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The media clip, an excerpt of an episode called *Broken Brains*, is a part of a documentary by BBC Four, featuring a variety of neurological disorders including the one in question, Alien Hand Syndrome (AHS). BBC Four, a British television channel run by the British Broadcasting Operation, first aired this documentary on 12 April 2011. This an excerpt of the third episode out of three in the series *The Brain: A
Secret History, all of which detail the extraordinary ability of the brain to dictate our behaviours. Through an amalgamation of interviews, footage and narration by Dr Michael Mosley, Broken Brains focuses on the life-changing experimentation of abnormal brains resulting in both rare and common neurological disorders.

As AHS is such a unique and rare disorder, it is of significant interest due to the limited scope of understanding on this matter. We decided to research AHS as our topic not only because it tied in with an earlier topic (epilepsy treatments), but mainly because we were intrigued by its eccentric symptoms. Although rare, the involuntary and often goal-orientated behaviour caused by AHS highlights the ability of neuroscience to explore human nature, including volition, intention, consciousness and identity. The potential multitude of modules coexisting in each of these, poses many fascinating questions which we sought to explore and understand through this media item that appeared scientifically informative and objective. Exploration through this media item was also prompted by its highly prestigious reputation as a scientific channel, which The Telegraph described as one of British TV's 'unique treasures' (Midgley, 2012). Furthermore, the patient and experience orientated approach allows for great insight into such incomprehensible symptoms, as well as a personal level of understanding.

2. Neuroscientific Context

2.1 Background

Alien Hand Syndrome (AHS) is a rare, neurological condition characterised by involuntary movements, typically of the non-dominant hand, which causes the patient to personify or experience estrangement from it. This syndrome differs from other conditions of involuntary limb movement as the affected limb is often goal-oriented. Patients have also been known to exhibit unusual behaviour, such as talking to the affected limb, and referring to it in third person (Goldberg, 2000). This presently accepted definition has been considerably broadened, having first been properly introduced in 1972 by Brion and Jedynak as a dispossession of the patient's hand and the failure of inter-hemispheric communication in patients with corpus callosum tumours. The first case of AHS was reported by Goldstein (1908), that a 57 year old woman had a left hand which had a will of its own and would behave in its own fashion, at one stage grabbing the woman's throat and suffocating her. A post-mortem examination revealed multiple vascular brain lesions involving the right hemisphere which included the corpus callosum. Only 40-60 cases have been recorded, with misdiagnosis playing a role in the low amount of cases (Kumral, 2001).

Figure 1: Patient SA was instructed to make a squeeze response with the left hand if the object presented
belonged in a kitchen, and to make a squeeze response with the right hand if the object belonged in a toolbox. The experiment proved that the left and right brain cannot communicate with each other (McBride J, 2013).

AHS is typically the result of the cerebral hemispheres being surgically separated by severing the corpus callosum (mainly due to reducing epileptic seizure symptoms) or acute focal lesions from strokes. It is also sometimes associated with Alzheimer's and Creutzfeldt-Jakob disease. AHS patients have disorders of motor control, but do not have any associated disorders with their awareness of the motor system (Frith, Blakemore & Wolpert, 2000). Hence, the 'alien' hand's actions cannot be controlled by the will of the patient, but they are able to recognise the discrepancy between the hand's actions and their intentions. Although this disorder is typically viewed as a nuisance rather than a medical threat, patients have been placed in dangerous situations due to the alien limb's actions (Turkington, 2009).

AHS is a consequence of brain lesions to various different regions of the brain. For example, lesions to the supplementary motor area, anterior cingulate, corpus callosum, anterior prefrontal cortex, thalamus, and posterior parietal cortex have all been reported to result in AHS. Three distinct variants have been identified including the frontal variant, callosal variant and posterior variant, allowing for such a broad acceptable usage of the term AHS.

### 2.2 Variants

#### 2.2.1 Frontal variant

This variant is associated with unilateral injury towards the frontal lobe including the supplementary motor area, anterior cingulate gyrus, medial prefrontal cortex of the dominant hemisphere, and anterior section of the corpus callosum (Epinosa, Smith & Berger 2006). It involves purposeful movement of the contralateral hand (the hand opposite the damaged brain hemisphere), such as reflexive and disinhibited grasping and groping. Often, these are exploratory where grabbing or reaching for visible objects with an arm's reach or which have been removed from contact with the hand, are done so meaningfully or functionally, however they are not intentional. Self-directed grasping may also occur during their sleep, causing the patient to wake up. (Banks et al., 1989; Nicholas et al.,1998; Ortega-Albas et al., 2003; Giovannetti et al., 2005 cited in Mark, 2007).

Patients usually have difficulty releasing objects from their grasp (Biran and Chatterjee, 2004) and the more they attempt to release the grip, the more it tightens. This causes them to often resort to using their dominant hand to peel their other fingers off the object.

![MRI scan displaying left mesial frontal lesion (A) and extension to corpus callosum (B)](Biran, Giovannetti, Buxbaum & Chatterjee, 2006)
2.2.2 Callosal variant

The callosal variant involves lesions to only the partially or entirely severed corpus callosum, inhibiting communication between the two hemispheres. Always left-sided, it is characterised by intermanual conflict (conflicts with intentions), with little evidence of limb paresis (partial paralysis) (Bogen, 1993). The affected hand counteracts voluntary actions by the healthy hand. For example, in this variant, the patient may pull off a sock immediately after it has been put on. The two phenomena involved are agonistic dyspraxia and diagonistic dyspraxia:

- Agonistic dyspraxia involves compulsive, involuntary execution of motor commands with the opposite hand to which they were asked to use while the other hand does not respond to the command (see Figure 3).
- Diagonistic dyspraxia occurs after the unaffected act has voluntarily engaged in some action, where the affected hand seeks to oppose the purpose or outcome of this desired act.

Figure 3: MRI from a midsagittal view depicting lesioned regions along the corpus callosum of a patient with agonistic dyspraxia (arrowheads) (Aboitiz et al., 2003).

Figure 4: Cerebral MRI showing Posterior Cortical Atrophy (left parietal lobe), a cause of posterior AHS as indicated by the arrow.

2.2.3 Posterior variant

Less commonly, the posterior form of AHS is linked towards damage to the posterolateral parietal and/or occipital lobe, usually in the non-dominant hemisphere. This occurs from corticobasal degeneration involving posterior cortical atrophy (see Figure 4) or resulting from cerebrovascular accidents. Movements of patients suffering from this variant of AHS tend
to withdraw their afflicted hand away from environmental contact, rather than making grasping motions prevalent within the frontal form of AHS. Non-purposeful and non-conflictual movements (for example, arm levitation), characterise this AHS variant (Bundick and Spinella, 2000). Patients experiencing damage to the posterolateral parietal and/or occipital lobe part of the brain tend to be less coordinated in their everyday activities, differing from the hand movements seen in the frontal variant. The posterior form also involves disorders of sensation and sensory processing, involving optic and cerebellar ataxia of the left arm.

2.3 Explanatory Theories

The brain is made up of two hemispheres, each with 4 lobes (frontal, parietal, occipital and temporal) which coordinate to control speech, movement, emotion, and many other important functions. The frontal lobe, responsible for motor skills that include movement and speech, is most relevant to AHS.

Making conscious decisions for movement creates a signal within the frontal lobe, which is then directed towards the motor strip (runs from the head to toe, responsible for all movement). The corpus callosum, which is made up of 55 million nerve fibres, is the key to this sending and receiving of information, as it connects the two hemispheres together, allowing information to be shared.

AHS often arises as a result of damage to the nerves within the corpus callosum which may result from brain aneurysms (localised enlargements of an artery due to a weakening of the artery wall), stroke patients, and those with infections within the brain. However, AHS can also arise as a side effect of brain surgery, most notably from a radical procedure treating severe cases of epilepsy called "corpus callosotomy", where the corpus callosum is severed.

Figure 5: The corpus callosum is a central feature of Alien Hand Syndrome, due to its importance in connecting both hemispheres (eDoctorOnline, 2013)

Once the corpus callosum is damaged, information from one hemisphere cannot be relayed onto the other, which results in one limb being incapable of being controlled by the frontal lobe. This results in an "alien" limb acting on its own accord, occasionally in opposition to the functioning side (Turkington, 2009). A study in 2007 by Swiss doctors discovered the neuroscientific aspect of AHS, using functional magnetic resonance imaging (fMRI) tests to determine what brain activity occurred during voluntary and involuntary movement. As planned movements originate within the frontal lobe before being sent to the motor strip, unplanned 'alien' movements originate from the motor strip itself without frontal lobe involvement. The signal also remains within the motor strip used for involuntary movement without sending the usual message back to the frontal lobe, leaving patients unable to control their own movements (Assal, 2007).
Due to the exceedingly small number of cases, it is not known what triggers the signal within the motor strip for involuntary movements.

### 2.4 Treatment

There is currently no known cure for AHS. However, practical treatments include controlling the symptoms by keeping the affected hand occupied with an object. Another method involves limiting this hand, with the inability to recognise a sensory feedback coming back to the hand, from the environment. This involves placing a restrictive "cloak" such as an oven mitt or glove to inhibit the hand from sensing the environment.

Theoretically, carrying out these methods can restrict the patient from recovering because neural activity in the primary motor cortex controls the type of unconscious motor movement patients with AHS (Assal, Schwartz and Vuilleumier, 2007). Inhibiting the 'alien' hand from recognising the environment would not allow the neuroplasticity involving the voluntary will to control the actions of the hand to be fully restored.

For unilateral damage to a singe cerebral hemisphere, usually the patient has a gradual reduction in the frequency of ‘alien’ behaviours over an extended period and an eventual restoration of voluntary control over the afflicted hand. The exact method on how this occurs is not entirely understood, however one theory involves the neuroplasticity in the bihemispheric and subcortical brain systems which are involved in voluntary muscle movements. Over time, it is believed that they can re-establish a connection between the executive production process and the registration process in order to regain control of the hand. This kind of gradual recovery has been frequently reported when the lesion is confined to a single cerebral hemisphere.

Research is being undergone to develop medication to decrease the activity of the alien hand. Two types of medication have been proposed: clonazepam and botulinum. Clonazepam, a drug that is currently used to control certain types of seizures and to relieve panic attacks, functions by reducing abnormal electrical activity in the brain. When administered, the drug is able to reduce alien hand activity by 73% (Haq et al., 2010). Botulinum, a purified toxin, functions by inhibiting nerve signals from the brain to the muscle, and when administered through an injection, is able to reduce alien hand activity by 84% (Karri, 2012). However, these studies are somewhat inconclusive as treatments were tailored to suit the patient, and as AHS is not a life-threatening condition, physical methods of restraint are an efficient way of keeping the alien hand from misconduct.

### 3. Critical Analysis

*Broken Brains* is a television documentary episode aired by BBC Four in 2011, the third of three hour long episodes, under its Science and Nature programme. Dr Mosley conducts this documentary, whom
having received a degree in psychiatry in London, largely contributes to the overall credibility of this
documentary. BBC operates BBC Four and is a public service corporation funded by a television license
fee set by the British Government which does not induce commercial motivations but genuinely seeks to
inform. It can be concluded that it seeks to present information in an impartial manner, as enshrined
through their six policies enacted by the Royal Charter and Agreement for the general public.

*Broken Brains* embodies the characteristics of "popular science" as it educates its audience of various
neuroscientific disorders including AHS, by forming a platform between general knowledge and
professional scientific research. As BBC Four is multi-genre, and even under this Science and Nature
programme, explores a range of sciences, it can be concluded that it targets all open-minded, curious adult
audiences in support of the scientific method. It is unlikely to be suitable for children due to the surgery
footage. Scientific information is presented in layman terms, allowing high-level scientific concepts to be
easily comprehended through the use of analogies and metaphors. For example, the corpus callosum and
its neurological function is described as the "highway connecting the two brains", and AHS is described
as a "power struggle" between the two sides. These examples illustrate the tendency for layperson's
terminology to substitute any technical or scientific jargon.

Video footage, (Karen's alien hand attacking her) and an interview between Dr Mosley and Karen are two
types of evidence presented to support the claims made in the documentary. Footage of Karen's initial
suffering portrays her stress and vulnerability, both factors highly effective in contributing towards
connecting with the audience on an emotional level. Nonetheless, these are relatively minor cinematic
effects and it remains relatively unsensationalised.

As the documentary targets the general population, there is a lack of scientific depth throughout the video.
This documentary analyses to a minimal extent, the underlying neurological mechanisms behind this rare
disorder but rather, explores the experience of one sufferer. Rather than asking open-ended questions
about how Karen coped with her disobedient hand during her interview, Dr Mosley instead asked her
futile questions, such as "do you find it disturbing?" which negligibly informs us of the struggles of an
AHS patient. Additionally, even though concepts are simplified, minimal depth in scientific facts is
explored. It would have been advisable to include further quotes or research by other scientists or doctors
to add to the scientific depth and analysis of this syndrome. However as AHS is very rare, more research
must be conducted to contribute to a deeper understanding of AHS.

Furthermore, various unsupported claims throughout the documentary contradict its accuracy. Towards
the end of the interview Karen mentions that she has managed, with medication, "bringing her alien hand
back to her conscious control." Clarification is needed as it is unclear if she refers to medication that has
cured this condition, which is what she appears to suggest. This contradicts the consensus that there is no
known cure but manipulations of the affected hand to control it to an extent. Additionally, we are left with
the explanation that Karen was only "extremely unlucky" to be left with AHS after the operation, and "for
whatever reason", the right hemisphere of her brain refused to be dominated by the left which is highly
uninformative.

Despite limitations of the generalised presentation of scientific facts in displaying factual information to a
meaningful extent, *Broken Brains* nonetheless fulfils its purpose to allow the general adult population
without requiring thorough neuroscientific background, to glean some insight and potentially interest into the rare AHS. Although it provides a reasonable foundation for understanding AHS, more research is required to fully understand the neurological mechanisms of this rare disorder.

4. Appendix

4.1 Search Strategy

Shortly after forming our group, we brainstormed a multitude of topics including sleep paralysis, hereditary sensory and autonomic neuropathy, phantom limbs and alien hand syndrome. An agreement was made by the group to research the topic, AHS as the video we found on YouTube captivated our interest, as justified in the introduction. Initially, we watched videos, read articles and websites including Wikipedia to gain a general, preliminary understanding of the issue. Emma created a discussion page through Facebook, where ideas and roles were exchanged between the members of our group.

Upon feedback from Dr. Vickery, we realised that we needed to locate the original source of the video. As it was only available in Switzerland, we decided to use this documentary by BBC Four, which also explores AHS and overlaps with our initial video in many aspects.

We searched for peer-reviewed articles on the UNSW databases such as PsycINFO, along with Google Scholar, to form our neuroscientific context, aiming for those published recently. For diagrams in the neuroscientific context, we looked at images on Google to find pictures of parts of the brain affected and journal articles that contained illustrations of specific processes related to AHS.

4.2 Reviewers' Feedback

The comments given by our reviewers were very helpful and provided us with direction, particularly when there was a general consensus between them regarding the strengths and weaknesses. Upon receiving feedback from our reviewers, we first highlighted all the specific areas of the wikipage that needed to be changed, edited accordingly to the specific suggestions of improvement (grammatical mistakes) and inserted comments on parts of the wikipage we were unsure about. We also researched and included suggestions that we agreed could enhance our page such as statistics and diagrams, and added them too.

Our wikipage was lacking in in-text referencing and a proper bibliography so we sought to include this immediately. We also included a section on explanation to address the lack of depth provided in the variants sections. An overlapping comment among certain reviewers was wordiness of certain sentences and worked on concision by reading through the page while making sentences clearer where possible and to delete words that were unnecessary.
Work Plan: E.T. Hand Syndrome Work Plan

5. References


Midgely, N. (2012). As BBC Four turns 10, are its best years already over?. From http://www.telegraph.co.uk/culture/tvandradio/9096867/As-BBC-Four-turns-10-are-its-best-years-already-over.html

