

# Hunch About a Punch? How to Define a Forceful Punch Within the Criminal Justice System: Effects of Mental Health Problems and Neurological Sequelae

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## Abstract

*Being punched can have detrimental consequences to the injured. However, measuring the force of a punch and determining whether or not it was forceful requires some careful science. Two ways of measuring a forceful punch are considered together with the implications for injury and for the criminal justice system. The effects of a forceful punch are also considered in terms of neurological sequelae and mental health problems. The research literature on traumatic brain injury, boxing, and brain anatomy that give rise to psychopathology is considered and discussed.*

**Keywords:** Assault; Deviance; Expert witness testimony; Forceful punch, Mental health treatment, and Offender behaviour.

## 1. Introduction

When the human head is subjected to blunt force impact, several mechanical responses may result from the forces involved, including contre coup injury where the brain is shunted across the skull, and also the absorption of impact forces through the various layers of the head [1].

There can be difficulty identifying the result of blows to the head, e.g., from a forceful punch, because the primary injuries caused by direct contact loading can occur in the region of the impact as well as in regions that are distant from the original impact site. However, researchers have found a strong correlation between an internal response such as increase in brain pressure, often caused by leakage of the cerebrospinal fluid covering the brain, and external linear acceleration to the head [2]. Transient increase in brain pressure can also cause neurological dysfunction and the extent

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of damage is dependent upon the peak pressure achieved during the period of injury, e.g., during the period of repeated punches [3]-[5].

Within the criminal justice system, it has been historically difficult to define a 'forceful blow' or punch when there may be many parameters defining the amount of force used, the differences between assailant and defendant, and other factors such as the expectedness of the assault which might enable the punch to be delivered more forcefully to an unexpected recipient.

## 2. Defining a Forceful Punch

Within the world of amateur and professional boxing, attempts have been made to discuss and define the parameters involved in delivering the maximum punch. Boxers strive to achieve their best efforts in the boxing ring and these attempts at scientific measurement having been particularly helpful in assisting criminal cases where it is otherwise unknown as to the extent of effort involved in the delivered punch or the amount of intent by the assailant.

The angular acceleration of a punch can be measured in "radians per second per second" denoted by  $\text{rad/s}^2$  since it is an accelerating force and therefore over a defined period of time. In one study, the acceleration of a boxer's punch was between 4.6 and 8.4  $\text{krad/s}^2$  where "k" represents thousands of radians (per second per second) [6].

However, a second manner of measuring a punch is to compare it with the force of gravity which is  $9.8 \text{ m/s}^2$ . An acceleration of 60 g would be  $60 \times 9.8 = 588 \text{ m/s}^2$  or nearly 60 times that of gravity. This method is dependent upon knowing the amount of mass being delivered at the time which is often difficult to determine if considering the measurement of a forceful punch. Therefore, the former method using  $\text{rad/s}^2$  is generally favoured.

Concussion occurs for angular head acceleration as low as  $1.2 \text{ krad/s}^2$ ; and with a resultant angular acceleration of  $6.9 \text{ krad/s}^2$  there is 75 per cent concussion likelihood.<sup>7</sup> Using the second method of measurement of force, other researchers have found 50 per cent and 75 per cent concussion likelihood for linear head accelerations of 65.1 g and 88.5 g, respectively [8].

Thus, it is thought that concussion is potentially the result of high linear and/or angular acceleration to the head [9]. Rates of acceleration experienced by the head exceeding 80 g to 90 g are likely to result in concussion for healthy young male athletes [10], [11].

It is possible that concussion could occur from the punch of an average male non-boxer when a punch could be delivered from within the range of 4.6 to  $8.4 \text{ krad/s}^2$  and which corresponds to the "worst" and "best" punch of an amateur boxer, respectively. These figures are also above  $1.2 \text{ krad/s}^2$  considered to be the minimal value to cause concussion.

Ability for achieving a higher force is of course possible and is dependent upon the athletic status of the assailant and whether or not the target of the punch is stationary. In this instance, the target would undoubtedly provide less

resistance to the punch and especially if the punch was unexpected, and the force of the punch would have the effect of greater damage such as confusion, concussion, neurological damage and even death to the target.

One observational measure of the force of a punch may also be seen when the target of the punch is physically moved by the assailant's punch. Again, this would be dependent upon several factors such as the force of the punch, the unexpected nature of the situation and the respective weights and athleticism of the individuals involved.

### 3. Discussion

There may be many consequences for the target of a forceful punch that can be long-lasting, serious in nature and detrimental or debilitating. Consequences of repetitive punching is known to lead to extensive neurotrauma and has been reported in professional boxers [12] and termed 'dementia pugilistica' [13]. Association with the brain anatomical structure cavum septum pellucidum (CSP) has also been found in boxers [14] together with mood disorders, mental health problems and cognitive dysfunction [15] such as memory impairment [16].

Psychopathy has been noted as a consequence of repeated and traumatic brain injury such as that sustained by boxers and those who have experienced forceful punches and brain trauma [17]. Disinhibition, especially if the frontal lobes are damaged, and enduring mental health problems are common amongst ex-boxers particularly when associated with CSP pathology, [18] and may require long-term treatment after injury.

Mental health problems can be costly to health care services and present a potential burden to the tax payer. Aside from determining appropriate criminal sentences resulting from assaults, the assailants as well as the target injured may also present the Court with a problem in terms of appropriate sentencing and institutional placement. It is one challenge being able to measure the forcefulness of a punch, and another challenge deciding who is to blame whilst considering mitigation and other mental health components that may be involved amongst both assailant and the target injured.

### 4. Conclusions

Measuring the force of a punch potentially poses many difficulties not only because of the complexity and differences of anatomical structures, i.e., hand size variations; placement of fingers; force and direction of punch; etc. but also because of the difficulties in achieving a uniform scientific measurement. Brain scans are limited due to the limits of technical capabilities, e.g., pixelation, and because they cannot measure retrospectively. They provide significant information about anatomical structure but their advantages do not include the measurement of force, especially when it is occurring during the event.

However, striving towards such a measurement by other scientific means not only attempts to allow for comparisons between punches and between parties involved but also potentially provides accountability in a legal framework. Therefore, it is a good pursuit. Expert witness testimony has provided courts increasingly with valuable information and this is such an arena where science may be a useful addition to an otherwise bewildering set of circumstances, motives and events for any legal setting and juror.

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