Effect of swearing on strength and power performance

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WARNING: This paper contains language that some readers may find offensive

Abstract

Objectives: Swearing aloud increases pain tolerance. The hypothesis that this response may be owed to an increase in sympathetic drive raises the intriguing question as to whether swearing results in an improvement in strength and power.

Design: Employing repeated measures designs, we evaluated the effect of repeating a swear word *v.* a neutral word on strength and power during anaerobic and isometric exercise through two experiments.

Method: Experiment #1 (n=29) employed the Wingate Anaerobic Power Test (WAnT). Experiment #2 (n=52) employed an isometric handgrip test.

Results: Greater maximum performance was observed in the swearing conditions compared with the non-swearing conditions for WAnT power (Experiment #1; dz = 0.618, p = 0.002) and hand grip strength (Experiment #2; dz = 0.962, p < 0.001). However, swearing did not affect cardiovascular or autonomic function assessed via heart rate, heart rate variability, blood pressure and skin conductance.

Conclusions: Data demonstrate increased strength and power performance for swearing *v.* not swearing but the absence of cardiovascular or autonomic nervous system effects makes it unclear whether these results are due to an alteration of sympathovagal balance or an unknown mechanism.

Key words: power; isometric grip; Wingate Anaerobic Power Test (WAnT); autonomic function; swearing.

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Introduction

Offensive or obscene language, known as cursing in the US and swearing in the UK (Soanes, 2002), is a near-universal feature of human language (Van Lancker & Cummings, 1999). To swear may be defined as to utter a word or phrase that is considered taboo, or in other words, forbidden (Pinker, 2007). This may be due to offense against a minority (e.g. derogatory terms referencing race, gender or disability) or citing vulgarities that most people would find obscene (e.g. references to incestuous intercourse). It is the swear words or phrases themselves that are taboo rather than the semantic meanings they convey. So, for example, talking about sexual intercourse need not of itself be obscene, however the word ″fuck″ is a well-recognized swear word deemed ″very severe″ by 71% of 1033 respondents in a national UK survey (Millwood-Hargrave, 2000). Nevertheless, there is not universal agreement as to which words are swear words and the same survey found that 9% of male responders and 4% of female responders deemed ″fuck″ to be a mild swear word or not a swear word at all.

While it may be difficult to define exactly what differentiates *swearing* from words that are just *unpleasant* still most people understand what swearing is; asked to nominate the swear words they most often use, a sample of Dutch students provided strikingly similar examples, such that ″shit″ and ″cunt″ were respectively nominated by 80% and 75% of respondents (Rassin & Muris, 2005). This shared cultural understanding of swearing has enabled researchers to begin to make progress in understanding why people swear and what functions swearing may have. For example, (Allan & Burridge, 2009) suggest four functions of swearing based on their analysis of written and spoken Antipodean corpi. These are social swearing (as a marker for in-group solidarity), abusive swearing (which is self-explanatory), stylistic swearing (the use of bad language to make what is being said sound more enticing) and swearing as an emotive response (to frustration or the unexpected).

One common source of frustration is acute pain arising from accidental injury and prior research has found that, for most people, swearing in response to pain produces a pain lessening, or hypoalgesic effect. Participants repeating a swear word have been shown to withstand an ice-water challenge for some 40 seconds (s) longer, on average, compared with a non-swear word (Stephens, Atkins, & Kingston, 2009; Stephens & Umland, 2011). The concept that swearing represents an extreme form of emotional language (Jay & Janschewitz, 2012) together with elevations in heart rate and increased skin conductance reported as a consequence of swearing (Bowers & Pleydell-Pearce, 2011) suggests a casual path in which swearing leads to an emotional response, in turn activating the sympathetic nervous system, so facilitating a stress-induced analgesia which is mediated by this sympathetic nervous system activation. Such activation would be likely to result in the release of several neurotransmitters including the catecholamines epinephrine and nor-epinephrine. It is interesting to observe that these catecholamines act to raise heart rate and blood pressure providing greater oxygenation to working muscles (Reid & Rubin, 1989) such that muscle force production is improved with increased levels of catecholamine release (French et al., 2007). Given the links between swearing, sympathetic activation and the subsequent release of epinephrine and nor-epinephrine, the intriguing question arises as to whether swearing can affect physical performance via similar changes in organismic milieu.

This paper examines two scenarios where this might be expected. In Experiment #1 a well-known high-intensity 30s anaerobic cycling power challenge known as the Wingate

Anaerobic Power Test (WAnT) was applied (Bar-Or, 1987) while in Experiment #2 an isometric hand-grip strength task was performed. The experiments examined how swearing affected strength, power, and cardiovascular and autonomic function in men and women. In both experiments it was hypothesised (i) that muscular performance would be improved by swearing; and (ii) that there would be increased sympathetic activation due to swearing. We discounted employing sex as a variable because, although women's and men's physical performance capabilities differ, we did not expect any specific effect of swearing. Previous research on pain tolerance (cold pressor latency) using a similar related design comparing swearing and non-swearing conditions has noted effect sizes of dz = 0.57 (Stephens & Umland, 2011) and dz = 1.2 (Stephens, Atkins & Kingston, 2009). In our a priori power calculation for Experiment #1 we set effect size at dz = 0.6 and two-tailed alpha at 0.05, finding that a sample size of N=32 would provide 90% power in comparisons across the swearing and non-swearing conditions.

Methods: Experiment #1

Participants

These were 29 adults aged 18-25 years (mean age 21.0 years, SD 1.84) including 18 females. Data from a further six participants was not analyzed; two participants were unable to finish the protocol, one was taken ill and three withdrew. Participants were eligible if absent of any metabolic, cardiovascular, and pulmonary dysfunction or history of cardiac arrhythmia. The mean weight was 73.2 kg (SD 15.1) and the mean height was 170.5 cm (SD 10.7). The Long Island University Institutional Review Board granted research ethics approval for Experiment #1. Participants provided written informed consent to participate in the study. Participation was voluntary with no incentives.

Materials

The Borg CR10 Scale was employed to self-report exertion level between 0 (nothing at all) and 10 (very, very hard) (Borg, 1998). The Monark 894E Peak Bike (Monark Exercise AB, Langley, WA) is a stationary exercise machine encompassing a 22kg metal flywheel with two metal crankshafts and clipless pedals. The bike's software program calculated peak power, time to peak power, average power and power drop. Peak power (measured within the first 5s of the test) is calculated by: Power (W) = [force (N) x maximum revolutions x 6(m)] / 5(s). Time to peak power is the amount of time (s) taken to achieve peak power. Average power (measured over the course of a 30s intensive bout) is calculated by: Average power (W) = [Force setting (N) x Revolutions x 6(m)] / 30(s). Power drop (measured over the course of a 30s intensive bout) is calculated by: Power drop (watts) = Peak Power – lowest power / Peak Power.

To record heart rate a Polar FT4 heart rate monitor (Polar Inc. Lake Success, New York) consisting of a wristwatch and chest strap with fabric sensors was employed. Respiratory recordings were taken with the use of a 3cm thermistor (TM 100, Iworx Inc., Dover, New Hampshire) taped to the face and placed under the nostrils. These data are not reported due to space restrictions. Body weight was determined on a weight beam eye level scale (Dectecto, Webb City, MO). Blood pressure was assessed using an anaeroid blood pressure cuff (Briggs Healthcare, Waukegan, IL) and Stethescope (All Heart Medical, Louisiana, MO).

Heart rate variability was recorded and analyzed in the time domain as follows: 1) SDNN; the standard deviation of the normal to normal (NN) interval reflects all the cyclic components (high frequency and low frequency) responsible for the variability in the recording period. 2) RMSSD; the root mean squared of successive differences is a wellestablished time domain analysis of heart rate variability preferred for its reliability across short term (5-minute) components. Measures of high frequency (HF) and low frequency (LF) in the frequency domain were also employed. These variables were normalized relative to the total power recorded and their ratio LH/HF is expressed as a percentage. The LH/HF ratio was calculated and employed to demonstrate sympathovagal balance such that the higher the ratio the more prevalent the sympathetic activation. R wave intervals were determined via a 3-lead configuration sampled at 500 Hz. Labscribe version 7.0 data acquisition software was used and data was digitized through an IX-114 analog to digital (A/D) board (Iworx Inc., Dover, New Hampshire). The A/D board was interfaced with a Cybernet Computer (Cybernet Inc., Irvine, CA) and data was stored on the hard drive and backed up on thumb drives. Acquisition of autonomic data was conducted for a 5 minute baseline to extrapolate data into a 24 hour recording in accordance with the 1996 position statement by the Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology, 1996).

Procedure

Participants reported to the laboratory between 10:00 AM and 4:00 PM on weekdays and were at least 4 hours post-prandial having performed no maximal exercise at least 24 hours before testing. Prior to testing participants were required to complete a health status and exercise history questionnaire. Eligible participants were outfitted with the heart rate monitor upon which an electrocardiograph (ECG) gel (Signagel; Parker Laboratories, Inc, Fairfield, NJ) was applied over the fabric sensors of the heart rate monitor chest strap to improve conduction.

Following the intial set up, participants were asked for a swear word they might use in response to banging their head accidentally, and, as a control, a word they would use to describe a table. After randomization to either an initial swearing or non-swearing condition, participants were asked to sit quietly in a chair while three hypoallergenic Series 800 ECG electrodes (S&W Healthcare, Brooksville, FL) were placed on the left ribcage, right shoulder and right hip (IX-114, Iworx Inc., Dover, New Hampshire). With the 3cm thermistor in place under the nostrils to record respiration, participants were instructed to maintain a normal breathing pattern during the collection of data as is consistent with the notion that controlled breathing may unduly influence the parasympathetic branch of the autonomic nervous system (Grossman, Karemaker, & Wieling, 1991). After baseline ECG and respiratory recordings, participants were escorted to the Monark 894E Peak Bike.

The bike's seat height and handle bars were adjusted to allow for optimal power during the assessment. Each WAnT trial was preceded by a 5 minute intermittent warm up phase consisting of pedaling at 50 rpm against a workload of 1kg for 54 seconds, followed by sprinting at 90 rpm for the remaining 6 seconds of each minute (Inbar & Bar-Or, 1986). After this warm up period, participants rested; sitting quietly in a chair for 5 minutes. Following the 5-minute rest period, participants' feet were fastened to the bike pedals with toe clips. Once comfortable, participants were instructed to pedal as fast as possible against zero workload and when they reached what they perceived to be their peak speed they would say "Go!". At this command one tester flipped the metal lever to allow the weight basket of the Peak bike to drop and apply resistance to the wheel while a second tester simultaneously activated the acquisition software (Dotan, 2006). Workload was set as per previous methods.

Participants were instructed to pedal as fast as possible against a low resistance to overcome the inertial and frictional resistance of the fly wheel and to shorten the acceleration phase. The full load (based on Kg) was applied once the participant reached his/her maximal revolutions per minute. As soon as the resistance was applied, the recording of revoulutions began and lasted for a duration of 30 seconds.(Bar-Or, 1987; Dotan, 2006)

Verbal encouragement was provided by the tester as the participant uttered either the swear word or the non-swear word to which they were randomized 10 times (every three seconds) until the trial was complete. Participants were instructed not to shout, but to use a strong and clear voice, and to pedal from a seated position “in the saddle” during the entire test. Participants were blinded to the load added to the cycle to eliminate motivation bias. WAnT trials were repeated twice separated by a 20-minute rest period. During the rest period participants rated their perceived exertion of the previous bout. Heart rate was assessed continuously and peak heart rate during each WAnT was determined 5 seconds after the highest power output was achieved in accordance with previous work (Weinstein, Bediz, Dotan, & Falk, 1998).

Blood pressure was taken at rest and immediately after the load was removed from the flywheel. Participants continued to pedal for 1-2 minutes to cool down until heart rate was lower than 110 beats per minute (bpm) after which they were asked to dismount. Recovery blood pressures were taken every two minutes for 6 minutes after each WAnT. The testing protocol and measurement timeline is displayed in Table 1.

TABLE 1 ABOUT HERE PLEASE

Design

Two designs were applied. First, a repeated measures design was applied in which scores in the swearing and non-swearing conditions were compared using paired samples t-tests. The dependent variables were WAnT peak power, WAnT time to peak power, WAnT average power, WAnT power drop, perceived exertion, heart rate, systolic blood pressure, diastolic blood pressure and time domain and frequency domain measures of heart rate variability. Second, a 2 × 2 mixed design was applied with the within-subjects factor swearing (swearing vs. non-swearing) and the between-subjects factor condition order (swearing first vs. non-swearing first) for the dependent variables WAnT peak power, WAnT average power and WAnT power drop. This was to assess possible carryover effects arising from the repeated measures design.

Results: Experiment #1

All variables followed a normal distribution although tending towards skew in some cases. However, where appropriate transforms could be identified, analyses yielded identical results and so only non-transformed analyses are reported. Descriptive data and inferential statistics for Experiment #1 are shown in Table 2.

TABLE 2 ABOUT HERE PLEASE

Paired t-tests (see table 2) showed that in the swearing condition participants were able to exert greater levels of peak power and average power on the WAnT task compared with the non-swearing condition. The power drop was greater overall in the swearing condition compared with the non-swearing condition. Time to peak power and perceived exertion did not differ across the swearing and non-swearing conditions. There were no significant effects for mean heart rate, systolic blood pressure, diastolic blood pressure and time and frequency domains of heart rate variability during the WAnT trials across the swearing and non-swearing conditions.

Condition order interaction effects were examined via a series of 2 × 2 mixed ANOVAs for the dependent variables peak power, average power and power drop. For peak power there was a main effect of swearing, $F(1, 27) = 10.229$, $p = 0.004$, partial eta squared = 0.275, but no swearing by condition order interaction, $F(1,27) < 1.0$, and no main effect of condition order, $F(1, 27) = 1.018$, $p = 0.322$, partial eta squared = 0.036. For average power there was a main effect of swearing, $F(1, 27) = 9.447$, $p = 0.005$, partial eta squared = 0.259, but no swearing by condition order interaction, $F(1,27) < 1.0$, and no main effect of condition order, $F(1, 27) = 1.116$, $p = 0.300$, partial eta squared = 0.040. For power drop there was a main effect of swearing, $F(1, 27) = 7.634$, $p = 0.010$, partial eta squared = 0.220, but no main effect of condition order, $F(1,27) < 1.0$ although the swearing by condition order interaction neared significance, $F(1, 27) = 3.190$, $p = 0.085$, partial eta squared = 0.106. A greater level of power drop was apparent in the swearing condition relative to the non-swearing condition but only when swearing followed non-swearing; power drop was similar across conditions when the swearing condition preceded the non-swearing condition. Please note that the full dataset for Experiment #1 is included in the Supplementary Information.

Discussion: Experiment #1

Hypothesis (i), that muscular performance would be improved by swearing, was supported. Greater peak power and average power were exerted during the WAnT when participants repeated a swear word during the 30 second challenge. However, this was traded off against a larger degree of power drop, a measure of fatigue, in the swearing condition. The increase in fatigue is likely to occur due to insufficient metabolic energy toward the end of the test and indicates that participants were not able to generate more overall energy in the swearing condition. As in other studies, fatigue may have been owed to altered metabolic contribution, rapid glycolytic metabolism, lactate accumulation and loss of type I fiber contribution during the test (Esbjornsson-Liljedahl, Sundberg, Norman, & Jansson, 1999; Gratas-Delamarche, Le Cam, Delamarche, Monnier, & Koubi, 1994).

Hypothesis (ii), that there would be increased sympathetic activation due to swearing, was not supported. Despite the improved physical performance the cardiovascular and autonomic function variables did not differ in the swearing and non-swearing conditions. One explanation is that any alterations in autonomic function were overshadowed by the high level of physiological arousal brought about by theWAnT. Indeed the WAnT produced significant increases in heart rate (77 bpm – 183 bpm; baseline to peak, respectively) and systolic blood pressure (112 mmHg – 154 mmHg; baseline to peak, respectively) regardless of the condition presented. Still, previous research with a similar sample size was able to detect age-related differences in heart rate in adolescents performing the WAnT (Goulopoulou et al., 2006) making this "overshadowing" explanation possible but unlikely. On the other hand, increased muscular performance during swearing may be achieved by mechanisms other than sympathetic activation. Distraction of attention away from a painful stimulus is known to reduce pain perception via descending pain inhibitory pathways (Edwards, Campbell, Jamison, & Weich, 2009). It is possible that reduced pain perception due to swearing-induced distraction underlies the improved performance on the WAnT task by making it more tolerable to pedal hard against the resistance on the WAnT.

Experiment #1 is open to the criticism that, due to attrition, the final sample fell several participants short of N = 32 identified in the power calculation. However, we decided to proceed with analyzing a final sample of N = 29 on the basis that, for the same parameters as in the original power calculation (dz = 0.6 and two-tailed alpha at 0.05), N = 29 would still deliver analytic power of 87%, comfortably above the 80% minimum power recommended by Cohen (1988). Possible fatigue effects were mitigated by requiring a 20-minute recovery period between WAnT's. Others have looked at the effect of the WAnT on fatigue and found that in young adult populations similar to the present study, 10 minutes of full recovery after a WAnT is sufficient for young adults to reproduce their performance (Goulopoulou et al., 2006). Consistent with these studies, we observed no condition order effects on the WAnT performance parameters.

A further criticism applicable to Experiment #1 is that, while it is standard procedure for participants to receive verbal encouragement as they perform the WAnT (Bar-Or, 1987), this was unable to be carried out blind to study condition and so may have introduced a bias. To further investigate the effect of swearing on physical performance without verbal encouragement, a second experiment was conducted. In experiment #2 a hand dynamometer was used to examine how swearing affects grip strength and perceived exertion relative to non-swearing. In addition we assessed pain perception during the task to investigate whether swearing induced hypoalgesia may underly gains in physical performance. Hypotheses (i) and (ii) were the same as for experiment #1 with the additional hypothesis (iii) that swearing would predict reductions in pain perception during the grip task. Our a priori power calculation for Experiment #2 was based on the effect size dz = 0.62 for Peak Power in Experiment #1, with two-tailed alpha set at 0.05. This showed that a sample size of N=50 would provide 99% power in comparisons across the swearing and non swearing conditions.

Methods: Experiment #2

Participants

These were 52 adults aged 18-23 years (mean age 19.1 years, SD 0.7) including 38 females. The Keele University Research Ethics Committee approved the study. Participation was in return for course credit and conditional upon written informed consent.

Materials

The JAMAR® hand dynamometer (Lafayette Instruments, Lafayette, IN) was used to assess preferred hand isometric grip force up to 90kg. Heart rate (beats per minute) and skin conductance (micro siemens) were assessed using a BIOPAC Systems Inc. MP36E-CE data acquisition unit in conjunction with BIOPAC Student Lab software version 3.7.7. Skin conductance scores were standardized using z scores in recognition of the fluctuating level of this parameter even at rest. Mean and SD peak skin conductance readings were calculated for each participant and then utilized in z transformations of skin conductance readings per participant, per trial (Braithwaite & Watson, 2015). The Borg Perceived Exertion scale (Borg, 1998) assessed self-reported exertion during the hand grip trials. This scale has been shown to have excellent reliability with coefficients usually above 0.90 (Borg, 1998). Perceived pain was assessed using the Borg Perceived Pain Scale; this scale has also been shown to have excellent reliability with coefficients usually around 0.90 (10).

Procedure

Participants were asked to verify, verbally, that they were free of any injury that might otherwise affect their ability to apply grip with maximum force. The five BIOPAC electrodes were affixed, according to manufacturer’s instructions, to the first and second fingers of the non-preferred hand, the right wrist and, medially, to each ankle. Cables connected to the BIOPAC unit were clipped onto each electrode, upon which the system calibration procedure was followed. Next, participants were asked for a swear word they might use in response to banging their head accidentally, and, as a control, a word they would use to describe a table.

Participants were asked to hold the dynamometer comfortably in their preferred hand and begin repeating either the nominated swear word or non-swear word, depending on randomized condition order. Participants remained seated and maintained a steady pace and volume of word recital. After 10 seconds participants squeezed the dynamometer grips as tightly as possible for up to 10 seconds while continuing to repeat the same word. Mean maximum grip performance across three trials was calculated. During a five-minute recovery period the Borg Perceived Exertion and Perceived Pain scales were completed. Participants then repeated the hand grip procedure for the remaining experimental condition (so if they swore first, the second set of trials would be non-swearing, and vice versa). Mean heart rate and peak skin conductance were collected across the three trial periods including the 10s of word recital and up to 10s when grip was applied for each condition.

Design

Two designs were applied, each employing the same set of dependent variables: isometric hand grip force, perceived exertion, perceived pain, heart rate and skin conductance. First, a repeated measures design was applied in which scores in the swearing and non-swearing conditions were compared using paired samples t-tests. Second, a 2 x 2 mixed design was applied with the factors swearing (swearing v non-swearing) and condition order (non-swearing first vs. swearing first) to assess possible carryover effects arising from the repeated measures design.

Results: Experiment #2

All dependent variables followed a normal distribution although in some instances tending towards positive skew and platykurtosis. Where appropriate transformations could be identified these yielded identical results and so only non-transformed analyses are reported. Descriptive data and inferential statistics are shown in Table 3.

TABLE 3 ABOUT HERE PLEASE

With respect to the hand dynamometer, 42 participants (81% of the sample) applied a greater level of force in the swearing condition. This was a greater proportion than would be expected by chance, chi-square = 19.692, $p < 0.001$. Paired t-tests (see Table 3) showed that in the swearing condition participants were able to exert a greater level of maximum force and that participants perceived this greater effort compared with the neutral word condition. However, there was no difference between the swearing and neutral word conditions for perceived pain, heart rate or z transformed skin conductance response.

Condition order interaction effects were examined via a series of 2 × 2 mixed ANOVAs as described earlier. For maximum force there was a significant main effect of swearing $F(1,50) = 26.926$, $p < 0.001$, partial eta squared = 0.350, but no main effect of condition order, $F(1,50) < 1.0$ and no swearing by condition order interaction, $F(1,50) < 1.0$. For perceived exertion there was again a significant main effect of swearing $F(1,50) = 23.694$, $p < 0.001$, partial eta squared = 0.322, but no main effect of condition order, $F(1,50) = 2.514$, $p = 0.119$, partial eta squared = 0.048 and no swearing by condition order interaction, $F(1,50) = 1.646$, $p = 0.205$, partial eta squared = 0.042. For perceived pain there were no main or interaction effects ($p > 0.120$). For heart rate there was an interaction of swearing and condition order, $F(1,50) = 10.854$, $p = 0.002$, partial eta squared = 0.178 and there was a similar interaction for z transformed skin conductance response, $F(1, 50) = 24.142$, $p < 0.001$, partial eta squared = 0.326. Heart rate was greater in the first condition encountered relative to the second condition encountered, but did not differ as a function of swearing compared with non-swearing. Skin conductance was greater in the second condition encountered relative to the first condition encountered, and also did not differ as a function of swearing compared with non-swearing. Please note that the full dataset for Experiment #2 is included in the Supplementary Information.

Discussion: Experiment #2

Hypothesis (i) that muscular performance would be improved by swearing was supported. The majority of participants produced a greater maximum isometric grip force on the hand dynamometer task while swearing, and across the entire sample participants could produce, on average, an additional 2.1kg of force on the isometric grip task when repeating a swear word. The accompanying increase in perceived exertion suggests that participants were aware of the increase in grip strength. On the other hand, hypothesis (ii), that there would be increased sympathetic activation due to swearing, was not supported as swearing produced no clear changes in heart rate or skin conductance compared with non-swearing. While unexpected, this finding is consistent with the absence of signs of sympathetic activation observed in Experiment #1. Hypothesis (iii) that swearing would predict reductions in pain perception during the grip task also was not supported.

General Discussion

Two experiments are presented in which participants completed physical performance tests while repeating swear words or non-swear words. The two experiments showed a consistent pattern of results such that swearing increased muscular performance relative to not swearing, but in the absence of increased sympathetic activation. A boost to muscular performance is in line with our predictions and with earlier research indicating that swearing can trigger sympathetic activation, sometimes described as the fight or flight response (Stephens et al., 2009; Stephens & Umland, 2011). Moreover, while Experiment #1 might be criticised because verbal encouragement to perform maximally was not blind to study condition, this criticism does not apply to Experiment #2. Therefore we argue that these studies provide reasonable evidence that swearing aloud can bring about increased physical performance. However, the absence of any measurable cardiovascular or autonomic arousal effects requires interpretation.

One line of explanation maintains that sympathetic activation underlies the observed swearing-induced increase in strength and power, but that the research design lacked the sensitivity to detect changes in cardiovascular or autonomic function. However, Experiment #1 detected no swearing-induced changes in heart rate variability, known to be an excellent biomarker of autonomic function associated with activity response and stress (Blumenthal et al., 2005; Cervantes Blasquez, Rodas Font, & Capdevila Ortis, 2009; Dishman et al., 2000; Hamer & Steptoe, 2007; Litscher, Zhang, Huang, & Wang, 2011; Matsuura et al., 2010). That neither experiment showed evidence of increased heart rate with swearing is at odds with previous research utilizing the cold pressor task (Stephens et al., 2009). While the sample sizes in the experiments reported here of N = 29 (WAnT) and N = 52 (Grip) are smaller than those in the previous studies, of N = 67 (Stephens, et al., 2009) and N = 71 (Stephens & Umland, 2011), the effect sizes of dz = 0.12 (WAnT) and dz = 0.12 (Grip) were also far smaller than the effect sizes for heart rate changes observed previously of dz = 1.32 (Stephens, et al., 2009) and dz = 0.61 (Stephens & Umland, 2011). On this basis there are reasonable grounds to look beyond sympathetic activation in seeking to explain the beneficial effects of swearing for physical performance observed here.

Experiment #2 assessed whether swearing-induced hypolagesia might underlie the increased physical performance on the grip task but pain perception was not reduced in the swearing condition, apparently countering this hypothesis. However, one still cannot preclude swearing-induced hypolagesia as a possible mechanism. It is notable that pain perception ratings were similar in the swearing and non-swearing conditions of Experiment #2. This is consistent with an interpetation that swearing rendered the pain and discomfort of the physical challenge of the grip task more tolerable such that a greater amount of force could be exerted while the pain rating remained stable. Further research maintaining constant muscular activity and assessing pain perception in swearing and non-swearing conditions would help to elucidate the influence of this potential mechanism.

Increased muscular performance may alternatively have occurred due to a generalised disinhibition brought about by swearing. While disinhibition is more often thought of in terms of psychological disinhibition whereupon one’s inner self-control is less attended to, perhaps swearing brings about a more general disinhibition in which somatic self-monitoring becomes less attended to. In this case, concerns that over-exertion may cause injury or embarrassment become less salient because of a disinhibition brought about by swearing, in turn facilitating the improved somatic performance detected by the WAnT and hand grip tasks. A similar but opposite effect was noted in a study finding that self-consciousness predicts competition anxiety in sports people via the mediating variable social anxiety (Dishman et al., 2000). To assess this, we are planning further research examining the effects of swearing on a variety of somatic challenges such as balancing and manual dexterity.

Although motor unit drive was not measured in this investigation, findings of significant increases in power during the WAnT in the swearing condition may be owed to an increase in neuromuscular drive. To support this notion, Farina et al., found during repetitive dynamic movements, such as cycling, that muscle fiber conduction velocity increases with the external force developed, the instantaneous knee angular speed, and the average pedal rate, indicating progressive recruitment of large, high conduction velocity motor units with increasing muscle force (Farina, Macaluso, Ferguson, & De Vito, 2004). Further study should also measure neuromuscular system performance in light of the fact that the WAnT elicits substantial motor unit activiation of the quadriceps.

A final possibility is that there is something particular to the sound and articulation of swearing that is less common in non-swear words, for example plosiveness (i.e. a speech sound produced by complete closure of the oral passage and subsequent release accompanied by a burst of air). While many non-swear words are also plosive, a systematic assessment of plosiveness would make for interesting further research.

One limitation of this study is that in focussing on one particular kind of emotional language – swearing – we cannot rule out the possibility that other kinds of emotionally provocative language might also have similar effects, via similar mechanisms. Indeed, if one shares the view of Jay (2000), who considers swear words as extreme examples of emotional language, then we would not argue against the possibility that other kinds of language capable of provoking an emotional reaction might have similar effects on physical performance, albeit to a lesser degree. Research using fMRI has found that words such as “rape” and “slaughter”, which are not swear words, produce activation of the amygdala, a part of the brain strongly linked to emotion processing (Kensinger & Corkin, 2004). Unfortunately appropriate data to elucidate this question, such as a study assessing the impact on physical performance of emotion-invoking non-swear words (e.g. “slaughter”) does not, to the best of our knowledge, exist. Further research assessing effects of emotionally valenced non-swear words on physical performance would enable evaluation of the role of the emotional resonance of words, separate to their status as swear words, with respect to changes in physical performace.

In conclusion, this paper presents two experiments each finding that swearing can increase physical performance depending upon muscular force. Participants were able to achieve increased power on a high-resistance bike pedaling task and a stronger hand grip when repeating a swear word compared with a non-swear word. However, increased physical performance occurred in the absence of detectable changes in cardiovascular or autonomic activity, indicating that the primary mechanism underlying the effect of swearing on physical performance may be other than sympathetic activation.

Appendices

Experiment #1 data spreadsheet – “Expt 1 Data Wingate Test.xlsx”

Experiment #2 data spreadsheet – “Expt 2 Data Grip Test.xlsx”

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Table 1. WAnT Testing Protocol and Measurement Timeline

	HRV	HR	BP	RPE	WAnT Power
Baseline	X	X	X		
WAnT[#1]		X	X		X
Rest Period	X	X	X	X	
WAnT[#2]		X	X		X
Recovery	X	X	X	X	

Abbreviations: WAnT: Wingate Anaerobic Power Test; HRV: Time and Frequency Measures of Heart Rate Variability; HR: Heart Rate; BP: Blood Pressure; RPE: Rating of Perceived Exertion; PP: Peak Power; AP: Average Power; PD: Power Drop.

Table 2. Means (*SDs*) for WAnT scores, rating of perceived exertion score, heart rate, systolic blood pressure, diastolic blood pressure, time and frequency domains of heart rate variability during WAnT trials by condition and related t-test and effect size (Cohen's *dz*) statistics for the swearing *v.* non-swearing comparison for each variable.

Variables	Non-swear Word	Swear word	*t(28)*	*p*	*dz*
WAnT Peak Power (W)*	545.06 (180.65)	569.98 (199.04)	3.330	.002	0.618
WAnT Time to Peak Power (s)	5.42 (5.27)	4.14 (3.02)	1.197	.242	0.222
WAnT Average Power (W)*	417.00 (143.22)	428.60 (149.70)	3.283	.003	0.610
WAnT Power Drop (W)*	265.57 (95.81)	299.15 (117.37)	2.400	.023	0.446
Rating of perceived exertion score	7.19 (1.65)	7.15 (2.01)	0.118	.907	0.022
Heart Rate (bpm)	183.69 (8.24)	183.03 (8.94)	0.665	.512	0.123
Systolic Blood Pressure (mmHg)	152.65 (16.44)	154.93 (17.56)	1.133	.267	0.210
Diastolic Blood Pressure (mmHg)	65.83 (8.94)	66.55 (8.28)	0.559	.580	0.104
Time Domain SDRR (ms)	42.65 (17.78)	36.89 (7.18)	1.568	.128	0.291
Time Domain RMSSD (ms)	32.93 (10.82)	30.51 (6.10)	0.948	.351	0.176
Frequency Domain HF (Hz)	17.93 (10.33)	21.02 (14.47)	1.015	.319	0.188
Frequency Domain LF (Hz)	73.78 (13.84)	68.12 (21.56)	1.300	.204	0.241
Normalized Frequency LF/HF (%)	5.77 (3.62)	5.37 (3.88)	0.529	.601	0.098

Abbreviations: s: Seconds; W: Watts; bpm: beats per minute; SDRR: Standard deviation of normal to normal heart rate intervals; RMSSD: Root mean squared of successive differences; HF: High frequency (0.15-0.4 Hz); LF: Low frequency(0.04-0.15 Hz); LF/HF: Ratio of Low to high frequency.

*Significant swearing v non swearing difference

Table 3. Means (SDs) for grip force, perceived exertion score, perceived pain score, heart rate and skin conductance response by condition and related t-test and effect size (Cohen's *dz*) statistics for the swearing v non-swearing comparison for each variable

Variables	Non-swear Word	Swear word	*t(51)*	*p*	*dz*
Grip force (kg)*	26.21	28.35	5.217	<.001	0.723
	(10.58)	(9.50)			
Perceived exertion score*	13.13	14.75	4.753	<.001	0.659
	(3.27)	(2.42)			
Perceived pain score	0.64	0.66	0.200	.842	0.028
	(0.94)	(0.87)			
Heart rate (BPM)	92.56	94.15	0.877	.384	0.122
	(12.99)	(13.76)			
Skin conductance response (z transformed	0.004	-0.004	0.046	.964	0.006
micro siemen)	(0.63)	(0.63)			

*Significant swearing v non swearing difference