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A Scandal in Belgravia… for whom?

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Abstract

This paper investigates the observations and deductions made by Sherlock Holmes in the BBC television show *Sherlock*. Sherlock makes many incredible observations to solve his cases, including spotting dog hairs on a pant leg across the room. This paper uses the angular resolution to determine if Sherlock's observations are scientifically plausible.

Introduction

Sherlock Holmes is a fictional detective, created by Sir Arthur Conan Doyle in 1887. Recently, the BBC has recreated the Sherlock Holmes novels as a television show, set in the present. The show, titled *Sherlock* has become quite popular, and it chronicles the adventures of Sherlock Holmes and Dr. John Watson. Throughout the show, Sherlock makes a number of astounding deductions to help solve London's most difficult mysteries. This leads to the question: can Sherlock actually make these deductions? Or is the BBC bending human limitations to make a good television show?

This paper looks into one particular deduction Sherlock made in the first episode of the second season, titled *A Scandal in Belgravia*. In the episode, members of the Royalty Protection Command arrive at 221B Baker St. to transport Sherlock to Buckingham Palace for a client consultation. However, the men do not tell Sherlock who they are; he deduces it by making observations. One specific observation was the presence of dog hairs on the pant leg of one of the men. Could Sherlock actually see those dog hairs?

Angular Resolution

To determine if Sherlock Holmes could indeed observe the dog hairs, the angular resolution of the human eye and the angular diameter of dog hairs at that distance needs to be determined. The latter may be accomplished using the small angle approximation, which is a variation of the equation used by astronomers to determine the angular diameter of celestial objects [1]:

$$\theta = 206265 \left(\frac{d}{D} \right)$$

In this case, d is the width of a dog hair and D is the distance between Sherlock's eyes and the dog hairs. A study conducted in 2009 determined that the average width of a dog hair is 25µm (2.5×10^{-5}m) [2]. D is determined using Pythagoras' Theorem, the vertical distance between Sherlock's eyes and the dog hairs (a) and the horizontal distance between the two men (b) as shown in Figure 1.
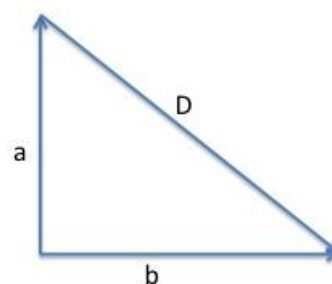

Figure 1: A representation of the measurements used to determine *D*, where *a* is the vertical distance between Sherlock's eyes and the dog hairs, and *b* is the horizontal distance between the two men.

Using a still from the episode, b is estimated to be 5ft or ~1.5m. Since Sherlock is sitting down when he makes the observations, to find a, his sitting height must be found. Sherlock's height when standing is

1.83 m [3]. The height in question is the height of Benedict Cumberbatch, the actor who plays Sherlock. A recent study found the ratio of sitting to standing height in adult males is 0.52, which makes Sherlock to be about 0.957m tall when sitting [4]. The last factors to account for are the height of Sherlock's eyes (~10cm lower) and the height of the dog hairs (~15cm off the ground) both of which were estimated from the still of the episode. This results in a measurement of 0.61m for *a*. Using Pythagoras' Theorem, the value of *D* is around 2.6m.

With values for *d* and *D*, the angular resolution of the dog hairs can be determined using the small angle formula:

$$\theta = 206265 \left(\frac{d}{D} \right)$$

$$\theta = 206265 \left(\frac{2.5 * 10^{-5} m}{2.6 m} \right)$$

$$\theta = 2''$$

Therefore the angular resolution of the dog hairs is close to 2 arcseconds. The angular resolution of the human eye, or the smallest value of θ that can be seen by the human eye, is 50 arc seconds [5]. Since the angular resolution of dog hairs well below angular resolution of the human eye, it was not possible for Sherlock to observe the dog hairs.

Conclusion

While basic principles of angular resolution have determined that it was not possible for Sherlock to deduce the man spent a lot of time with dogs, there are other factors involved. In this investigation, the width of the dog hairs was used as opposed to the length. In a further study, the angular resolution of the dog hair should be calculated using their length. This will account for the possibility that the length of the dog hairs could have allowed Sherlock to see them.

In addition to angular resolution of the dog hairs, there are many other factors that could have contributed to Sherlock's observation. Further investigation into this deduction should look at the effects of colour contrast and quantity of hairs present on visual resolution. It is possible that these factors could have allowed Sherlock to see the dog hairs.

It appears that the real scandal in Belgravia was caused by Sherlock Holmes.

References

[1] Anon, 2014. *Small Angle Formula*. [online] Imaging the Universe. Available at: http://astro.physics.uiowa.edu/ITU/glossary/small-angle-formula/ [Accessed 7 Feb. 2014].

[2] Kshirsagar, S.V., Singh, B. and Fulari, S.P., *Comparative Study of Human and Animal Hair in Relation with Diameter and Medullary Index*. Indian Journal of Forensic Medicine and Pathology, **2**(3), pp.105–8 (2009).

[3] Benedict Cumberbatch Height – How tall. 2014. *Benedict Cumberbatch Height – How tall*. [ONLINE] Available at: http://www.celebheigts.com/s/Benedict-Cumberbatch-2886.html. [Accessed 8 Feb. 2014].

[4] De Arriba Munoz, A., Dominguez Cajal, M., Rueda Caballero, C., Labarta Aizpun, J.I., Mayayo Dehesa, E. and Ferrandez Longas, A., *Sitting/standing height ratio in Spanish children from birth to adulthood*. Archivos Argentinos De Pediatria, **111**(4), pp.309–314 (2013).

[5] Huard, T., n.d. *Angular Resolution*. Available at: http://www.astro.umd.edu/~thuard/astr288c/lecture6-notes.pdf [Accessed 8 Feb. 2014].