. The process of resilience to negative events could thus involve a strategy of blocking any emotions that could be felt in order to preserve peaceful contact.

In exploratory analyses, we observed a positive influence of living in a Reconciliation Village on the pain of the offspring of the group of former perpetrators. Past literature indicated that prejudice is reduced with contact with the outgroup (Beelmann & Heinemann, 2014; Cameron et al., 2011; Crisp & Turner, 2009; Kang et al., 2022), and living in Reconciliation Villages involves more contact with the outgroup compared to not living in Reconciliation Villages, which could explain this result. Yet, we observed that living in a Reconciliation Village compared to not having had a negative influence on the neural response to the pain of others for children of both former perpetrators and survivors. Results also revealed that children of survivors living in Reconciliation Villages scored higher on social distance toward former perpetrators and children of former perpetrators compared to those not living in Reconciliation Villages. A possible explanation relates to the freedom of the decision to live in a Reconciliation Village and the personal willingness to reconcile. Past studies further indicated that one's own motivation to engage in contact with the outgroup is a critical determinant for reducing prejudice, beyond simply being in contact with the outgroup (Cernat, 2011; Halperin et al., 2012; Lemm, 2006; Ron et al., 2016). Regarding our fourth hypothesis, we indeed observed that a higher willingness to reconcile was associated with a greater neural response overall. This result would be supported by current theoretical views suggesting that empathy, despite being an inner process, is also a motivated phenomenon (Zaki, 2014). Past studies showed that a free decision to forgive seems to be a key step in reaching complete forgiveness, which has the potential to bring emotional and behavioral changes (Worthington et al., 2000). While individuals alive during the genocide may have been voluntarily chosen to live in a Reconciliation Village, their children generally do not have the choice and live where their parents choose to live. Importantly, as this association relies on a correlational approach, it is also possible that having a higher neural response to the pain of others motivates the process of reconciliation.

We also observed that living in a Reconciliation Village had no effects on survivors, a result which can be explained by the fact that even if the decision is relatively free, at least more than for children, some other motivations could have underlined their decision. Indeed, accepting to live in such villages frequently comes with free housing and financial benefits, which can be a critical incentive for individuals living in a low-income country. Some survivors reported that they felt forced to reconcile, either because reconciliation is encouraged by the government or because of religious ideology (Hatzfeld, 2007).

An interesting future line of research would be to understand the cross-culturality of these effects. A previous fMRI study showed that cultural variation in preference for social hierarchy modulates neural response underlying intergroup empathy, with a higher preference for social hierarchy being associated with a higher intergroup empathy bias (Cheon et al., 2011). The Rwandan culture involves a high deference to authority (Caspar et al., 2021; Prunier, 1998; Staub, 1992), which is associated with family honor (Green, 2020). It is thus possible that the intergenerationality of the intergroup empathy bias observed in the present study would differ in other cultures with less preference for social hierarchies, but the lack of previous literature prevents answering this question.

Conducting such a research project involves also taking care of the local sensibilities and adapting our experimental design. In Rwanda, the genocide has been committed in the name of ethnicity that was described as physically quite different. As a part of reconciliation strategy, it is forbidden to identify or ask people to identify with their ethnicity. We thus selected individuals that had relative similar physical traits and blurred their faces. Pictures were also randomized across participants, so each individual could have been presented with a different story. With this procedure, we ensured that individuals presented in the pictures were associated with a story, not with an ethnicity.

Several limitations should be considered in the present study. A first limitation concerns the fact that we did not predict how complicated it would be for a high number of our participants to learn to use a keyboard precluded to investigate if our neural results would correlate with subjective reports of pain in the pictures. Several of our participants could barely read numbers and only used the few they could recognize. When this happened, we told them to use the smallest one after the presentation pictures displaying nonpainful stimuli and the highest one after the presentation pictures displaying painful stimuli. Therefore, the scale could only be used to verify that they were paying attention to the stimuli but could unfortunately not be used to detect small variations in their subjective estimation of pain toward the different individuals presented. This may explain why the results from the pain scale are not modulated similarly to the results with the neural pain response. One possibility in future studies could be to use pictorial material instead of digital numbers, which may be more difficult to learn. Another limitation is that although we observed a reduction of the pain response in survivors compared to the other groups, we do not know if the pain response for the other groups is also reduced compared to neutral controls, or not. As the other groups also reported stressors during the genocide and PTSD symptoms, it is possible that their neural pain response is also somehow attenuated. However, finding neutral controls with our Rwandese participants is almost impossible as each Rwandan citizen is, in one way or another, linked to the genocide.

By recruiting the Rwandan population in a cross-sectional study which involved actual survivors and former perpetrators, and their children, this study offers the first critical investigation of how a human-caused trauma impacts empathy in the conflicting group and their children. We observed that suffering from PTSD symptoms is not the best predictor variable of a reduced pain response. Rather, it seems that the type and origins of stressors experienced during the genocide are the best predictive factor associated with the reduced pain response. Second, we observed that a deliberate and free decision to reconcile is associated with a higher pain response. This may be critical for encouraging reconciliation in peacebuilding programs and for fostering empathic repair after trauma.

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