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Visual attention in violent offenders: Susceptibility to distraction

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ABSTRACT

Impairments in executive functioning give rise to reduced control of behavior and impulses, and are therefore a risk factor for violence and criminal behavior. However, the contribution of specific underlying processes remains unclear. A crucial element of executive functioning, and essential for cognitive control and goal-directed behavior, is visual attention. To further elucidate the importance of attentional functioning in the general offender population, we employed an attentional capture task to measure visual attention. We expected offenders to have impaired visual attention, as revealed by increased attentional capture, compared to healthy controls. When comparing the performance of 62 offenders to 69 healthy community controls, we found our hypothesis to be partly confirmed. Offenders were more accurate overall, more accurate in the absence of distracting information, suggesting superior attention. In the presence of distracting information offenders were significantly less accurate compared to when no distracting information was present. Together, these findings indicate that violent offenders may have superior attention, yet worse control over attention. As such, violent offenders may have trouble adjusting to unexpected, irrelevant stimuli, which may relate to failures in self-regulation and inhibitory control.

1. Introduction

The quest for neuropsychological markers and predictors of violent behavior is ongoing. While important leads have emerged, it remains unclear which factors uniquely predict violence and violent recidivism. Violent offenders appear to have reduced control over behavior and impulses (Blair, 2001; Rogers, 2003) and are diagnosed with disorders that are characterized by this lack of control (Harris et al., 1993; Schroeder et al., 2013). In this light, the role of executive functioning in the general offender population has been extensively investigated (Morgan and Lilienfield, 2000; Ogilvie et al., 2011). Impairments in executive functioning are related to aggressive, antisocial behavior and impulsivity, to decreased self-control, socially inappropriate behavior and impairments in the ability to respond to punishment and reward (Morgan and Lilienfield, 2000; Ogilvie et al., 2011; Rogers, 2003; Seres et al., 2009). Deficits in behavioral control are reflected in poor performance on various executive measures of neuropsychological functioning (Meijers et al., 2015; Ogilvie et al., 2011), such as the Iowa Gambling task (Beszterczey et al., 2013). As such, impairments in executive functioning may increase the risk of antisocial behavior (De Brito et al., 2013; Ogilvie et al., 2011; Hoppenbrouwers et al., 2013).

Clarification of the contribution of specific neuropsychological factors may help better understand the risk for future antisocial behavior. As such, it is important to further disentangle different cognitive processes that are represented within executive functioning. Attention is a crucial element of executive functioning and is essential for cognitive control and goal-directed behavior (Hofmann et al., 2012). In fact, attention (together with (spatial) working memory) appears to have a strong relation to antisocial behavior (Ogilvie et al., 2011). The identification and selection of information in the visual environment is important to be able to act in a goal-directed manner (Theeuwes, 1993). As such, visual attention is important in processing information, and helps focus on relevant information, while ignoring information that is irrelevant (Theeuwes, 1992). This selection of information occurs in different ways. Traditionally, a distinction is made between bottom-up and top-down visual attention. For bottom-

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up attention, information is selected based on the physical salience of environmental stimuli, which may lead to involuntary attentional capture. Top-down attention pertains to the processing of information based on current goals. In general, it is presumed that various stimuli compete for attentional selection (Theeuwes, 1993).

An offender group that has been heavily researched in terms of attention is that of psychopathic offenders. Psychopathic offenders are characterized by chronic antisocial behavior and attitudes (e.g., irresponsibility, irritability, impulsivity (Hoppenbrouwers et al., 2015a)), in combination with interpersonal and affective personality traits, (e.g., a deceitful interpersonal style, callousness, emotional superficiality, lack of empathy) (Hare, 2003). The latter characteristics have been associated with superior selective attention whereas the impulsive and antisocial lifestyle is related to worse attentional performance (Baskin-Sommers et al., 2011, 2012). This has been explained by the response modulation theory that states that psychopathic individuals have difficulty adjusting their behavior once goal-directed behavior is initiated (Newman and Baskin-Sommers, 2011; Wallace et al., 1999; Baskin-Sommers et al., 2011, 2012; Wolf et al., 2012).

With exception of the specific subgroup of psychopathic offenders, research on attention in offenders is limited. Offenders have problems in attentional set-shifting (Bergvall et al., 2001; Dolan and Park, 2002; Dolan, 2012) and antisocial offenders show a stronger attentional bias toward violence related words (Domes et al., 2013). On the other hand, attentional problems may vary for subtypes of offenders; affective/ impulsive murderers perform poorer on different measures of attention compared to predatory/ planning murderers (Hanlon et al., 2013). Taken together, these studies show impairments in attentional functioning in offenders. However, different subgroups are included, or different measures of attention are used, which involve emotional stimuli or more complex processes (shifting). Therefore, the exact underlying problem remains obscure with visual attention not being investigated in violent offenders in general.

As knowledge regarding the role of attentional control in offenders is limited, we used a well-known attentional task to determine attentional functioning in violent offenders. Since problems in executive functioning (including attention) are mainly related to criminal behavior in general and not to specific disorders (Morgan and Lilienfeld, 2000; Rogers, 2003), we chose to focus on the population of violent offenders and not include specific subgroups in terms of diagnoses or specific offenses.

A group of offenders residing in Dutch forensic hospitals and a control group of healthy controls were compared on an additional singleton paradigm, to determine the interaction between bottom-up and top-down control of visual attention. In this task, participants are required to search for a unique shape (e.g., a diamond) among similarly colored but differently shaped elements (e.g., circles). In a subset of trials, one of the task-irrelevant elements had a different color, thereby briefly capturing attention (Theeuwes, 1992). Attentional capture by task-irrelevant stimuli is a measure of the influence that stimulus driven (bottom-up) attention has on goal directed (top-down) attention. Based on the literature reviewed above, we expected to find that offenders would be more prone to distraction (i.e., increased attentional capture) compared to healthy controls.

2. Methods

2.1. Participants

We recruited 62 offenders from 3 Dutch forensic psychiatric hospitals and 69 healthy controls from the community. With regards to the offender group, offenses included (serial) rape, (serial) murder, manslaughter, theft, breaking and entering, kidnap, grand larceny, extortion, (aggravated) assault and robbery. All offenders were currently incarcerated for a violent offense with a minimum sentence of at least 4 years under Dutch law. In The Netherlands, one can only be admitted to such a hospital after committing a violent offense. For this reason we opted to name the offender population 'violent offenders'. All participants had normal or corrected to normal vision. Exclusion criteria were comorbid neurological disorders, (e.g., epilepsy), psychotic disorders, bipolar disorder or color blindness.

Table 1
Demographic variables.

	Offenders M (SD)	Controls M (SD)
Age	46.48 (11.25) (n= 52)	30.72 (10.31) (n= 60)
IQ	95.21 (13.73) (n= 43)	107.38 (13.73) (n= 58)
Psychotropic medication	22.56% (n=43)	0%

In total 18 participants were excluded from the original 131 participants. In the analyses, 113 participants were included, 53 offenders and 60 controls. Three offenders were excluded from the analysis because they turned out to be colorblind or have other vision problems. Three participants (1 offender and 2 controls) were excluded because the data was not usable due to computer malfunction. Two participants (1 offender and 1 control) opted to quit the experiment. Two participants (1 offender and 1 control) did not perform the task correctly. One participant in the control group had had a severe accident in the past with loss of conscience. Finally, 7 participants (4 controls and 3 offenders) were excluded due to poor accuracy rates(< 75%).

The age of the participants ranged from 19 to 68 years (M=38.04, SD =13.03). The average age of the offenders is significantly higher than the age of the control group (see Table 1) (t=7.737; $p < .01$). The total IQ-scores were lower for offenders (see Table 1). An independent samples t-test indicated a significant difference in mean IQ-scores (t=4.252, $p < .01$). For 43 offenders (81.1%), information was available about the use of medication. 22.56% of this group used psychotropic medication.

2.2. Procedure

Offenders who were interested in participating were asked to sign a permission form for the release of file information. Next, a review of psychological and medical files was performed. When the file review indicated that offenders were generally eligible, they were contacted and the study was explained to them again. When they agreed to participate, they signed the informed consent and were enrolled in the study. Data concerning socio-demographic information, medication and psychological and medical information were gathered in the medical and psychological files of the offenders.

The control group was recruited from the community using (online) advertisements in different regions of the Netherlands, mostly Amsterdam. All participants were informed about the study orally and in writing.

The healthy controls were screened for neurological and psychiatric disorders, addiction and medication use, through a standard interview. After confirmed eligibility, an appointment was made for conducting the tasks. Upon arrival, participants signed an informed consent form. All participants received a financial compensation of €7.50. For offenders, the compensation was transferred to the hospital, which paid it to the offender.

All participants were explicitly instructed that they could terminate enrollment in the study at any moment without giving a reason for doing so. Well-trained and certified psychologists or psychological test assistants administered all tests.The study was approved by the local ethics committee and was in line with the declaration of Helsinki ("WMA Declaration of Helsinki - Ethical Principles for Medical Research Involving Human Subjects," 2013).

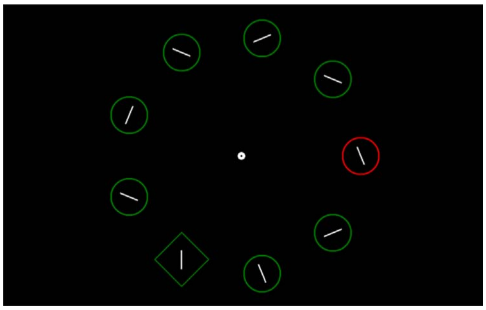

Fig. 1. Representation of the attentional capture task.

2.3. Instruments

For the offender group, intelligence quotient (IQ) had been previously measured with the Wechsler Adult Intelligence Scale-III (WAIS-III; Wechsler, 2001). For the control group, IQ was estimated via two subtests (i.e., vocabulary and matrix reasoning) of the WAIS-III. This short form has acceptable reliability and is a good abbreviated measure of the General Factor (Tellegen and Briggs, 1967).

2.3.1. Additional color singleton experiment

The additional color singleton task was used to measure processing of salient task-irrelevant stimuli (Theeuwes, 1992). In this task, participants search for a diamond among circles. The participants had to indicate whether the line in the diamond was horizontal or vertical. The lines in the circles were diagonal. Participants used the 'z'-key to indicate a horizontal line and the 'm'- key to indicate a vertical line (on a qwerty keyboard). In half of the trials, all elements had the same color (i.e., green). In the other half of the trials (36 trials), a distractor was present; one of the non-target circles was colored red, causing it to capture attention (see Fig. 1). Earlier research with this task has shown that the presence of the distractor increases reaction times and error rates which is the result of the capture of attention (Theeuwes, 1992).

The task started with 12 practice trials. Each trial started with a fixation dot that was presented for 600 ms. The 9 elements (8 circles and one diamond) were presented on an imaginary circle with a radius of 6.2 degrees visual angel. The circles were 1.9 visual degrees and the diamond was 2.8 visual degrees. The lines were white and were presented on a black background. Non-target line-orientations were randomly picked from the following orientations: 22.5, 45, 67.5, 112.5, 135 or 157.5 degrees. The display remained on the screen until a response was made, but no longer than 4 s. After an incorrect response, a red fixation dot was shown. After a correct response, a green fixation dot was shown.

2.4. Data reduction and statistical analyses

Data-analyses were conducted with SPSS 21. For all tests, the alpha level was set at .05. All reaction times below 200 ms were excluded. For each participant, all reaction times that were more than 2 standard deviations above their mean reaction time were excluded. This was done to prevent outliers to affect the mean too strongly. Consequently, 4,24% of trials had to be excluded, on average. Subjects that had less than 75% accuracy were excluded from the analysis. Only correct and non-practice trials were included in further analyses on reaction times.

We conducted a repeated measures General Linear model, with *condition* (distractor present versus distractor absent) as within subject factors and *group* (offender versus control) as between subject factors. IQ and age were entered as a covariate to check for the influence of intelligence and age. In addition, to control for the use op psychotropic medication, medication was entered as a between-subjects variable for the offender group. These analyses were conducted for both reaction time and accuracy. Effect sizes are reported in terms of partial eta squared (partial n^2); partial n^2 of .01 are considered small; medium =.06; large =.14. Prior to any analyses it was hypothesized that offenders would be more susceptible to distraction, compared to controls. This hypothesis follows logically from the literature that was reviewed in the Introduction and allows for one-tailed testing. Planned comparisons of within-subject and between-subject differences were done via *t*-tests.

Table 2
Reaction time in milliseconds and accuracy in % correct responses.

	Offenders (n=53) M (SD)	Controls (n=60) M (SD)
RT distractor absent	873.93 (177.77)	869.51 (223.97)
RT distractor present	902.84 (199.67)	908.84 (241.38)
Accuracy distractor absent	98.38% (2.64)	95.59% (4.67)
Accuracy distractor present	96.75% (5.25)	95.46% (5.04)

3. Results

3.1. Reaction times

A repeated measures General Linear Model with *condition* (distractor present vs distractor absent) as within subjects variable and *group* (offender vs control) as between subjects variable showed a significant main effect for distractor presence, with a large effect size (F (1, 111)=21.96, $p < .001$, partial η^2=.165). Reaction times were higher in the distractor present condition than in the distractor absent condition (see Table 2 and Fig. 2). There was no main effect of group (F (1, 111) < .001, p=.984, partial η^2 < .001), indicating that both groups had comparable reaction times. There was no interaction effect between condition and group (F (1, 111) =.511, p=.476, partial η^2=.005).

A second GLM with *condition* as within subjects factor, *group* (offender vs control) as between subjects variable and *IQ* as covariate showed no interaction between condition and IQ (F (1, 98=.454, p=.502, partial η^2=.005). This indicates that IQ does not influence the interference by a distractor.

A third GLM with *condition* (distractor present vs distractor absent) as within subjects variable, *group* (offender vs control) as between subjects variable and *psychotropic medication* (yes vs no) as between subjects factor was conducted. There was no significant interaction effect (F (1, 41)=.151, p=.228) partial η^2 =.035). This indicates that psychotropic medication does not influence reaction times.

Fourth, a repeated measures GLM with *condition* (distractor present vs distractor absent) as within-subjects variable, *group* as between-subjects and age as a covariate showed that *age* did not interact with condition in terms of reaction times, (F (1,109) =2.454,

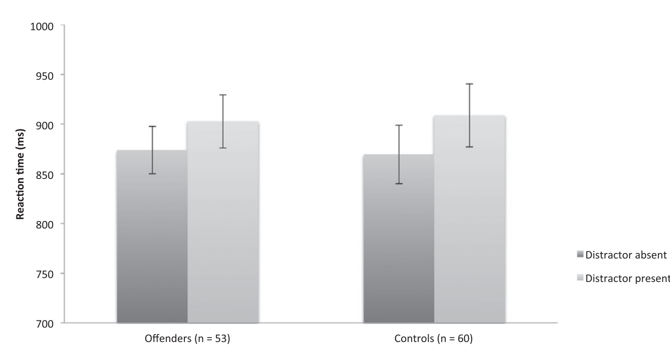

Fig. 2. Reaction times are higher in the distractor present condition than in the distractor absent condition for both offenders and controls. There are no significant group differences. Error bars reflect standard error of the mean (SEM).

p=.120). This shows that age does not affect the degree to which the distractor slows down reaction time. With age as a covariate, the interaction between *condition* and *group* is marginally significant (F(1,109) =3.116, p=.08).

3.2. Accuracy

A repeated measures General Linear Model with *condition* (distractor present vs distractor absent) as within subjects variable and *group* (offender vs control) as between subjects variable, showed a main effect for condition (F (1, 111)=5.279, p=.023, partial η^2=.045). In addition, a main effect of group was observed (F (1, 111)=7.289, p=.008, partial η^2=.062). This between-subjects comparison showed that, over both conditions, offenders were more accurate than controls. There was a near significant interaction effect between condition and group (F (1, 111)=3.786, p=.054, partial η^2=.033). Post hoc t-tests showed that offenders were more accurate than controls in the distractor absent condition (t *(111)*=3.963; $p < .001$), but not in the distractor present condition (t (111)=1.333; p=.185). Compared to when not distractor was present, the accuracy of offenders decreased in the distractor present condition (t (111)=2.726; p=.009), whereas the accuracy of controls remained equal (t (111)=.274; p=.785) (see Table 2 and Fig. 3).

A second GLM with *condition* as within subjects factor, *group* (offender vs control) as between subjects variable and *IQ* as covariate showed no interaction effect between *condition* and IQ (F=(1,98) =.904, p=.344, partial η^2=.009). This indicated that IQ does not influence accuracy.

A third GLM with *condition* (distractor present vs distractor absent) as within subjects variable, *group* (offender vs control) as between subjects variable and *psychotropic medication* (yes vs no) as between subjects factor was conducted. There was no significant interaction effect (F (1, 41)=.001, p=.975, partial η^2=.000). This indicated that psychotropic medication did not influence accuracy.

Finally, a repeated measures GLM with *condition* as within subjects factor, *group* (offender vs control) as between subjects variable and *age* as covariate showed no interaction effect between condition and age (F(1,109)=.319, p=.574) indicating that age does not affect the degree to which participants make erroneous responses when a distractor is present. The interaction between condition (distractor absent vs present) and group (offenders vs controls) is marginally significant F(1,109)=3.116, p=.08.

3.3. Speed-accuracy trade-off

We did not observe a speed-accuracy tradeoff (calculated by a correlation between the difference in conditions for reaction time and accuracy, respectively) in the control group (r=−.041, p=.755). There was a significant correlation in the offender group (r=.336, p=.014). However, this correlation showed that offenders that became slower by

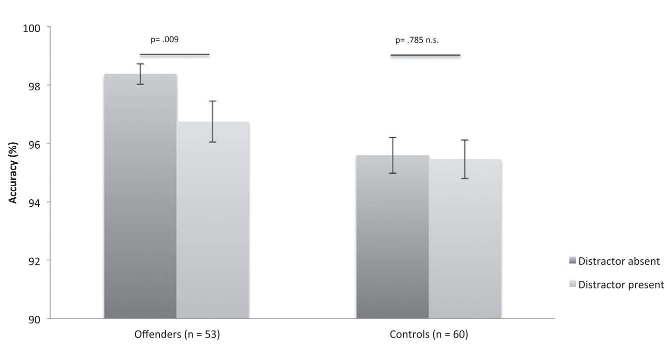

Fig. 3. Offenders are more accurate than controls. Only for offenders, accuracy decreases in the disctractor present condition. Error bars reflect standard error of the mean (SEM).

the distractor also made more errors when the distractor was present.

4. Discussion

The current study investigated the role of visual attention in violent offenders. There were two main findings. First, compared to healthy controls, violent offenders showed more erroneous responses when the distractor was present compared to when it was absent. Second, in terms of reaction times there were no differences between offenders and controls. For both groups reaction times increased when a distractor was present, demonstrating the well-known attentional capture effect (Theeuwes, 1992, 2010).

As noted, we did not find differences in speed (e.g. reaction time) between offenders and controls. In terms of accuracy, however, the current study shows that offenders are affected more strongly by a distractor than controls, even though offenders were more accurate overall. Also, offenders were significantly more accurate than controls when no distractor was present. While controls did not become less accurate in the presence of a distractor, violent offenders did show this pattern. This high accuracy in the absence of distracting information may suggest that violent offenders have superior attention. However, control over attention in violent offenders may suffer in the presence of distracting information. In turn, this may have consequences for the efficacy of inhibitory control.

Worse control over attention is likely to have consequences for how offenders navigate their environment and may result in problems in self-regulation in the presence of distracting information. This result corresponds with earlier research that shows that offenders make more errors than other subjects on different measures of executive functioning. For instance, impairments in attentional set shifting and inhibition have been found (Bergvall et al., 2001; Dolan and Park, 2002; Dolan, 2012) suggesting offenders may have trouble adjusting to unexpected or irrelevant stimuli. Also, attention has been found to be related to self-regulation and there is evidence that impairments in attention might lead to failure of inhibitory control in offenders (Bergvall et al., 2001; Hofmann et al., 2012). Indeed, as an increased error rate on executive functioning tasks is related to impulsivity, increased violence and more severe offenses (Hancock, Tapscott and Hoaken, 2010). So, inhibitory control is likely to consist of multiple cognitive functions, such as working memory and (top-down and bottom-up) attention, and abnormalities in one cognitive function will have consequences for the efficacy of inhibitory control. Our data add to this body of literature showing that violent offenders may have superior attention, reflected in higher overall accuracy, but have inadequate control over attention. Taken together, this suggests that offenders are insufficiently able to monitor and correct their own behavior, potentially contributing to a lack of inhibitory control.

It should however also be noted that it is possible that offenders were more motivated to perform well, resulting in higher levels of overall accuracy. In recent years, research on the effect of motivation (Engelman et al., 2009) and value-laden stimuli (i.e., rewards, threats) on attention has soared. These value-driven effects may both be bottom-up (Bucker and Theeuwes, 2016; Munneke et al., 2015; Schmidt et al., 2015), top-down (Libera and Chelazzi, 2006), or related to personality traits (Hickey et al., 2010). The current data do not conclusively rule out the possibility that other factors such as motivation account for the higher overall accuracy in violent offenders.

In the further interpretation of the results, four issues deserve attention. First, it should be noted that participants always received real-time feedback as to whether their response was correct. This feedback may have affected arousal states, which subsequently could have influenced the way the distractor was processed. This process may differ between offenders and healthy controls. In other words, real-time feedback could be a potential confound. Unfortunately, feedback was provided after every trial, which makes it difficult to draw a conclusion as to the direction of this potential effect. Externalizing psychopathology, which is typically high in offenders, has however been linked to reduced error-related negativity (Hall et al., 2009). This would suggest that offenders process errors to a lesser degree, which would contradict the idea that offenders are more alert to errors in lieu of feedback. Future research could account for this potential influence by adding a condition in which no feedback is presented.

Second, it is important to note that in the current study, reaction times were higher compared to earlier research with a similar task (Theeuwes, 1992, 2010). Typically, these reaction times are around 600 ms, whereas the marginal means were 871 ms (distractor absent) and 905 ms (distractor present) in the present study. These higher reaction times that we observed here may be accounted for by the nature and age of the sample. First, this is the first study that used a visual search task in offenders and therefore we cannot compare our results with a similar group of violent offenders. The carefully selected control group consisted of a community sample that also included people that are not used to psychological testing and have lower education levels. Higher response times might also be representative for offenders and a result of a prolonged antisocial lifestyle accompanied by for instance drug abuse and trauma capitis. In addition, most visual attention studies make use of young highly educated undergraduates whereas in this community sample the average age was 36 years. As reaction times increase when subjects get older, this may also account for the higher reaction times. However, it is crucial that both groups showed attentional capture, indicating that experimental manipulation was successful.

Third, attention research in the general offender population is rather scarce, with the exception of psychopathic offenders. The primary focus of the current manuscript was on the relationship between a crucial element in executive functioning (i.e., attention) and offending/ antisocial behavior in general. Psychopathic offenders are a specific subgroup and have a very specific set of attentional abnormalities. The relationship between psychopathy and attention has been addressed in other papers (Hoppenbrouwers et al., 2015a, b, 2016). In these papers it was shown that psychopathy is related to abnormalities in top-down attention and selection history, but not to abnormalities in bottom-up attention, which was shown in an offender sample and replicated in a community sample (Hoppenbrouwers et al., 2015a, b, 2016). We can therefore be certain that the degree of psychopathy does not influence the current results.

Last, it was found that neither IQ, age or the use of psychotropic medication influenced attention. This matches earlier research that has shown that intelligence is not related to executive functioning deficits (Bergvall et al., 2001), although offenders in general have lower IQ scores than controls (Morgan and Lilienfield, 2000; Ogilvie et al., 2011), which was also observed here. In addition, depending on the type of medication, drugs may either have a negative or positive influence on attention. For instance, methylphenidate has been linked to improved response inhibition (Pauls et al., 2012) whereas other psychotropic medication, such as antidepressants or anxiolytics might negatively influence attention. Here, no effect of medication effect was found. However, because limited information on medication use was available, it was not possible to look at the effect specific types of drugs on attentional performance. Further research is needed on the specific effects of different types of psychotropic medication on attentional performance.

In sum, the current study shows that offenders are more sensitive to distracting information as they showed more errors in the condition in which a distractor was present than when it was absent.

Conflict of interest

The authors report no conflict of interest.

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