CASE REPORT

Journal of Behavioral Addictions 7(1), pp. 189–191 (2018)
DOI: 10.1556/2006.7.2018.09
First published online March 10, 2018

# Cognitive inflexibility in a young woman with pyromania

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(Received: October 6, 2017; accepted: January 21, 2018)

*Background:* Pyromania is a rare disorder that is characterized by multiple episodes of deliberate and purposeful fire-setting. It is typically associated with significant psychosocial dysfunction and legal problems. Even so, little research has examined cognitive aspects of the disorder. *Case presentation/study:* In this study, we compared a 24-year-old woman with pyromania with 19 age- and gender-matched healthy controls using a battery of computerized neurocognitive tasks. Our participant affected by pyromania showed impaired cognitive flexibility but intact functioning on measures of impulsive action and decision-making. *Discussion:* Although pyromania shares phenomenological similarities with other urge-driven disorders, our results suggest that pyromania may have features of compulsivity as well. *Conclusions:* Pyromania is relatively understudied from a neurobiological perspective. Further research is needed to understand the pathophysiology, classification, and treatment of pyromania.

**Keywords:** forensic, impulse control disorders, neurocognition, pyromania

## BACKGROUND

Pyromania is a disorder characterized in DSM-5 by repetitive and deliberate fire-setting that is unrelated to external reward and not better explained by another diagnosis or behavior (e.g., drug use) (American Psychiatric Association, 2013). Although fire-setting is a common behavior and many people are fascinated by fire, pyromania is a rare disorder associated with loss of control over the behavior and often legal consequences (Burton, McNiel, & Binder, 2012; Grant & Odlaug, 2011). Like those with other putative impulse control disorders (ICDs), people with pyromania have strong urges to engage in harmful behaviors and experience an intense high or "rush" from the behavior.

It is hypothesized that pyromania may share a pathophysiological basis with other urge-driven behaviors (Grant & Odlaug, 2011). The neurobiological underpinnings of pyromania, however, are poorly understood. In one case report, neuroimaging – using single photon emission computed tomography – found a left inferior frontal perfusion deficit in an 18-year-old male with pyromania (Grant, 2006). In another case report, neuropsychological assessment revealed impairments in attention, verbal/visual memory, and executive functioning (but intact visuospatial skills) in an individual with pyromania (Parks et al., 2005). No study, to our knowledge, however, has examined dissociable cognitive functions in pyromania using previously validated computerized paradigms. Neurocognitive assessments may be useful in understanding the neural substrates of pyromania and subsequently treating the disorder. We hypothesized that the patient with pyromania described here would show deficits in impulse control and decision-making as compared with healthy controls.

## CASE PRESENTATION/STUDY

The patient is a 24-year-old college-educated female with a history of alcohol abuse (in remission) who self-referred for management of fire-setting that had resulted in legal problems. She had set innumerable fires beginning from childhood and continued to have moderate-to-severe urges to set fires daily upon presentation to our clinic. She had been arrested for setting multiple fires in trash cans and for manufacturing and igniting incendiary devices. The diagnosis of pyromania was confirmed by a structured clinical interview with a board-certified psychiatrist with extensive experience in the diagnosis and treatment of ICDs. She had no current or lifetime history of other psychiatric disorders.

After making initial treatment recommendations and obtaining written informed consent, we performed cognitive testing using well-validated translational paradigms from the Cambridge Neuropsychological Test Automated Battery (www.cambridgecognition.com), including the Intra–Extra Dimensional Set Shift task (IED) (examining adaptability to rule changes), Stop Signal Task (assessing control

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over pre-potent motor responses), One Touch Stockings of Cambridge task (measuring executive planning), Cambridge Gambling Task (testing decision-making abilities and risk-taking actions), and Spatial Working Memory task (assessing errors incurred and strategy use during a visual search task). Raw scores on tasks were transformed to standardized $z$ scores.

The results of the assessments are summarized in Table 1. Cognitive performance was comparable with normative data from a sample of 19 healthy control subjects, except that the patient made more total errors ($z = 1.69$) and extra-dimensional or shifting errors ($z = 1.63$) on the IED.

### *Ethics*

The study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the University of Chicago approved the study and the consent statement. After a complete description of the study procedures, participants provided written informed consent.

## DISCUSSION

Pyromania is currently categorized as an ICD in DSM-5 based on phenomenological similarities between these conditions (in this case, rising tension before the act of fire-setting, followed by relief or pleasure after fire-setting or watching the aftermath). Neurocognitive data from this case report, however, suggest that impairments in planning and decision-making, common in other ICDs, may not characterize the behavior of all patients with pyromania. Contrary to our expectations, our participant showed deficits in cognitive flexibility – a feature of compulsivity – that resemble findings seen in obsessive–compulsive disorder (Chamberlain, Leppink, Redden, & Grant, 2016). Some additional evidence for pyromania as a compulsive behavior comes from a case report in which an 18-year-old male with pyromania was successfully treated with cognitive behavioral therapy including imaginal exposure with response prevention and cognitive restructuring of fire-setting urges (Grant, 2006).

Although we have presented data only from a single participant, these findings raise the question of how best to conceptualize pyromania. Is pyromania related to the obsessive–compulsive spectrum of disorders, as proposed by McElroy and colleagues (McElroy, Hudson, Pope, & Keck, 1991; McElroy, Hudson, Pope, Keck, & Aizley, 1992; McElroy, Keck, & Phillips, 1995) and Hollander and Wong (1995)? It is also possible that certain disorders historically characterized as impulsive, such as pyromania, may exhibit features of compulsivity as well, suggestive of a heterogeneous neurobiology (Grant & Potenza, 2006). Future studies are needed to investigate the possible relationship between compulsivity and impulsivity in pyromania and examine its implications for prevention and treatment strategies.

*Table 1*. Cambridge Neuropsychological Test Automated Battery (CANTAB) performance in a 24-year-old woman with pyromania compared with age-and gender-matched normative data[a]

| Task measure | Raw score | $z$ |
|---|---|---|
| Intra–Extra Dimensional Set Shift task, total errors (adjusted) | 57 | **1.69** |
| Intra–Extra Dimensional Set Shift task, ED shift errors | 26 | **1.63** |
| Stop Signal Task, SSRT (ms) | 142.5 | −0.84 |
| One Touch Stockings of Cambridge task, problems solved | 20 | −0.82 |
| Cambridge Gambling Task, risk adjustment | 0.87 | 0.31 |
| Cambridge Gambling Task, overall proportion bet | 0.59 | 0.60 |
| Cambridge Gambling Task, quality of decision-making | 1.00 | −0.91 |
| Spatial Working Memory task, strategy use | 27 | 0.71 |
| Spatial Working Memory task, total errors | 26 | 0.28 |

*Note*. Bold indicates $z > 1.5$. In all cases, positive $z$ scores indicate worse performance versus healthy controls. ED: extra-dimensional; SSRT: stop-signal reaction time.

[a]Normative data are derived from an unpublished database of participants with no current or lifetime psychiatric disorders ($n = 19$).

## CONCLUSIONS

The neurobiological basis of pyromania is poorly understood. These neurocognitive data – albeit from a single patient – suggest that pyromania may have compulsive features. Further research, incorporating larger patient samples, is needed to understand the neurobiology of pyromania and its relationship with other disorders.

*Funding sources:* Internal funds.

*Authors' contribution:* AWB conducted data analysis and drafted the manuscript. BLO assisted in drafting the manuscript. JEG designed the study, collected the data, and drafted the manuscript. All authors had full access to all data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

*Conflict of interest:* JEG has received research grants from Brainsway, Takeda, and Psyadon Pharmaceuticals. BLO has consulted for and is currently employed by H. Lundbeck A/S. H. Lundbeck A/S had no part in any of the studies mentioned in this paper and did not contribute to this paper in any form, including the decision to submit this paper for publication. AWB reports no financial or other potential conflicts of interest.

*Acknowledgments:* None.

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