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Anabolic-Androgenic Steroids, Violence, and Crime: Two Cases and Literature Review

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Abstract

Background and Objectives: Anabolic-androgenic steroid (AAS) use has become a major worldwide substance use disorder, affecting tens of millions of individuals. Importantly, it is now increasingly recognized that some individuals develop uncharacteristically violent or criminal behaviors when using AAS. We sought to summarize available information on this topic.

Methods: We reviewed the published literature on AAS-induced behavioral effects and augmented this information with extensive observations from our clinical and forensic experience.

Results: It is now generally accepted that some AAS users develop uncharacteristically violent or criminal behaviors while taking these drugs. Although these behaviors may partially reflect premorbid psychopathology, sociocultural factors, or expectational effects, accumulating evidence suggests that they are also attributable to biological effects of AAS themselves. The mechanism of these effects remains speculative, but preliminary data suggest a possible role for brain regions involved in emotional reactivity, such as the amygdala, and regions involved in cognitive control, including the frontal cortex. For unknown reasons, these effects appear idiosyncratic; most AAS users display few behavioral effects, but a minority develops severe effects.

Conclusions: Professionals encountering AAS users in clinical or forensic settings should be alert to the possibility of AAS-induced violence or criminality, and should employ strategies to assess whether AAS are indeed a contributory factor in a given case.

Scientific Significance: Further research is needed to elucidate the mechanism of AAS-induced violence and to explain why only a subset of AAS users appears vulnerable to these effects.

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Declaration of interest: Dr. Pope has occasionally treated or consulted on anabolic-androgenic steroid users in his private medical practice and has testified as an expert witness approximately once per year on steroid-related cases in his private forensic practice. The two cases described in this paper were both drawn from Dr. Pope's forensic practice. Dr. Hudson has received consultation fees from Shire, Sunovion, and Idorsia and has received research grant support from Sunovion. Drs. Kanayama and Kaufman declare no conflicts of interest.

In recent decades, the non-medical use of anabolic-androgenic steroids (AAS) – testosterone and its synthetic derivatives – has emerged as a worldwide public health issue. Today approximately 3-4 million individuals in the United States and tens of millions worldwide have used these drugs for athletic purposes or simply to enhance personal appearance.^{1, 2} About 98% of all AAS users are male,¹ and thus the following discussion refers to male AAS users unless otherwise specified.

Although AAS were used by elite athletes as early as the 1950s, it was not until the 1980s in the United States and the 1990s elsewhere that AAS use spread into the general population.³ Thus, our knowledge of the adverse effects of AAS is derived primarily from studies in just the last 3-4 decades. Among these studies are reports of violent or criminal behavior associated with AAS use. In the following paper, we present two forensic case examples, provide an updated review of the relevant literature, and discuss potential strategies for approaching cases in forensic or clinical settings where violent or criminal behavior has been associated with AAS use.

Case examples

We begin with two accounts of men who committed serious crimes while using AAS. One of the authors (HGP) performed forensic evaluations of both men and testified on their behalf at subsequent court proceedings.

Case 1

Mr. A is a 58-year-old man. As a child, he was small for his age, stuttered at times, and was often bullied. At age 11, he was sexually abused regularly for a year by a faculty member at boarding school. By high school, he finally began to develop self-esteem as an accomplished soccer player, and at age 15 first used AAS. In his 20s, fellow AAS users introduced him to the male stripper/exotic dancer industry, and he was financially successful in this business, touring the country over the next 15 years. He continued to lift weights and use AAS to maintain good physical shape and succeed in the “club scene.” By his 40s, he became less successful in the club scene and faced increasing financial difficulties. He began to live out of his van and delivered pizzas to make money while continuing to take AAS intermittently. On interview, he reported that his perception was that when using these drugs, he occasionally “mouthed off,” “joked,” or “kidded around,” whereas others perceived him as hostile – resulting in suspensions, transfers to less desirable positions, or outright termination of employment.

At age 56, Mr. A secured a job as a bouncer at a gentlemen’s club and wanted to “bulk up” quickly, stating that “in gentlemen’s clubs, size and image is everything.” Using substantial doses of AAS, he soon achieved a bench press of almost 495 pounds – a remarkable weight for a man of his age. While taking high-dose AAS, he reported that he felt “invincible,” stating that “nothing could harm me, and I did not need to bow to anyone.” He also developed marked irritability. As a strong supporter of President Trump, he became infuriated with what he perceived as the left-wing bias of the media. He covered his van with Trump stickers and posters, and became increasingly obsessed with left-wing “bias,” to the point that he could think of little else. He resolved to do something to scare or deter

prominent individuals on the political left. Accordingly, he obtained fireworks, created crude inoperable devices that looked like pipe bombs, and mailed them to numerous major public figures, including Barack Obama, Hillary Clinton, George Soros, and Robert De Niro. He reported that it never occurred to him that there might be serious consequences to these actions, because he felt “invincible.” He even sent a boastful text to his AAS dealer with a link to a New York Times article regarding the package sent to George Soros’ house.

The “mail bomber” story quickly made national news. A few nights later, as Mr. A was watching television, a federal official appeared on the screen and assured the public that the full resources of the United States government and the Federal Bureau of Investigation would be devoted to a manhunt for the culprit. In a sudden moment of shock, Mr. A realized, “good God, that’s me!”

Mr. A was quickly apprehended and incarcerated. With the abrupt discontinuation of AAS, his feelings of invincibility vanished, and he looked back with disbelief on what he had done. Although he had a history of a few petty crimes (e.g., shoplifting) in the past, he had never committed a crime even remotely comparable to mailing the decoy “bombs.” In a report and subsequent testimony, HGP opined that Mr. A would not have committed the crime had he not been ingesting high-dose AAS at the time. Although the government sought a life sentence, Mr. A received a prison sentence of 20 years, which was judged by his legal team to represent a relatively lenient outcome that resulted in part from consideration of the mitigating effect of AAS.

Case 2

Mr. B, now 50 years old, was an aspiring young athlete at a secondary school with a very successful football program when he first used AAS. On a forensic psychiatric interview, he reported that his most serious crime prior to AAS use was stealing a pack of chewing gum from a convenience store. He reported no prior history of any psychiatric disorder, nor of any violent or unusually aggressive behavior. Indeed, he stated that he deliberately avoided associating with other teenagers who were known for getting into trouble.

When he was age 15, older football players at his local gymnasium introduced him to AAS, and with these drugs he gained 20 pounds of muscle in a few months. On AAS, he noticed increased self-confidence, and he became obsessed with the idea that he needed to buy “throws” (beads that one tosses into the crowd from a Mardi Gras float) to impress his girlfriend. To get the money, he resolved to break into a seemingly unoccupied house to steal valuables. He reported that on AAS, he felt that no one could harm him, and that he never even considered that there would be any consequences.

Mr. B pried open a window with a hunting knife, began searching the house, and was shocked when the owner suddenly appeared, confronted him, and attempted to restrain him. He stabbed the owner approximately nine times with the hunting knife, concluding by slitting his throat, resulting in his death. He then heard the owner’s wife in a neighboring room attempting to call the police. He ran into her room, grabbed the telephone from her hand, and stabbed her multiple times, again concluding by slitting her throat, resulting in death. He then left the house with the owner’s credit card and, a day or two later, began to

use the card to buy throws for the parade. He stated that it never occurred to him at the time that he would be apprehended, because he was “invincible.”

Mr. B was quickly apprehended and sentenced to life in prison. Once incarcerated and no longer exposed to AAS, he promptly reverted to his original benign personality and went on to exhibit a prison record that included numerous commendations and awards for activities that he performed there as well as a virtual absence of reprimands or discipline from prison authorities. He reported that he felt deep remorse for his actions and could not comprehend how he could have committed such a crime.

At a hearing in 2019, numerous witnesses, including even children of one of the victims, testified to Mr. B’s good character. HGP testified that the crime would not have occurred but for Mr. B’s ingestion of AAS. The judge ruled that Mr. B’s sentence of life without the possibility of parole be vacated, making him eligible for parole. In June 2020, Mr. B received a parole hearing and was released from prison. Mr. B did not appear to have developed an AAS dependence syndrome⁴ when using these drugs as a teenager, but the parole board required that he attend online Alcoholics Anonymous meetings following his release to better understand the issues of addiction. Although Mr. B would likely be at increased risk for another crime if he were to again use AAS, the parole board elected not to require him to undergo periodic random AAS testing.

The association of AAS with violent or criminal behavior: the data

Observational studies

Starting in the 1980s, anecdotal reports first suggested that AAS might cause some individuals to develop “manic” or “hypomanic” syndromes, characterized by exaggerated self-confidence, hyperactivity, irritability, impaired judgment, aggression, violence, and rarely even psychotic symptoms such as paranoid and grandiose delusions.^{5, 6} Other early reports suggested that some individuals could develop depression during AAS withdrawal, with symptoms of depressed mood, fatigue, impaired sleep and appetite, and sometimes suicidal ideation or actual suicide attempts.⁷⁻⁹ By the late 1980s, our group reported similar syndromes in a sample of 41 AAS users evaluated using structured clinical interviews^{10, 11} and subsequently reported comparable findings in a comparison of 88 AAS users and 68 non-AAS-using weightlifters.¹² From the 1990s to the present, numerous additional case reports and field studies, using psychological rating scales or structured interviews, have reported increased hostility, anger, and various other measures of pathology among men currently taking AAS or withdrawing from AAS, as compared to AAS users during off-drug intervals or as compared to non-users.¹³⁻³⁷ Studies using anonymous questionnaires³⁸⁻⁴³ or epidemiological data^{19, 20, 44-46} have also reported similar associations between AAS use and hostile, aggressive, or violent attitudes or behaviors. These studies have been summarized in various review articles^{2, 47-55}. Importantly, it appears from this literature that these effects are idiosyncratic, in that most AAS users appear to experience few psychiatric effects, while a minority of users experience prominent effects with severe changes in mood or personality.^{2, 56}

Among these many reports, a number have presented cases of violent or criminal behavior in men exposed to AAS. For example, several publications have described men with little or no history of violence or criminal behavior prior to AAS use who committed murder or attempted murder while using AAS.^{14, 57-59} Additional papers have reported violent or criminal behavior by AAS users that appeared entirely uncharacteristic of their premorbid personalities.⁶⁰⁻⁶² Another paper described two murders in Australia apparently associated with AAS use, prompting the suggestion that violent offenders be routinely tested for AAS.⁶³ A review article⁵² mentioned six cases of AAS-induced violence seen personally by the authors, involving three homicides and three violent assaults. These men were described as exhibiting “stereotypic qualities of irritability, aggressiveness, and grandiosity.” The authors reported that all six men returned to a normal mental status within two months of stopping AAS. Another study in Sweden evaluated 32 AAS users seeking treatment and also accessed their criminal records; in comparison to other drugs of abuse, AAS use proved to be associated with a greater frequency and severity of violent crimes.⁶⁴

Although the weight of this evidence strongly suggests an association between AAS use and aggressive or violent behavior, one might still question whether this is a *causal* association. For example, it has been argued that aggressive behaviors might be potentiated by peer influences or expectational factors arising from the AAS-using subculture, rather than by a biological effect of AAS themselves.^{33, 65-67} Also, individuals with pre-existing aggressive tendencies, or with childhood conduct disorder, adult antisocial personality disorder, and other forms of psychopathology, might be more likely to use AAS than individuals lacking such premorbid features.³⁹ Thus, aggressiveness might lead to AAS use rather than AAS to aggression. In addition, AAS users often ingest other types of drugs, including alcohol, opiates, cocaine, and others⁶⁸⁻⁷² – and these other drugs might contribute substantially to the behavioral changes observed.⁴¹ However, as illustrated in a recent analysis using directed acyclic graphs,⁷³ the causal pathways among AAS use, other substance use disorders, and antisocial behaviors are complex, and thus cannot easily be untangled by simply adjusting for confounding factors.

On the other hand, several observations weigh in favor of a causal role for AAS in aggressive behaviors. For example, many of the case reports cited above described individuals with no apparent prior history of psychopathology, violence, or criminal activity who displayed striking behavioral changes coincident with an episode of using AAS, and remission of these effects when AAS were discontinued. We are also aware of three cases of monozygotic twins who had similar weightlifting experience, but where one twin in each pair used AAS and the other did not. In one case, the AAS-using twin abducted and shot a woman (who survived) while on a course of AAS; his co-twin reported no history of violence or criminality.⁵⁸ In the other two cases, the AAS-using twins displayed markedly elevated measures of hostility, aggressiveness, and paranoid ideation on two psychometric instruments when taking AAS as compared to their non-using co-twins.²⁷

Controlled Trials

Placebo-controlled laboratory studies: Probably the best test for establishing a causal role of AAS is through placebo-controlled trials. In the early 1990s, a few such trials

assessed psychological measures in volunteers receiving doses of testosterone up to 300 milligrams per week under blinded conditions. One trial reported no effect of testosterone, 280 mg per week sublingually, on a mood checklist,⁶⁷ the second mentioned only transient “minor behavioral alterations” in one of 10 men receiving testosterone enanthate, 300 mg per week,⁷⁴ and a third reported significant increases in Minnesota Multiphasic Personality Inventory scale scores for “hostility” and “resentment and aggression” among men receiving 100 mg and 300 mg per week of either testosterone or nandrolone esters.⁷⁵ However, the doses used in these three studies are well below those used by most AAS users in the field, who often ingest more than 1000 mg per week of testosterone equivalent.^{11, 12, 18, 76-78} Therefore, these early laboratory studies provide little evidence of the psychiatric effects of AAS as they are actually used in the field.

We are aware of four placebo-controlled studies in normal volunteers using higher doses of AAS in which psychological measures were reported. These studies administered maximum weekly doses of 500 mg,⁷⁹ 600 mg,⁸⁰⁻⁸² and 1440 mg⁸³ of testosterone or equivalent. A fifth blinded study⁸⁴ administered testosterone 600 milligrams per week to 13 men but did not provide data from psychological measures. Collectively, the four evaluable studies evaluated 109 men; five (4.6%) developed hypomanic or manic syndromes during blinded AAS administration, whereas none showed such syndromes on placebo. In one of these studies,⁸³ one of the 20 volunteers, a man with no prior psychiatric history, became so aggressive during blinded AAS administration that he was placed in a seclusion room. In another study,⁸¹ a previously asymptomatic man became so aggressive on 600 milligrams per week of testosterone that he frightened people at his job and needed to be withdrawn from the study for safety. In the course of this latter study, the investigators also administered the Cherek Point Subtraction Aggression Paradigm⁸⁵ to a subgroup of the study participants.⁸⁶ In this protocol, the participant played a “game” on a computer against an unseen opponent. The participant could press a button to accumulate points exchangeable for money (the “non-aggressive” response) or press another button to subtract points from his opponent (the aggressive response). In fact, the unseen “opponent” was a computer program that deliberately subtracted points from the participant in order to provoke an aggressive response. In this protocol, participants displayed strikingly and significantly higher levels of aggression when receiving 600 milligrams per week of testosterone as compared to placebo.

It should be considered that these studies likely underestimated the frequency of AAS-induced manic or hypomanic syndromes or of AAS-induced aggression and violence as they occur in the field. First, three of the four studies used maximum weekly doses of only 500-600 mg of testosterone – doses still below those commonly used by many AAS users under natural conditions. Second, subjects in the studies were screened to exclude individuals with significant premorbid psychiatric disorders – but AAS users in the outside world are not subject to such screening.

Recently, other studies using single-dose testosterone under blinded conditions have further suggested that testosterone plays a causal role in human psychological responses. One group has shown that men receiving testosterone exhibited significantly greater anger in response to both social⁸⁷ and non-social⁸⁸ provocations than those receiving placebo.

In another study,⁸⁹ testosterone significantly reduced scores on the Cognitive Reflection Test, indicating a decreased ability to override false intuitive judgments with deliberate correct responses. found that exogenous testosterone rapidly increased aggressive behavior in another study,⁹⁰ but only among men with dominant or impulsive personality styles. Another study⁹¹ found that testosterone increased aggression in response to provocation, but also increased generosity if this action was perceived as enhancing social status. Conversely, one group⁹² using an ultimatum game questioned whether testosterone genuinely increased aggressive behaviors. In interpreting these results, however, it should be recognized that these single-dose studies produced much lower testosterone levels than those typically achieved by illicit AAS users in the field.

Summary

The accumulated evidence shows that high doses of AAS can cause some individuals, albeit a minority, to develop substantial personality and mood changes, and to display aggressiveness, violence, or criminal behavior that appears entirely different from their usual personalities. This effect likely has a biological basis, and apparently cannot be explained merely by premorbid psychopathology, sociocultural influences, or expectational effects. Indeed, as early as 2003, one group of investigators concluded that "... after considering the breadth of the anabolic steroid scientific literature, it would seem that the finding that AS [anabolic steroids] promote aggression meets the Daubert criteria [the American legal standard indicating that a concept is sufficiently scientifically established to be admissible in court testimony]."³¹ In the 17 years since this paper was published, the literature has continued to support this conclusion.

Biological mechanisms of AAS-induced aggression

Neuroimaging findings offer plausible biological mechanisms underlying AAS-induced aggression and violence. The amygdalae – groups of small nuclei in the right and left anterior temporal lobes – play key roles in emotion regulation and in the control of aggressive behaviors.⁹³ The amygdalae are structurally and functionally connected with parts of the frontal cortex involved in executive function and so-called top-down cognitive control, which normally limits aggression and violence.⁹³ We have reported right amygdala enlargement in long-term AAS users, and on functional MRI (fMRI), these same subjects exhibited reduced intrinsic resting state (task-independent) right amygdala connectivity with the frontal cortex.⁹⁴ These structural and functional connectivity abnormalities may reflect impairment of the amygdala-frontal cortex circuit in AAS users, which could attenuate top-down cognitive control and regulation of amygdala activity and reactivity. Amygdala enlargement and frontal cortex shrinkage are associated with violent behavior in humans⁹⁵ and reduced resting-state fMRI connectivity between the amygdala and frontal cortex is associated with increased risk for reactive violence.⁹⁶ A subsequent resting state fMRI connectivity study of Norwegian AAS users similarly reported impaired amygdala functional connectivity with the default mode brain network,⁹⁷ a network active during passive rest and mind wandering. In this AAS cohort, structural MRI failed to detect overall amygdala enlargement, but the study did not specifically analyze for a right-lateralized amygdala volume abnormality.⁹⁸ Thus, two independent studies suggest that amygdala

connectivity may be impaired by AAS in ways that could reduce cognitive control over aggressive and violent behaviors.

Additional neuroimaging data in humans and postmortem data from animals also suggest that levels of testosterone and other AAS affect amygdala volume and connectivity. For example, testosterone levels predict right amygdala volume in boys⁹⁹ and in adult men.¹⁰⁰ In adult male rats, medial amygdala volumes were lower in castrated animals, an effect that was abolished by testosterone replacement.¹⁰¹ In healthy adult men undergoing short-term chemical androgen deprivation treatment, testosterone replacement increased amygdala fMRI reactivity to angry faces versus amygdala reactivity during chemical deprivation.¹⁰² Further, the testosterone/epitestosterone ratio, higher levels of which reflect current exogenous testosterone use, was inversely associated with amygdala-default mode network resting-state fMRI connectivity.⁹⁷ These investigators also showed that amygdala-DMN connectivity was lower in active (“on-cycle”) AAS users than in past or off-cycle users. In addition, acute low-dose androgen supplementation rapidly abolished right amygdala-right dorsolateral prefrontal cortex bidirectional fMRI connectivity in healthy men.¹⁰³ Thus, in males, amygdala structure, reactivity, and functional connectivity with other brain circuits appear to be determined by current androgen levels. Collectively, these findings support the possibility that the abnormally high testosterone and other androgen levels attained during AAS use could alter brain structure and connectivity. Of course, other brain regions and circuits are involved in violence and aggression⁹⁶ and may also contribute to increases in these behaviors in AAS users.

Forensic and clinical considerations

Establishing that an individual was actively using AAS

Despite the accumulated psychological evidence that AAS may increase the risk for violence or criminality, together with evolving theories of plausible biological mechanisms for these effects, it may be difficult to establish causality in the specific case of an individual AAS user presenting for forensic or clinical evaluation. First, one must establish that the individual was actually ingesting AAS at the time that the behavior occurred. AAS are typically used in courses or “cycles,” with off-drug intervals in between.² Thus, even if a man is known to be an AAS user (e.g., because he exhibits muscularity above the upper limit naturally attainable^{104, 105}), one must still ascertain that he was actually on-cycle when the behavior occurred, because there is little evidence that such reactions can occur off-cycle. His own word in this respect may not be trustworthy. False-negatives may arise because men often deny their AAS use to clinicians,¹⁰⁶ and false-positives may occur in forensic settings where a man may falsely claim AAS use in the hopes that an AAS defense might represent a mitigating factor in his ultimate criminal penalty.

Current AAS use is best established by urine testing, but this is an expensive procedure available in only a few specialized laboratories. Moreover, urine may be positive for AAS for weeks or even months after last use, and thus does not prove contemporaneous use. In addition to prominent muscularity, observations of truncal acne or gynecomastia on physical examination may suggest AAS use, as do various laboratory findings, such as greatly reduced HDL cholesterol, elevated hematocrit, and abnormal serum testosterone levels,²

as well as decreased sex hormone binding globulin (SHBG), which is markedly depressed during AAS use and remains depressed even for months after AAS are discontinued.¹⁰⁷ Again however, none of these tests proves contemporaneous use, and thus one must still rely on the individual's own report, perhaps supplemented by outside witnesses or external corroborating evidence (e.g., syringes, bottles of AAS preparations, etc.).

This task becomes more challenging in forensic settings where an individual reports AAS use at the time of a crime committed months or even years earlier. If by chance routine laboratory tests were conducted at that time, some of the abnormalities listed above may be found. Otherwise, a retrospective diagnosis of AAS use must rest largely on individual reports, together with any forensic evidence obtained at the time.

Establishing that the individual's behavior on AAS was markedly inconsistent with his baseline personality

Even if an individual was unequivocally using AAS during an episode of violent or criminal behavior, one still cannot postulate a causal role for AAS unless it can be shown that such behaviors occurred exclusively at a time or times when he was exposed to AAS, and not at times in the absence of AAS. Such an evaluation requires a detailed psychiatric interview, review of any records from contact with mental health professionals and other clinicians, an assessment of any criminal record, and if possible, corroboration from impartial outside observers who have known the individual over the long-term. In addition, one must establish that there were no other influences besides AAS (e.g., alcohol intoxication) at the time of the behaviors. In some instances, such as the two cases presented above, the AAS-associated behaviors are so inconsistent with the individual's baseline personality (as assessed both before and after AAS exposure) that one is left with the impression that other plausible contributing factors could not fully explain the criminal behavior. In other cases, however, a prior psychiatric or criminal history may cast doubt on whether AAS was a contributory agent.

Possible clues to a causative role of AAS in cases of violence or criminality

Over the last three decades, we have anecdotally noted several stereotypic features of AAS-induced violence or criminal behavior that appear in multiple cases. These features may contribute to an evaluator's index of suspicion.

Obsessionality: Since severe AAS-induced violence or criminality is uncommon, many clinicians have never directly encountered this phenomenon, and therefore they may misunderstand the nature of these effects. This misunderstanding is partially perpetuated by the common but non-scientific term, "roid rage," which might seem to suggest that AAS users display abrupt outbursts of temper or sudden acts of violence. Although such behaviors may occur, it is more common that AAS users report a "slow boil" rather than a sudden outburst. More specifically, they frequently describe chronic obsessional preoccupations that they cannot get out of their heads – such as Mr. A's fixation on left-wing "media bias" or Mr. B's obsession with getting money to buy throws. Other examples include one AAS user who described an instance where he ordered pancakes and specified that he did not want butter. The waitress nevertheless automatically brought butter with the pancakes. He

reported that for days afterwards, he found himself constantly preoccupied with this error, even waking up in the middle of the night and angrily thinking “but why did she bring me butter when I had *specifically* explained that I did *not want butter?*” He recalled no comparable obsessions at times when he was not using AAS. In another case we presented in an earlier paper (“Mr. A” in reference 57), a man using AAS was driving to work to start his shift as a prison officer. He experienced car trouble and borrowed the telephone at a nearby store to call explain that he would be late. The lady managing the store joked, “you officers use my phone so often I ought to start charging for it!” After leaving the store, Mr. A began to obsess about this remark, feeling that the clerk had belittled him. The angry obsessions continued through the night; he had trouble sleeping and his wife could not reassure him. The next day he returned to the store, forcibly abducted the clerk into his car, and then shot her with his service revolver when she jumped out and tried to escape (she survived). He was soon apprehended and incarcerated. In prison, and discontinued from AAS, he promptly returned to his mild-mannered baseline personality. On interview at a later date, he reported no history of a psychiatric disorder, violent behavior, or criminal activity prior to the incident.

Anosognosia: The term “anosognosia” was coined by neurologist Joseph Babinski to describe a condition in which the patient is unaware that he or she is ill.^{108, 109} Anosognosia is seen in certain neurological disorders (e.g. in conjunction with a left hemiplegia, as in Babinski’s original case example) and also in some psychiatric disorders, such as the manic phase of bipolar disorder, where a patient may be brought to the hospital by the police, protesting that he is the Messiah and not in need of any psychiatric treatment. Individuals with AAS-induced violence or criminality may also frequently display apparent partial or complete anosognosia, with little or no awareness at the time that their behavior was abnormal, even though this fact became clear to them later after AAS had been discontinued. Such users are typically shocked and perplexed when they look back at what they have done – as illustrated by Mr. A’s moment of revelation when the federal official appeared on the nightly television news. The mechanism of this phenomenon, as with other deficits of insight in drug use and addiction, remains little understood and in need of further research.¹¹⁰

“Invincibility”: Finally, individuals experiencing AAS-induced violence or criminality typically report a near-delusional feeling, perhaps related to their anosognosia, that nothing could harm them, that they could not possibly suffer any consequences for their behavior, that – in a word – they were “invincible.” These individuals do not quite appear to have been psychotic in the psychiatric sense of the term (e.g., they do not report Schneiderian first-rank symptoms such as thought insertion or experiences of influence^{111, 112}) nor insane in the forensic sense of the term (e.g., they do not appear to meet the M’Naghten test of failing to understand at the time that their acts were legally wrong¹¹³). Nevertheless, they report a striking loss of reality testing, as exemplified by Mr. A’s failure to recognize, until his moment watching television, that he would be the focus of a national manhunt, or Mr. B shopping with the credit card of a man that he had just murdered. To cite two other examples, another man whose case we presented in earlier paper (“Mr. C” in reference 57) asked the police if he could go out to the gym and lift weights while he was in the midst of being arrested for an attempted murder. Another man was arrested for murder on a day when

he and his girlfriend were planning to attend a local bodybuilding competition that evening. He reported that as the police were booking and interrogating him, he grew concerned that he would not be able to reach the performance in time – seemingly failing to realize that he would likely never see the outside world again. Later on, all of these individuals were easily able to recognize, retrospectively, that their thinking had been irrational.

Although AAS users may show severely impaired reality testing when in the midst of AAS-induced reactions such as those described above, one might still argue from a forensic standpoint that they should have known of the possibility of such reactions before they elected to use AAS in the first place. By this argument, choosing to use AAS would not “excuse” violent or criminal behavior any more than choosing to drink alcohol would excuse drunken violence. However, it could be countered that any adult should reasonably be expected to know the behavioral effects of alcohol, whereas AAS users might not be expected to know of the uncommon and idiosyncratic severe effects occasionally seen with AAS. Although a full discussion of these considerations is beyond the scope of this paper, it is important to acknowledge their forensic importance.

Future Directions

Imaging research may help to advance our understanding of these phenomena in AAS users and in other clinical populations, which also experience amygdala-frontal cortex structural and functional connectivity abnormalities. For example, obsessional thinking reported by some AAS users resembles that seen in obsessive-compulsive disorder, in which right amygdala volume, hyperactivity to emotional stimuli, and resting state connectivity with cortical regions, are abnormal and associated with clinical severity.¹¹⁴⁻¹¹⁷ Feelings of invincibility in AAS users also could be related to abnormal reactivity and/or connectivity of these regions^{118, 119} that is partially normalized after lithium treatment.¹²⁰ Thus, neural abnormalities common to these disorders could reflect transdiagnostic phenotypes that could be elucidated by studying individuals with any of these disorders.

Conclusions

It has long been recognized that human males are typically more aggressive than females, but only in the last 80 years has it become technologically possible for men to be exposed to levels of testosterone and other synthetic androgens that far surpass natural limits. In the last few decades there has been increasing recognition of an uncommon but dangerous consequence of this technological capability: syndromes of aggressive, violent, or criminal behavior apparently induced by high doses of testosterone or other AAS in individuals showing no prior history of comparable symptoms. Although the mechanism of these idiosyncratic responses remains poorly understood, accumulating evidence suggests that they have a biological basis and cannot be explained purely by psychological or situational factors. When assessing cases of apparent AAS-induced violence or criminality in forensic or clinical settings, it is important to establish that an individual was actually using AAS at the time of the abnormal behavior, and to ascertain that the behavior cannot be explained by other factors such as a prior history of antisocial and criminal behavior. We suggest

that AAS-induced reactions display certain stereotypic features which may help to alert clinicians to identify them.

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