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Abstract: Traumatic exposure is particularly devastating for those who, at a young age, have become combatants or experienced massive adversity after abduction by armed movements. We investigated the impact of traumatic stressors on psychopathology among war-affected young men of Northern Uganda, including former child soldiers. Adaptation to violent environments and coping with trauma-related symptoms often result in an increasing appetite for violence. We analyze implicit attitudes toward violence, assessed by an Implicit Association Test (IAT), among 64 male participants. Implicit attitudes varied as a function of the number of experienced traumatic event types and committed offense types. As the number of traumatic experiences and violence exposure increased, more appetitive aggression was reported, whereas the IAT indicated increasingly negative implicit attitudes toward aggression. The IAT was also the strongest predictor of cortisol levels. Diffusion-model analysis was the best way to demonstrate IAT validity. Implicit measures revealed the trauma-related changes of cognitive structures.

Keywords: posttraumatic stress disorder, appetitive aggression, Implicit Association Test (IAT), combatants

The 21st century "modern warfare" is often characterized by violence between rivaling groups within state borders and the recruitment of children as soldiers. Children are involved as active fighters in over 75% of the world's armed conflicts (Twum-Danso, 2003). The UN estimates that up to 300,000 child soldiers – that is, any person under the age of 18 years who is part of armed forces – are currently fighting in 50 different states around the world (Singer, 2001). Over a decade, Uganda's Lord Resistance Army (LRA), a military movement operating in Northern Uganda and adjacent countries, has forcibly abducted over 12,000 children to turn them into soldiers for their fight against the Ugandan government.

The mental health consequences of being exposed to extreme violence have been extensively investigated: In line with a dose-response effect, repeated exposure to different traumatic event types increases the risk for trauma spectrum disorders, foremost Posttraumatic stress disorder (PTSD) and affective disorders, such as Major Depression (Schauer & Elbert, 2010). The dysregulation of the hypothalamus-pituitary-adrenal (HPA) axis is a key feature of a range of trauma-related symptoms (de Kloet, Joëls, & Holsboer, 2005). The HPA axis describes a set of interactions between the hypothalamus, the pituitary gland, and the adrenal gland, which results in the release of its effector cortisol. For example, patients with a history of chronic traumatization displayed altered cortisol responses after exposure to acute stressors (Heim et al., 2000). Consequently, serious mental problems can be found among child soldiers as well (Betancourt, Brennan, Rubin-Smith, Fitzmaurice, & Gilman, 2010). A study with former child soldiers in northern Uganda suggested that PTSD in severely traumatized individuals who continue to live under stressful conditions might be associated with general hypercortisolism (Steudte et al., 2011). Many of juvenile war survivors not only suffer from PTSD and/or depressive symptoms, but also show an increased level of aggressive and disruptive behavior (Shaw, 2003). Aggressive behavior

in the aftermath of trauma exposure has often been traced back to increased anger or a general hyperarousal as one of the trauma symptoms (e.g., Jakupcak et al., 2007).

However, there is also another form of aggressive behavior that is not linked to merely increased impulsivity or defensive responses toward threats. This aggression subtype, called *appetitive aggression*, can rather be found in combatants and perpetrators of serious atrocities. It describes the phenomenon that violence is perceived as self-rewarding, appealing, and exciting without being linked to pathological aggressive behavior (Elbert, Weierstall, & Schauer, 2010). Whereas a moral perspective insists that aggression in most cases poses a problem for the human species that needs to be solved, contemporary trends in aggression research also consider its functionality and adaptive value (Duntley & Buss, 2011). In line with such a conception, we demonstrated that appetitive aggression facilitates the adaptation to an adverse environment and may serve as a resilience factor for the development of trauma symptoms, by altering the processing of violence cues (e.g., Hecker, Hermenau, Maedl, Schauer, & Elbert, 2013; Weierstall, Huth, Knecht, Nandi, & Elbert, 2012; Weierstall, Schaal, Schalinski, Dusingizemungu, & Elbert, 2011). Instead of eliciting traumatic processing of violence cues (e.g., triggering fear), events, such as witnessing serious atrocities or being in life threat during combat, rather lose their frightening connotation. In its place, combatants develop an attraction to participate in cruel acts; they experience violence more and more as self-rewarding. Joining military forces at a young age and perpetrating violence intensify this appetite for aggression (Hecker, Hermenau, Maedl, Elbert, & Schauer, 2012; Nandi, Crombach, Bambonye, Elbert, & Weierstall, 2015).

Unsurprisingly, the assessment of appetitive aggression with questionnaires is plagued with two major difficulties: First, acknowledging being attracted to cruelty and enjoying violent behavior is usually a social taboo and may result in shame or criminal prosecution – maybe even more so in crisis regions such as Rwanda that have just recently been pacified (Weierstall et al., 2011). Secondly, not everyone is aware of his or her own affect in violent situations, and most likely some parts of our affective responses to aggressive behavior are beyond our capacity for conscious perception or remain unconscious due to self-censorship (Bluemke & Teige-Mocigemba, 2015; Bluemke & Zumbach, 2012).

To mitigate these difficulties, indirect methods for assessing aggression rely on associative impulses rather than deliberate reflection. Implicit measures assess attitudes, for instance, via speeded-classification tasks. Assessing appetitive aggression via automatic associations would effectively reduce blatant desirable responding in a socially sanctioned domain. Crucially, one may detect impulsive precursors of appetitive aggression that the participants cannot introspectively access or find hard to deliberately control (Strack & Deutsch, 2004; Nosek & Smyth, 2007). Considering that the conflict in Northern Uganda has lessened since 2006, individuals' attitudes toward aggressive behavior are most likely buried under social norms, though they still have a strong influence on people's behavior. Implicit measures of appetitive aggression should allow an objective view on the impact of traumatic experiences on people's attitudes toward violence (Richetin, Richardson, & Mason, 2010).

The Implicit Association Test (IAT) is the most reliable implicit measure based on response latencies (Greenwald, McGhee, & Schwartz, 1998; LeBel & Paunonen, 2011), and the only currently available implicit measurement procedure to successfully assess aggressiveness (Bluemke & Teige-Mocigemba, 2015; Richetin & Richardson, 2008). For instance, Banse, Messer, and Fischer (2015) reported significant correlations between the IAT and observers' aggression ratings. The IAT incrementally predicted unprovoked aggression too, at least for people high in trait aggression (Bluemke & Friese, 2012; Brugman et al., 2015). Of note, the evidence is limited to a specific variant – the self-concept IAT.

The present study was part of a larger project (for other aspects of this project, see Crombach, Weierstall, Hecker, Schalinski, & Elbert, 2013; Weierstall, Schalinski, Crombach, Hecker, & Elbert, 2012); in this part, we administered an attitudinal IAT that is less frequently used in the domain of aggression (cf. Gray, MacCulloch, Smith, Morris, & Snowden, 2003). The aim of the study was to investigate the relationships of attitudinal IATs to trauma-related symptoms (i.e., PTSD symptoms, depressive symptoms) and appetitive aggression in a highly unique sample of Ugandan war-affected youth including former child soldiers. We hypothesized that, on one hand, traumatic experiences and trauma-related symptoms in war-affected young men from Northern Uganda would rather be related to negative associations of violence. On the other hand, if appetitive aggression were directly related to automatic associations, this might pull associations of violence more toward the favorable side. As a physiological validation criterion, we used cumulative hair cortisol as a physiological marker of long-lasting stress due to previous traumatic experiences. Similar relationships had been observed with Ugandan child soldiers before (Steudte et al., 2011).

Method

Participants

Sixty-four (out of 83) male Ugandans provided valid IAT data (some participants had to be dropped due to

difficulties with the computer-based task; see "Computation of IAT effects" below). Out of these 64 men, 29 had been abducted by the LRA, so that they spent between 2 days and 12 years in the bush (median = 7 months; *M* = 2.13 years, *SD* = 3.20). On average, they were 11.45 years old when abducted. They had returned from the bush on average 8.74 years ago (*SD* = 4.14; range: 1–17). The other 35 participants had also experienced the war in Northern Uganda, but not been abducted. Consequently, they had not stayed as child soldiers in the bush (few hours of abduction, if any). Participant groups were nearly the same age (*M* = 21.31 years, *SD* = 2.48 vs. *M* = 21.54 years, *SD* = 2.51).

Procedure and Materials

Assessments were conducted individually in a private setting in a camp for internally displaced people in Pabbo, Northern Uganda (September–October 2009). Four clinical psychologists carried out semi-structured interviews with the help of five local interpreters, who had been trained in the concepts of mental disorders and aggression for 2 months (Ertl et al., 2010). All questionnaires were translated into local language, Acholi, using back-and-forth translations. After the semi-structured interview, participants took the IAT on a laptop computer. For many participants it was the first time to use or see a laptop computer.

The Ethical Review board of the University of Konstanz and the Uganda National Council for Science and Technology had approved this study as part of a larger project on the impact of combat exposure on mental health in former child soldiers. All participants (alternatively two caretakers) gave their informed consent. Participants received a financial compensation of 4,000 Ugandan Shilling (US $1.50) for the 2.5-hr assessment.

Traumatic Event Types

Traumatic event types were indexed by a checklist of 34 war- and non-war-related potentially life-threatening events such as injury by weapon, rape, accidents (Neuner et al., 2004), including those from the Posttraumatic Diagnostic Scale (Foa, Cashman, Jaycox, & Perry, 1997; see below). The number of times a specific event had been experienced was not assessed; measuring event types provides an accurate and practical measure of trauma experiences (Wilker et al., 2015). We initially distinguished event types they had experienced themselves from those they had witnessed (Neuner et al., 2004). On average, the participants reported 16.38 (range: 5–28) different traumatic event types altogether. Previously collected data from Uganda showed that the event list had high test-retest reliability (*r* = .73), significant accordance with the Composite International Diagnostic Interview (CIDI) Event List (Ertl et al., 2010), and correlated with cortisol in hair as indicator of chronic stress (Steudte et al., 2011).

PTSD Symptom Severity

The validated Acholi version of the widely used Posttraumatic Diagnostic Scale (PDS) in its interview form (Ertl et al., 2010; Foa et al., 1997) assessed PTSD symptom severity. Each of the 17 items corresponds to one PTSD symptom specified in *DSM-IV* with ratings ranging from 0 (= "*never*") to 3 (= "*5 times per week or more/very severe/nearly always*"). Participants evaluated the severity of PTSD symptoms in the past four weeks with regard to their most stressful life event.

Depression

The short version of the Hopkins Symptom Checklist (HSCL; Derogatis, Lipman, Rickels, Uhlenhuth, & Covi, 1974) was used to assess the extent of depression. It is a valid screening instrument for 15 depression symptoms, available for use in many languages. It is also suitable for samples of refugees in post-conflict countries including Uganda (cf. Pfeiffer & Elbert, 2011; Roberts, Ocaka, Browne, Oyok, & Sondorp, 2008; Vinck, Pham, Stover, & Weinstein, 2007; Winkler et al., 2015). The respective HSCL section can also be used with a locally validated depression cut-off (Ertl et al., 2010).

Cortisol

Following Steudte et al. (2011), we used cumulative hair cortisol as a known physiological correlate of stress due to habitually elevated cortisol levels, for instance, due to reexperiencing traumatic episodes. Close-to-the-scalp hair strands of up to 3 cm length were taken (posterior vertex position) to estimate the cumulative cortisol exposure across the previous 15 weeks or less (Loussouarn, 2001). In line with the procedure reported by Davenport, Tiefenbacher, Lutz, Novak, and Meyer (2006) and Kirschbaum, Tietze, Skoluda, and Dettenborn (2009), first the hair strands have to be washed to remove contaminants; then cortisol molecules are extracted chemically from the hair by so-called steroid extraction, and then an immunoassay with chemiluminescence detection is run to quantify the cortisol concentration (CLIA, IBL-Hamburg, Germany).

Number of Offense Types Committed

We assessed aggressive behavior via the number of different types of committed offenses (OFF), perpetrated either individually or as part of a group. The checklist of 17 different offense types ranged from physical assault to rape or killings. Each offense type was coded as 1 (= *committed*) or 0 (= *not committed*), and the total score represented the number of different offense types committed.

General Aggression

The Buss and Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992) serves as a reliable and valid quasi-standard index of overall aggressiveness (e.g., Collani & Werner, 2005). Participants evaluated on 5-point Likert scales of 16 culturally adapted items how much they agreed or disagreed with statements that relate to facets of physical aggression, verbal aggression, hostility, and anger.

Appetitive Aggression

The Appetitive Aggression Scale (AAS; Weierstall & Elbert, 2011) is a relatively recent measure that has been validated with over 1,600 ex-combatants and has shown good psychometric properties. Its 15 items assess participants' perceptions while committing acts of violence (e.g., "*Is it exciting for you if you make an opponent really suffer?*" or "*Once fighting has started do you get carried away by the violence?*"), rated on 5-point Likert scales (0 = disagree; 4 = agree; range: 0–51). Previous analyses showed that the scale sum score is reliable (α= .85) and represents a distinct construct of human aggression (32% of variance explained by a first factor; Weierstall & Elbert, 2011).

Implicit Association Test (IAT)

Procedure

The attitudinal IAT is a computer-based measure for the assessment of attitudes that are otherwise prone to social desirability (Greenwald et al., 1998). Based on objective response latencies, it aims to measure participants' automatic associations between the concepts of violence (violent vs. peaceful) and valence (good vs. bad). The procedure requires participants to sort stimuli presented in random order according to one of four categories, and with the help of only two response keys. Following Gray and colleagues (2003), in one crucial block of trials evaluatively compatible categories are mapped onto shared response keys ("violent+bad," "peaceful+good"). Another block combines the same categories in an incompatible manner ("violent +good," "peaceful+bad"). In both blocks the stimuli have to be categorized by pressing the appropriate left or right response key as quickly as possible without error.

Necessary cultural adaptations of the stimulus materials included, first, representing the categories on the computer screen with symbols and, second, using pictures instead of words as test stimuli. "Violent" and "peaceful" were represented by a fist and a handshake, "good" and "bad" by a thumb up and a thumb down, all symbols meeting cultural validity. Violent and peaceful stimuli, matched for authorship, background scenes, and complexity, were 10 pairs of pencil drawings that reflected typical Ugandan social situations. They were selected out of a pool of 40 drawings according to their potential to best represent violence and its counter-category as rated by 11 Ugandan men. Valence stimuli were photos of 10 happy and 10 angry Ugandan men unbeknown to our participants, with the same male individuals displaying the respective emotions.

The procedure was programmed in PsyScope X Build 53 (Cohen, MacWhinney, Flatt, & Provost, 1993). The setup encompassed seven blocks of speeded classification (Greenwald, Nosek, & Banaji, 2003). Apart from typical practice blocks (20 trials each), one critical block assessed the normatively incompatible association of violent with good, while a compatible block coupled violent with bad (40 trials each). Counterbalancing order of block compatibility and left/right position of categories did not challenge any of the following conclusions. Keyboard buttons were marked accordingly to facilitate responses.

Computation of IAT Effects

Higher scores reflected more positive implicit attitudes toward violence, yet, just like the procedural setup, the computation of IAT effects required adjustments to participants' education level. None of the participants had ever used a computer, and over half of them had attended school for less than 4 years (primary school). To deal with the low computer literacy, (a) three different algorithms for computing the IAT effect were compared, while (b) procedural adjustments to the typical computation of these algorithms were necessary. As regards the algorithms, we computed (1) IAT effects as conventional difference scores based on the mean reaction times of correct responses in compatible and incompatible blocks (IAT-RT effects), after dropping latencies outside a response window from 300 to 3,000 ms (Greenwald et al., 1998); (2) an improved algorithm, so-called IAT-D scores (Greenwald et al., 2003), which typically converts wrong responses arbitrarily into latencies by adding latency penalties; its advantage over the algorithm for IAT-RT effects is that it reduces nuisance variance by individually standardizing an individual's difference score by his/her pooled standard deviation; (3) finally, IAT-DM effects on the basis of diffusion-model analysis, extracting speed of information processing in compatible and incompatible blocks by means of simultaneously modeling response latencies of accurate and inaccurate responses (Klauer, Voss, Schmitz, & Teige-Mocigemba, 2007). Given that the young men had low education levels and difficulties when working on the IAT, a substantial number of errors occurred. Diffusion-model analysis is ideally suited to incorporate all information available also from erroneous trials while minimizing the influences of decision bias and the duration of general non-decisional (executive) processes.

As regards the necessary procedural adjustments for the computation of the three algorithms in light of the present sample, we first had to exclude participants with apparent limitations in motivation or cognitive skills (n = 19), sparing

Table 1. Intercorrelations

Measure	IAT (RT)	IAT (*D*)	IAT (DM)	CORT	T-witn.	T-exp.	T-total	PDS	HSCL	OFF	BPAQ	AAS
IAT effect (RT)	–	.97***	.63***	–.14	–.20	–.25*	–.25*	–.11	–.09	–.17	.06	–.08
IAT effect (*D*)	.97***	–	.70***	–.16	–.23†	–.27*	–.28*	–.11	–.12	–.20	.02	–.12
IAT effect (DM)	.69***	.75***	–	–.16	–.25*	–.27*	–.28*	–.18	–.21†	–.29*	–.04	–.12
Cortisol (nmol/L; CORT)	–.14	–.17	–.22†	–	–.03	.00	–.01	.07	–.08	–.08	–.15	–.07
Traumatic events witnessed (T-witn.)	–.19	–.22†	–.30*	–.04	–	.67***	.87***	.31*	.25*	.57***	.35**	.39**
Traumatic events experienced (T-exp.)	–.24†	–.26*	–.31*	.00	.66***	–	.95***	.55*	.42*	.74***	.39**	.58***
Traumatic events total (T-total)	–.24†	–.27*	–.33**	–.01	.86***	.95***	–	.50*	.39*	.74***	.41**	.55***
PTSD Symptom Severity (PDS)	–.10	–.11	–.24†	.06	.30*	.54***	.49***	–	.53***	.39**	.48***	.46***
Depression (HSCL)	–.11	–.13	–.19	–.07	.30*	.46***	.44***	.57***	–	.30*	.49***	.35**
Offenses committed (OFF)	–.16	–.20	–.35**	–.09	.57***	.74***	.74***	.38***	.33**	–	.43***	.66***
Buss & Perry Aggression (BPAQ)	.06	.02	–.05	–.15	.35**	.39**	.41***	.49***	.50***	.43***	–	.54***
Appetitive Aggression (AAS)	–.07	–.10	–.20	–.07	.38**	.58***	.55***	.47***	.37**	.67***	.55***	–

Notes. Above diagonal: $N = 64$; below diagonal: $N = 62$ without misfitting participants according to diffusion-model analysis. N = number of participants; IAT = Implicit Association Test; RT = reaction-time based IAT analysis; D = improved scoring algorithm based IAT analysis; DM = diffusion-model based IAT analysis; CORT = cortisol; T-witn. = traumatic event types witnessed; T-exp. = traumatic event types experienced; T-total = traumatic event types total; PDS = Posttraumatic Diagnostic Scale; HLSC = Hopkins Symptom Checklist; OFF = number of offense types committed; BPAQ = Buss & Perry Aggression Questionnaire; AAS = Appetitive Aggression Scale. $^{\dagger}p \leq .10$; $^{*}p \leq .05$; $^{**}p \leq .01$; $^{***}p \leq .001$.

64 participants. The excluded participants had obvious difficulties to follow task instructions promptly: They responded more than +1 *SD* more slowly (> 1,774 ms) than the typical respondent (M = 1,472 ms, SD = 329); and they had more than 50% incorrect responses or response latencies that fell out of the 300–3,000 ms response window. For them less than half of valid data existed, rendering the IAT procedure itself invalid, the computation of IAT effects unreliable, and the imputation of missing data unfeasible (cf. Nosek & Smyth, 2007). Second, although it is standard nowadays to include the double-discrimination practice blocks (3 and 6) in the computation of IAT effects, these practice blocks had very low criterion correlations. As participants had severe difficulties to adjust to the unfamiliar technical equipment, the unknown procedure, and the complex IAT tasks, all three algorithms were based exclusively on the trials of the main critical IAT blocks (4 and 7).

As regards the computation of standard IAT-RT effects (algorithm 1), the substantial number of implausibly short and long latencies (outside the 300–3,000 ms interval) prevented us from recoding slow/fast outliers to the boundary values; instead, we accepted these values as missing data. With regard to the computation of IAT-D effects (algorithm 2), we did not apply the proposed latency penalties for erroneous responses, because, in our sample, errors mostly reflected the difficulty to follow task instructions and were not indicative of proper associative processes (following a suggestion by Bluemke & Zumbach, 2012).

Given that we faced a massive loss of data and potentially limited skills among the retained participants, valid IAT effects are most likely to be expected on the basis of diffusion-model analysis (IAT-DM effects; algorithm 3). Information diffusion models (Ratcliff, 1978) are suitable to analyze data from binary choice tasks (e.g., IATs). They allow estimating the performance in information processing in the critical IAT blocks in a cognitively process-pure fashion (via the so-called drift rate, v, representing the speed of the information uptake in either compatible or incompatible block). A full account is beyond the scope of the present paper (Voss, Nagler, & Lerche, 2013, provide a simple and quick overview; for a full account of diffusion modeling applied to IATs, see Klauer et al., 2007). The conventional IAT-RT effect is a blend of information drift rates, nondecision components, and speed-accuracy settings; the diffusion-model based IAT-DM effect is based on the parameter of interest. We used the free software Fast-dm with Kolmogorov-Smirnov method for the estimation of parameters (Voss & Voss, 2007), allowing response latencies from slow responders between 300 and 5,000 ms, as they can be accommodated by diffusion models (Voss et al., 2013). Fast-dm provides chi-square distributed goodness-of-fit tests for each participant to check whether the assumptions of the diffusion model hold. As the decision-making process of two participants did not comply with the diffusion-model assumptions, they were excluded (compare Table 1 values above and below diagonal).

Results

Table 2 summarizes the descriptives of the present set of variables. As a preliminary analysis, we describe the impact of traumatizing experiences, beginning with the differences

Table 2. Descriptives of trauma-related variables ($N = 64$)

					Non-abducted ($n = 35$)		Abducted ($n = 29$)	
	Min	Max.	*M*	*SD*	*M*	*SD*	*M*	*SD*
IAT effect (RT)	–1,023.40	876.28	–395.17	356.45	–374.17	386.98	–498.32	273.41
IAT effect (*D*)	–2.21	2.21	–0.85	0.78	–0.80	0.88	–1.09	0.60
IAT effect (DM)	–5.81	0.95	–1.53	1.30	–1.37	1.38	–1.71	1.20
Cortisol (nmol/L; CORT)	0.02	48.43	13.57	8.01	12.83	6.97	14.46	9.17
Traumatic events witnessed (T-witn.)	3	13	8.64	2.41	7.49	2.13	10.03	1.96
Traumatic events experienced (T-exp.)	1	17	7.73	3.94	5.11	1.89	10.90	3.42
Traumatic events total (T-total)	5	28	16.38	5.84	12.60	3.35	20.93	4.87
PTSD Symptom Severity (PDS)	0	21	4.86	5.15	3.77	5.02	6.17	5.09
Depression (HSCL)	0	38	9.36	8.63	8.00	7.93	11.00	9.29
Offenses committed (OFF)	0	16	5.61	3.93	4.06	2.26	7.48	4.67
Buss & Perry Aggression (BPAQ)	2	53	23.06	12.52	21.94	13.47	24.41	11.35
Appetitive Aggression (AAS)	0	51	17.70	14.34	13.91	11.32	22.28	16.35

Notes. N = number of participants. IAT = Implicit Association Test; RT = reaction-time based IAT analysis; D = improved scoring algorithm based IAT analysis; DM = diffusion-model based IAT analysis; CORT = cortisol; T-witn. = traumatic event types witnessed; T-exp. = traumatic event types experienced; T-total = traumatic event types total; PDS = Posttraumatic Diagnostic Scale; HLSC = Hopkins Symptom Checklist; OFF = number of offense types committed; BPAQ = Buss & Perry Aggression Questionnaire; AAS = Appetitive Aggression Scale.

between abducted and non-abducted Ugandan men. In total, abducted participants had witnessed or experienced almost twice as many traumatic event types than non-abducted ones, $t(62) = 8.08$, $p < .001$, Cohen's $d = 2.05$. According to PDS scores, they also reported higher PTSD symptom severity than non-abducted participants, though not to an extent that the dose-response effect would suggest, $t(62) = 1.89$, $p = .06$, $d = 0.48$. They hardly differed in reported symptoms of depression (HSCL scores), $t(62) = 1.39$, $p = .17$, $d = 0.23$. Rather than being generally more aggressive (BPAQ scores), $t < 1$, $p = .44$, they displayed characteristically higher appetitive aggression (AAS scores), $t(62) = 2.41$, $p = .02$, $d = 0.61$.

As evident from the intercorrelations (Table 1) the number of traumatic event types correlated with the degree of traumatization, depression scores, and aggression scores across all war-affected young men. Exposure to traumatic experiences was positively related to PTSD symptom severity, and at the same time to appetitive aggression. Note that BPAQ and AAS did not merely represent the same kind of aggressiveness: the number of committed offense types (OFF) was more closely associated with appetitive aggression (ASS) than with general aggression (BPAQ). This underscores the motivational-affective quality of appetitive aggression, which theoretically serves as an instigator of aggressive acts and, at the same time, as a coping mechanism for trauma.

IAT scores were reliable (split-half correlations $r_{\text{odd-even}} = .88–.93$). The three IAT algorithms converged strongly, albeit imperfectly. Diffusion modeling handled the noise in the data of young Ugandan men best, because – despite similar reliability estimates – the sophisticated IAT-DM effect yielded consistently the highest criterion correlations. Note that cortisol levels were not significantly associated with any self-report measure ($|r| = .00–.15$). If there was a measure that reflected the stressful experiences encapsulated in hair strands best, it was the IAT ($r = .22$, $p = .08$), yet only when IAT scores were freed from as much error variance as possible (IAT-DM scores), and only so in the analysis of participants for whom the diffusion-model analysis fitted ($N = 62$; see Table 1 below diagonal).

Implicit attitudes toward violence were only weakly related to PTSD symptom severity (PDS). Yet, participants' traumatic encounters predicted negative implicit attitudes. The more exposure to traumatic events had occurred – and to self-experienced events in particular – the more negative were the associations toward violence (IAT scores). At the same time, a higher number of traumatic event types correlated with higher self-reported general and appetitive aggression. Likewise, the number of committed offenses correlated negatively with implicit attitudes toward violence (IAT scores), whereas it correlated positively with participants' self-reported aggression. An additional analysis of partial correlations showed that the relationships between IAT and explicit measures were not simply masked due to group differences between abducted and non-abducted men. Rather the relationships of IAT scores with general and appetitive aggression scores became weaker. (The relationships between IAT and trauma-related variables were, of course, slightly attenuated after partialling out relevant group differences.)

Discussion

The current research contributes to our understanding of the relationship between experiencing and perpetrating violence, particularly for those who were forced to grow up in war zones. Implicit attitudes toward violence were unrelated to an explicit measure of general aggression (BPAQ). Yet, for the first time, we demonstrated that indirect measurement techniques can reveal how traumatic events imprint on young men's associative structures: Higher exposure to traumatic experiences and violent offenses in the past were associated with more negative implicit associations toward violence. At the same time, in line with our expectations, general aggressiveness and specifically appetitive aggression were positively associated with violent experiences and committed offenses, supporting previous findings about the validity of appetitive aggression as a construct (Nandi et al., 2015; Weierstall, Huth, et al., 2012). Whereas the extent of traumatic events predicted negative implicit attitudes, it also predicted positive explicit attitudes (appetitive aggression).

Very revealing – and unlike what one might assume on the basis of typically positive implicit-explicit relationships (Hofmann, Gawronski, Gschwendner, Le, & Schmitt, 2005; Nosek, 2005; Nosek & Smyth, 2007) – admitting to being high in appetitive aggression (i.e., positive attitudes toward violence) was *not* reflected in *positive* associations toward violence according to the IAT. In other words, participants high in appetitive aggression did not have more favorable implicit associations toward violence; if anything they tended to have negative ones (r = .20; Table 1). Such a negative implicit-explicit correlation is an atypical finding in the domain of implicit attitudes (e.g., Hofmann et al., 2005). We attribute this to the special character of our sample and the experiences among young Ugandan men. This dissociation might be highly relevant for understanding appetitive aggression as a coping mechanism and inspires further research.

Note, however, that appetitive aggression and traumatic events themselves were correlated substantially, presumably because appetitive aggression serves an adaptive function in violent environments (see Weierstall, Huth, et al., 2012; Weierstall, Schalinski et al., 2012). In a cross-sectional design, the mere variance overlap between appetitive aggression and traumatic events prevents a clear-cut answer whether appetitive aggression indeed *alters* implicit violence associations into a positive direction. Of course, implicit attitudes can be subject to confluent dynamic processes: developing more negative implicit attitudes toward violence in response to traumatic experiences, and developing more positive implicit attitudes as a protective mechanism that prevents one from becoming overly traumatized by one's own atrocities.

We interpret the overall pattern in line with research on the consequences of trauma, where a substantial alteration in the processing of violence has been described (e.g., Elbert & Schauer, 2002). Cues that trigger previous traumatic experiences typically activate a fear-network in the brain, thereby provoking a fear-response and breeding the clinical symptoms of trauma-related disorders such PTSD, including hyperarousal and repetitive patterns of reliving traumatic memories, and depression. This reaction is rooted in altered brain mechanisms and physiological correlates such as cortisol responses as shown in altered cortisol responses of different, severely traumatized samples including child soldiers (Heim et al., 2000; Steudte et al., 2011).

We propose that the same mechanism is responsible for building up appetitive aggression in parallel: Despite a general tendency to predominantly associate violence with bad, the change of explicit attitudes toward experiencing aggression as appetitive must be rooted in the same pathways responsible for the altered processing of violence cues. The accelerated connection between violence and bad in those who experienced more traumatic events points to newly formed connections in the brain of traumatized people who acted as perpetrators (Elbert et al., 2011). Perpetrators perceive violence differently from victims. Elbert et al. (2010) proposed that the violence-related association network competes with the fear-network. The more appetite for violence perpetrators develop, thereby experiencing feelings of control, power, fascination, and lust while harming or killing someone, the more become cues (such as blood, pain, and screams) integrated in a positive association network while having reduced impact on the fear-network.

At first glance it may seem surprising that those who reported significantly more appetitive aggression did not have more positive implicit attitudes toward violence. Considering, however, that the IAT measures a *general* attitude toward violent situations, whereas the AAS specifically assesses how *self-committed* violence is perceived, the seeming contradiction dissolves. Note that the IAT stimuli, unlike the AAS items, were ambiguous with regard to who the perpetrator is. From a test-taker's perspective the IAT did not differentiate between perpetrating and victimizing situations. Child soldiers very often live in insecure and violent environments and are exposed to many traumatic events in active and passive ways (Hecker et al., 2012). That formerly abducted participants had experienced more traumatic events than the non-abducted ones may be responsible for the relationship between negative implicit attitudes and higher cortisol levels; but at the same time their appetitive aggression counteracted the stress they experienced.

It is possible that the attraction to violence among our participants decreased over time. The time spent in civil

society after returning from the bush amounted to more than 8 years on average. It is conceivable that any observed relationships represent only lower bounds for estimated strengths (see also Hermenau, Hecker, Schaal, Maedl, & Elbert, 2013). But this also shows how profound effects are and how persistently individuals are affected after engaging in violence and committing atrocities. Our findings highlight the importance of considering appetitive aggression when reintegrating former child soldiers into society.

Limitations

There are some caveats in our research. Some researchers (including some of us) have voiced concerns about the scientific merits of implicit *attitudes* toward violence and aggression (Bluemke & Zumbach, 2012). One would usually expect positive evidence for IAT validity if the procedure were based on the aggressive *self-concept*, not on *attitudes* toward aggression (Bluemke & Teige-Mocigemba, 2015). Yet, in the present case, our participants had been subject to the strongest life events we can think of – unlike, say, participants from the normal population who are merely exposed to virtual computer game violence. Intense forces may form a precondition to render the implicit attitude toward violence a reliable and valid indicator in the domain of aggression (cf. Gray et al., 2003).

Furthermore, not only was our sample limited to young men, who had little education. On the one hand, this may have limited participants' capacity to control associative impulses during the IAT task, fostering validity of the attitudinal IAT. On the other hand, the typical IAT procedure was less feasible than usual; instead, adjustments in the procedure were required, affecting the stimulus selection, the task labels, and the data analytic strategy. It is unclear to what extent our findings generalize to other samples.

Another limitation is small sample size. Our sample contained participants who are difficult to recruit, former abductees as well as war-affected, yet not formerly abducted youth. Computing refined analyses separately for each group is not feasible, as the correlations for such small group sizes ($Ns \leq 35$) would not be reliable. It is also impossible to control for any moderating impact of subtle group differences on the obtained correlation coefficients (interaction terms in regression models).

Conclusion

The present study demonstrated not only the methodological difficulties, but also the feasibility of applying implicit measures in field studies with populations that have handled neither computers nor reaction-time tasks before. It provides a perspective on the usefulness of computerized assessment of psychological measures beyond clinical interviews and self-rating instruments. Yet, the attitudinal IAT was rather related to traumatic repercussions than aggression. Only psychological interventions that consider the fundamentally altered processing of violence cues (e.g., Hecker, Hermenau, Crombach, & Elbert, 2015) will help the successful reintegration of war-affected youth into civil societies.

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