Psychomotor therapy and aggression regulation in eating disorders

Boerhout, Cornelis

Chapter 5

The Method of Stamp Strike Shout: Force production as behavioural measure of anger coping Part I: Instrumentation and reliability of force parameters

Submitted

Cees Boerhout [a,b]
Jooske T. van Busschbach [a,c]
Marije Vermerris [b]
At L. Hof [d]
Hans W. Hoek [a,e,f]

[a] *University Center of Psychiatry, University Medical Center Groningen, University of Groningen, Groningen, the Netherlands*
[b] *Lentis Psychiatric Institute, Groningen, the Netherlands*
[c] *Windesheim University of Applied Sciences, Zwolle, the Netherlands*
[d] *Center for Human Movement Sciences, University Medical Center Groningen, University of Groningen, Groningen, the Netherlands*
[e] *Parnassia Psychiatric Institute, The Hague, the Netherlands*
[f] *Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, USA*

Abstract

This study introduces a new performance-based measuring method for anger expression and control, called the Method of Stamp Strike Shout (MSSS). The MSSS originates from clinical practice in mental health care and is designed to meet the need for a behavioural measure of anger and aggression. The method is based on physical force production in directional movement of arms and legs and in voice expression. Recorded are the standardized impact of stamping on a force plate, hitting a punching bag, and the amplitude of shouting in a microphone at various force levels. The premise is, that these body behaviours stand for the 'urge to act or shout' that belongs to anger-related emotions.

The MSSS is a real-time psychomotor measuring method, which can be applied in addition to self-report questionnaires that are sensitive to biases in assessing anger and aggression issues. Besides application as a measurement tool in effect studies of therapy interventions, the MSSS can be an intervention tool in clinical practices.

The results of first explorative research in a student sample (n=104) are now presented in two papers, Part I and Part II. The focus of this first paper is on the internal structure and reliability of the MSSS. Test findings show correlation patterns between levels of force production within each subtest (25-50-75-100% maximum force) and between the three subtests (Stamp, Strike and Shout). We found excellent internal consistency of the three subtests and high test-retest reliability. The second paper (Part II) addresses the validity of the MSSS by exploring the relationship between force production levels and anger coping style. Follow-up research will target on application of the MSSS in clinical populations with marked problems in aggression regulation.

Keywords: body force production; shout; behavioural measure; anger; performance-based measurement

Introduction

Notwithstanding the importance of emotions as an outcome measure for psychological functioning, a long history of psychometric research has shown that developing instruments to quantify a person's emotional state still confronts researchers with methodological challenges in realizing ecologically valid measures. Despite adaptations, self-report measures remain limited by response biases and are not telling the whole truth.[1] Additional performance-based measures are needed to estimate behavioural and non-verbal aspects of emotion expression. Observational methods in laboratory or real-life situations may be a next step towards ecologically valid measurement of personal characteristics influencing the expression of emotion.

In their review of measures of emotion, Mauss and Robinson[2] start from a consensual model that distinguishes three levels of emotional responses: subjective experience, physiological reactions and subsequent behaviour. The behavioural level refers to theories that infer emotional states from vocal characteristics, facial displays, and body behaviours. These theories are based on linking emotions to communicative functions[3] or to action dispositions, like the tendency to fight or flight.[4] More research needs to shed light on behavioural measures of emotions. The present study focuses on measurement of body behaviour and vocal characteristics to contribute to a valid assessment procedure of anger coping. The ability to produce and to regulate physical force is studied in relation to the degree to which someone regulates anger expression or inhibition.

Research on body behaviour (movement, expression, posture) as measure of emotion is relatively sparse,[2] despite the importance of non-verbal communication.[5] On the level of motor behaviour, a growing amount of research indicates that pleasant and unpleasant emotions modulate force production.[6-8] To study the impact of anger on performance, various peak force tasks are applied, like kicking,[9] and pushing or pulling a lever.[10] Anger may facilitate physical performance, depending on the demands of the task, but findings point towards a complex role of individual differences in the anger-performance relationship and emotion regulation.[9] Motor-control probes appear to provide reliable insights into the influence of anger experience (trait anger) and anger regulation on behaviour.[11] However, compared to fear, sadness and happiness, anger remains relatively understudied (in terms of neuronal and physiological mechanisms of action) and it is harder to predict the likely influences of anger on cognition and behaviour.[12]

Regarding the influence of emotions on vocal characteristics, the basic assumption is that measurable voice parameters reflect a person's affective state. The physiological reactions involved modify the voice production process.[13,14]

Sympathetic arousal associated with anger often produces changes in respiration and muscle tension, which influence the acoustic characteristics of speech.[13] The most common measures are voice amplitude (loudness) and pitch (fundamental frequency). High-arousal emotions like fear, anger, and joy are linked with higher pitch than lower-arousal emotions such as sadness.[15] It is more difficult to find vocal characteristics that are linked to valence. Anger and joy are similar in arousal, but different in valence, yet both emotions have been linked to comparable vocal pitch and amplitude.[16]

The present study introduces a custom-made performance-based measuring method for anger and aggression called the 'Method of Stamp Strike Shout' (MSSS). The MSSS measures movement behaviour and vocal characteristics. Levels of force production and force control serve as an indication of anger and aggression regulation. The MSSS consists of three subtests. Recorded are the momentum of stamping on a force plate and hitting a punching bag, and the amplitude of shouting in a microphone. The MSSS is expected to trigger anger-related body reactions partly beyond someone's ability to manipulate. It is meant to be used in addition to self-report methods of measuring anger and aggression. These methods reflect one's retrospective perception of emotional responding rather than the emotional response itself and may be biased by social desirability, denial, and awareness deficits, as has been reported in case of anger.[17] Real-time assessment of body behaviour and vocal characteristics may add to ecologically valid measurement.

The rationale for the construct of the MSSS has been inspired by the temper tantrum of toddlers uncontrollably waving their arms and legs and screaming at high decibels as a result of the adrenaline rush. Apparently, the 'urge to act and shout' which belongs to anger primary finds an outlet in expressive movement by arms and legs and by voice expression (or breath holding spell). Physical responses like clenched fists, tense muscles, and swallow breathing belong to the trigger stage of the anger assault circle.[18] The MSSS offers the opportunity to observe the body in action and to combine quantitative outcome measures with qualitative observation and post-test interview.

The MSSS has its origin in body and movement-oriented therapy in the Netherlands, called psychomotor therapy (PMT). PMT is well integrated in mental health care in Belgium and the Netherlands.[19] PMT integrates body experiences and cognitive-emotional functioning in approaching aggression regulation in psychiatric patients. Randomized controlled research provided first evidence for the effectiveness of PMT in the treatment of excessive anger inhibition in patients with eating disorders.[20,21] PMT enables patients to practice body expression including force production exercises such as used in the MSSS. The MSSS is meant for diagnostic as well as therapeutic purposes. We developed the instrument at the Center for

Human Movement Sciences in cooperation with the Technical Support Unit of the Faculty of Science and Engineering, at the University of Groningen in the Netherlands.

Stamp – For the Stamp subtest, a simple portable force plate with force transducer measures vertical forces generated by stamping. In research, it is common to use force plates to measure centre of pressure.[22]

Strike – For the Strike subtest various methods were available, for example: using force sensors inserted into a target-block mounted on a lath,[23] measuring acceleration of a pendulum arm,[24] and using a dummy (head, neck, and torso) to measure punch velocity and force.[25] A power sensor unit can also be placed into the boxing glove instead of mounting it on the target,[26,27] or into a wristwatch device.[28] Another idea is to install a flexible impact force sensor on a load cell, a concrete wall or a sandbag.[29] The MSSS uses an accelerometer embedded in a punching bag. The use of a bag fits well with our therapy practice when working on aggression regulation issues. In a recent study the use of an accelerometer in a bag showed a small measurement error.[30]

Shout – For the Shout subtest, a microphone at a fixed distance recorded the amplitude of voice expression.

Testing the Method of Stamp Strike Shout: Part I and Part II

We tested the MSSS in a non-clinical sample of 56 women and 48 men in a laboratory set-up and we present the results in two papers, Part I and Part II.

The objective of the current paper (Part I) is to test the internal consistency and reliability of the MSSS. First, we introduce the instrumentation and task. Then, an explorative study focusses on the internal structure of the MSSS by measuring the intra-test correlations between four intensity levels of force production per subtest (25-50-75-100% maximum force) and by determining the inter-test correlations between the three subtests (Stamp, Strike and Shout). Within-subject variations and test-retest correlations indicate the reliability of the MSSS: the degree of precision and reproducibility of the routine.

The main objective of the second paper (Part II) is to test the validity of the MSSS by linking parameters of force production, as measured in Part I, with a self-report measure of anger expression and control. An explorative search addresses how levels of force production and control vary with degrees of anger inhibition, anger expression and anger control. The general objective of testing the MSSS is to find out whether the three measures of anger and aggression, Stamp, Strike and Shout, converge into a coherent response system that can be used for clinical and research purposes.

Methods

Participants

One hundred and four students (48 men, 56 women; M_{age} = 20.84, SD = 2.28), recruited through undergraduate courses and personal networks, volunteered for this study. Exclusion criteria were: (1) injuries to wrist, arm, shoulder, foot, leg, hip and a sore throat; and (2) using tranquilizing medication. The researcher informed the participants briefly about the study objective: to measure force production and to relate the results to the outcome of a questionnaire on anger coping. Institutional ethics approval was gained. Willing participants all signed informed consent, after which they received explanation about the test procedure. Out of 104 participants 22 were tested twice with an interval of five months. Only these 22 received a financial compensation for their participation.

Participants completed a questionnaire on personal characteristics to check for possible confounders, i.c. body weight, trained vocal skills, boxing experience.

Procedure

We tested the MSSS in a practice laboratory at the Center for Human Movement Sciences, University of Groningen, the Netherlands. Prior to the test participants completed a questionnaire on demographics and personal characteristics. Actual weight and body length were measured. After the test they completed a questionnaire on anger coping, the Self-Expression and Control Scale (SECS),[31] for the purpose of analysis in Part II of this study. Thereafter, participants performed predefined light exercises to stretch and warm up their muscles and prepare for the test. The researcher provided technical instruction on how to perform the three subtests. A randomization procedure determined the sequence of the subtests. The participants drew a note with one of three possible sequences out of an envelope. After performing the subtests the researcher checked whether the participant had experienced emotional arousal instigated by the test. If needed, the researcher could help to reduce tension at the end of the procedure.

Task

After standardized randomization of the sequence, participants performed the three different subtests of the MSSS: stamping, striking and shouting. They executed the three subtests twice, with increasing and decreasing force. The instruction was to produce respectively 25%, 50%, 75% and 100% of their maximum force, and then back to 75%, 50% and 25%. This sequence represents a *force pyramid* used to quantify one's ability to produce and control physical force.

During the Stamp subtest, the participants stamped a sequence with one foot at the time on a force plate (Figure 5.1), wearing shoes with flat soles. At every force level the participant stamped four times with each foot. The instruction was to lift de foot directly after stamping. In the Strike subtest, participants stroke a boxing bag four times at every force level, alternating with the left and right hand with both hands in gloves (Figure 5.2). They alternated between left and right hands and feet to control for the extra power of the dominant side.[32] In the Shout subtest, the participants shouted 'Haa' in a microphone (Figure 5.3), once at every amplitude level. The scores on the two repetitions of each subtest were averaged in order to achieve an acceptable level of measurement error.[22] The overall duration of the task was approximately 25 minutes.

Figure 5.1. Stamping on the force-sensitive area of the 'stamp-plate'

Figure 5.2. Striking the mid-section of a bag with boxing gloves

Figure 5.3. Shouting 'Haa' in a microphone

Instrumentation

A custom-made LabVIEW programme controls all three subtests of the MSSS (Figure 5.4). The output is a text file with the summary score of every stamp, strike or shout in the course of the trials. Sampling of analogue signals in the stamp and strike mode is done by an A/D converter USB-NI6008 (National Instruments).

Stamp – The 'stamp plate' is a custom-made force plate that only measures vertical force. The force transducer (Scaime AP200C3SH10eF, range 2000 N) is mounted in a 60 x 50 x 10 cm wooden box with a plywood plank 42 x 22 cm, thickness 1.8 cm, on top, flush with the surface of the box. Both surfaces are covered with a layer of closed-cell foam with a thickness of 0.6 cm. The force transducer was calibrated with known weights. Before each measuring session the force signal of the unloaded transducer is set to zero, the force threshold level and the minimum time between stamps are input into the programme. The force signal is preamplified and low-pass filtered with a cut-off of 50 Hz by an amplifier Scaime CPJ. Then it is sampled at 1000 Hz. An example signal is given in Figure 5.5. The momentum of the foot impact is determined by integrating the force signal starting from 10 ms before up to a time 100 ms after the trigger level. In this way only the first short force peak is included in the measured momentum. In a number of experiments it was determined that this part of the force signal is directly related to the momentum of the foot, the later part of the force signal seems related to indirect forces from leg and trunk, and is much more variable.

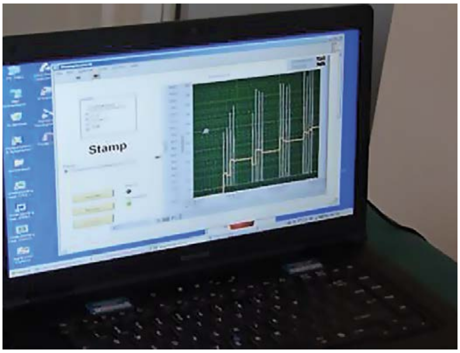

Figure 5.4. Labview image of the Stamp parameters

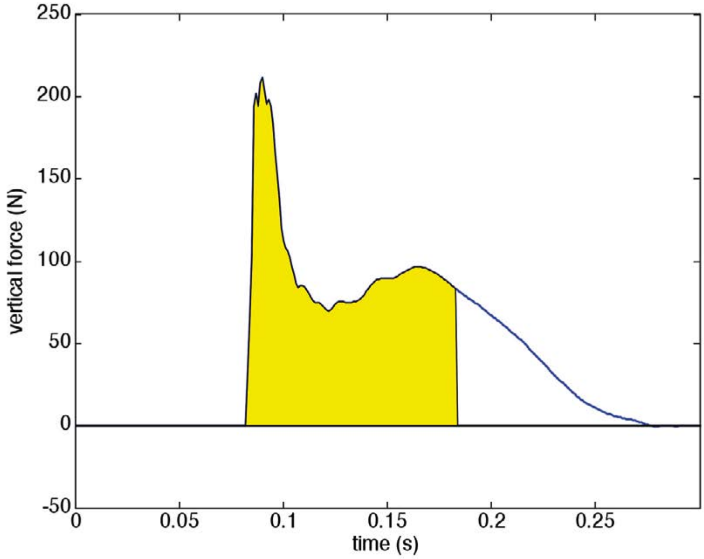

Figure 5.5. The low-pass filtered force signal of a stamp. The impulse of the foot stamp is equal to the shaded area under the curve $p_{stamp} = \int_{t_1}^{t_2} F dt$, with t_1 10 ms before the threshold (2 N) is passed and t_2 100 ms after the threshold crossing.

Strike – The impact of the boxing strike is also expressed as a momentum. A dual-axis accelerometer ADXL278 (Analog Devices, range 50g) is mounted in a small box, with the sensitive axes horizontal. This box is put in the middle of a punching bag which is hung from the ceiling by a chain. The two perpendicular components of the acceleration are sampled at 500 Hz. The total momentum is calculated by integrating both acceleration signals (Figure 5.6), from 30 ms before a trigger level is passed up to the first zero crossing (the latest of the two components). The total impulse is calculated as the vector sum of both integrated accelerations times the mass of the punching bag. In the present test the mass was 38 kg. Before the session this mass is input into the programme, together with the trigger level, and the zero level of the accelerometers.

Shout – The sound is recorded by an USB desktop microphone (Logitech 980186-0914, -47 dBV/Pa) via the PC sound card by means of dedicated LabVIEW programmes. The participant is positioned 1,5 m from the microphone. Over periods of 0.1 s the sound signal is sampled at 22 kHz and the maximum sound level in dB(A) over this period is calculated.

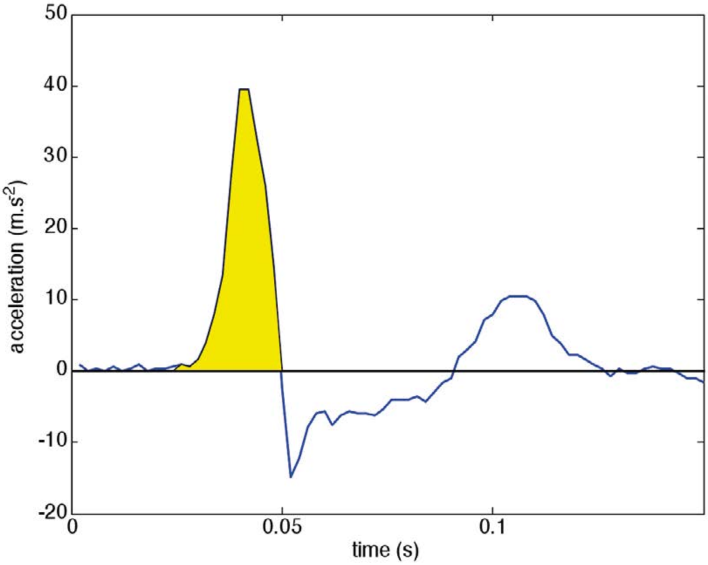

Figure 5.6. One of the two accelerometer signals in a strike on the punching bag. The impulses of the punch are equal to the shaded area under the curves times the mass of the punching bag $p_{x,y} = m_{bag} \int_{t_1}^{t_2} a_{x,y} dt$, with t_1 30 ms before the threshold (7 m·s2) is passed and t_2 the time of the first zero crossing. The total impulse p is calculated as the vector sum of the two perpendicular components: $p = \sqrt{p_x^2 + p_y^2}$. The accelerations measured after the first zero-crossing are due to vibrations and swinging of the bag after the strike.

Measures

The momentum of stamping and striking, and the amplitude of shouting are measured to quantify force production at different levels of executing the MSSS, that is 25%, 50%, 75%, 100% and back to 75%, 50% and 25% of maximum force. A series of numeric symbols represent momentum *p* as parameter for the Stamp and Strike force production, replaceable by amplitude *A* as parameter for loudness of the Shout: $p_{25\uparrow}$; $p_{50\uparrow}$; $p_{75\uparrow}$; p_{100}; $p_{75\downarrow}$; $p_{50\downarrow}$; $p_{25\downarrow}$. The arrows indicate the increasing (↑) and decreasing (↓) part of the force pyramid. The p_{SUM} represents represents the sum of all force levels per subtest. Additionally, extra Shout parameters indicate shouting with short and long duration and the time span when shouting long: Db_{short}, Db_{long}, T_{long}. The amount by which single levels of force production differ from a straight line may be seen as the 'error' in force distribution, which can be seen as a measure of force control. The amplitude of the Shout is directly related to sound-intensity measured in decibel on a logarithmic scale.[a]

Statistical analyses

Not all data from the 104 participants could be used. Based on visual inspection of the irregular scores, scores ± 3 standard deviations from the mean were removed. One participant could not execute the subtest Stamp because the force plate failed to process the measuring data. The final data set contained 94 participants for Stamp, 98 for Strike and 95 for Shout.

Statistical analyses were performed in SPSS version 22. Without the outliers, the data of the parameters for all three subtests were normally distributed. Pearson's correlations were calculated to test for possible confounders: the frequency of exercising on the stamping parameters, the frequency of exercising and boxing experience on striking, and the influence of trained vocal skills on shouting. Since weight and gender can be assumed to correlate with the outcomes of all three subtests, ANCOVA's were executed to test for differences between men and women with weight controlled for.

In this first study, an explorative search is used to detect patterns of performance. Pearson's correlations between parameters within each subtest were calculated to describe the relationship between parameters, both within and between the increasing and decreasing parameters. Cronbach's alpha over all parameters of each of the three subtests was calculated as an estimate of the internal consistency of that subtest. To investigate whether the three subtests are interrelated, Pearson's correlations between the subtests on the different parameters were calculated. According to Cohen[33] a Pearson correlation coefficient of r=0.10 is a small relationship, r=0.30 is a medium relationship, and r=0.50 is a large or strong relationship between outcomes.

The test-retest reliability of the MSSS was tested by the Intraclass Correlation Coefficient (ICC) for 22 participants that executed the test twice under similar laboratory conditions. A two samples t-test was done to check whether the scores on the extra test of the 22 participants deviated significantly from the scores of the 82 participants who were only tested once.

[a] The rule of thumb is that three decibels more means two times more sound-intensity. However, differences exist between actual values and perception of loudness: it takes a 10dB increase before the average listener hears 'double the sound.' (http://www.acousticsbydesign.com/acoustics-blog/perception-vs-reality.htm)

Results

Participants characteristics and their influence on measurements

Table 5.1 presents demographic data and other characteristics of the participants, all students at university or other institutes of higher education. After testing for possible confounders no correlations were found between the frequency of exercising during the week, the mean scores on the various levels of the force pyramid or any other research parameters in both Stamp and Strike subtests. Boxing experience was not significantly correlated with any of the research parameters for striking. And, no significant correlation was found for trained vocal skills and any of the research parameters for shouting. Male and female participants differed on height and weight: men in our sample were taller and heavier.

Table 5.1. Participants characteristics (n=104)[a]

	Men n (%)	Women n (%)	Difference p
Participants	48 (46%)	56 (54%)	
Boxing experience	8 (17%)	6 (11%)	.43
Trained vocal skills	3 (6%)	5 (9%)	.61
	M (SD)	M (SD)	
Age (years)	20.88 (2.26)	20.80 (2.32)	.87
Height (m)	1.84 (.08)	1.73 (.06)	<.001
Weight (kg)	75.59 (10.14)	65.81 (8.25)	<.001
BMI	22.37 (2.03)	21.94 (2.24)	.29
Physical exercise (#/week)	2.79 (2.11)	2.36 (1.59)	.24

[a] Since no outliers occurred simultaneously in all subtests, the total group characteristics have been included.

Total scores and the influence of gender and weight

There was a positive correlation ($p<0.01$) between weight and all seven sequential parameters of the force pyramid for Stamp ($0.43 < r > 0.49$). Weight was also significantly positively correlated with all seven sequential parameters of the force pyramid for Strike ($0.47 < r > 0.55$) and for Shout ($0.40 < r > 0.47$).

Table 5.2 shows the mean force production scores on the measured parameters, including the extra parameters for shouting with short and long duration and the time span when shouting long. For all subtests weight and gender explained a significant amount of variance on most sequential parameters. Gender was next to weight taken as confounders in the following calculations and tests.

Table 5.2. MSSS Stamp, Strike, Shout subtests: mean, standard deviation and confidence interval (CI=95%) for men and women.[a]

Stamp (n=94)	Men (n=40)		Women (n=54)	
	Mean (SD)	CI	Mean (SD)	CI
$p_{25\uparrow}$	17.7 (5.71)	15.2–20.1	12.1 (4.66)	10.4–13.8 [b,c]
$p_{50\uparrow}$	20.6 (5.63)	18.2–23.0	15.1 (5.45)	13.1–17.1 [b,c]
$p_{75\uparrow}$	22.4 (5.85)	19.9–24.9	17.5 (6.08)	15.3–19.7 [c]
p_{100}	24.8 (5.83)	22.3–27.3	22.0 (6.11)	19.8–24.2 [c]
$p_{75\downarrow}$	22.4 (6.29)	19.7–25.1	17.3 (6.21)	15.1–19.6 [c]
$p_{50\downarrow}$	20.9 (6.37)	18.2–23.7	15.3 (5.82)	13.2–17.4 [b,c]
$p_{25\downarrow}$	18.5 (6.32)	15.8–21.2	12.6 (5.51)	10.6–14.6 [b,c]
$p_{\mathbf{SUM}}$	**147.3 (39.4)**	**134.7–159.9**	**111.9 (38.2)**	**101.5–122.3** [c]
Strike (n=98)	Men (n=44)		Women (n=54)	
	Mean (SD)	CI	Mean (SD)	CI
$p_{25\uparrow}$	11.5 (3.97)	9.87–13.1	6.58 (3.00)	5.49–7.67 [b,c]
$p_{50\uparrow}$	15.1 (4.91)	13.1–17.1	8.51 (3.20)	7.34–9.67 [b,c]
$p_{75\uparrow}$	18.3 (6.82)	15.5–21.1	10.8 (3.43)	9.56–12.1 [b,c]
p_{100}	21.9 (6.65)	19.2–24.6	14.6 (3.98)	13.2–16.1 [b,c]
$p_{75\downarrow}$	17.0 (5.21)	14.8–19.1	10.4 (3.25)	9.22–11.6 [b,c]
$p_{50\downarrow}$	15.5 (5.53)	13.3–17.8	8.65 (2.99)	7.57–9.74 [b,c]
$p_{25\downarrow}$	12.9 (4.65)	11.1–14.8	7.04 (2.67)	6.07–8.01 [b,c]
$p_{\mathbf{SUM}}$	**112.3 (34.0)**	**101.9–122.6**	**66.6 (20.2)**	**61.1–72.1** [b,c]
Shout (n=95)	Men (n=46)		Women (n=49)	
	Mean (SD)	CI	Mean (SD)	CI
$A_{25\uparrow}$	74.8 (5.53)	72.6–77.0	67.6 (6.35)	65.2–70.1 [b,c]
$A_{50\uparrow}$	79.7 (5.40)	77.5–81.8	72.1 (6.33)	69.6–74.5 [b,c]
$A_{75\uparrow}$	83.6 (5.48)	81.4–85.8	76.1 (6.78)	73.5–78.7 [b,c]
A_{100}	88.8 (6.00)	86.4–91.1	82.0 (6.81)	79.4–84.7 [b,c]
$A_{75\downarrow}$	82.6 (6.48)	80.0–85.1	74.1 (7.60)	71.2–77.0 [b,c]
$A_{50\downarrow}$	78.8 (6.27)	76.3–81.3	70.5 (7.26)	67.7–73.3 [b,c]
$A_{25\downarrow}$	73.9 (7.06)	71.1–76.7	65.7 (7.72)	62.7–68.6 [b]
$A_{\mathbf{SUM}}$	**562.1 (39.6)**	**550.3–573.9**	**508.2 (44.8)**	**495.3–521.1** [b]
Db_{short}	74.6 (5.70)	72.83–76.17	67.91 (7.38)	65.76–69.88 [b]
Db_{long}	65.65 (8.27)	63.42–67.94	60.07 (8.42)	57.80–62.40 [b]
T_{long}	19.33 (8.45)	16.83–21.78	14.42 (5.45)	12.97–15.89 [b]

[a] Momentum p for the subtests Stamp and Strike is given in kg·m/s, amplitude A of the Shout in dB, T_{long} in seconds

[b, c] Differences between men and women explained by gender alone[b] and controlled for weight[c] ($p<0.01$)

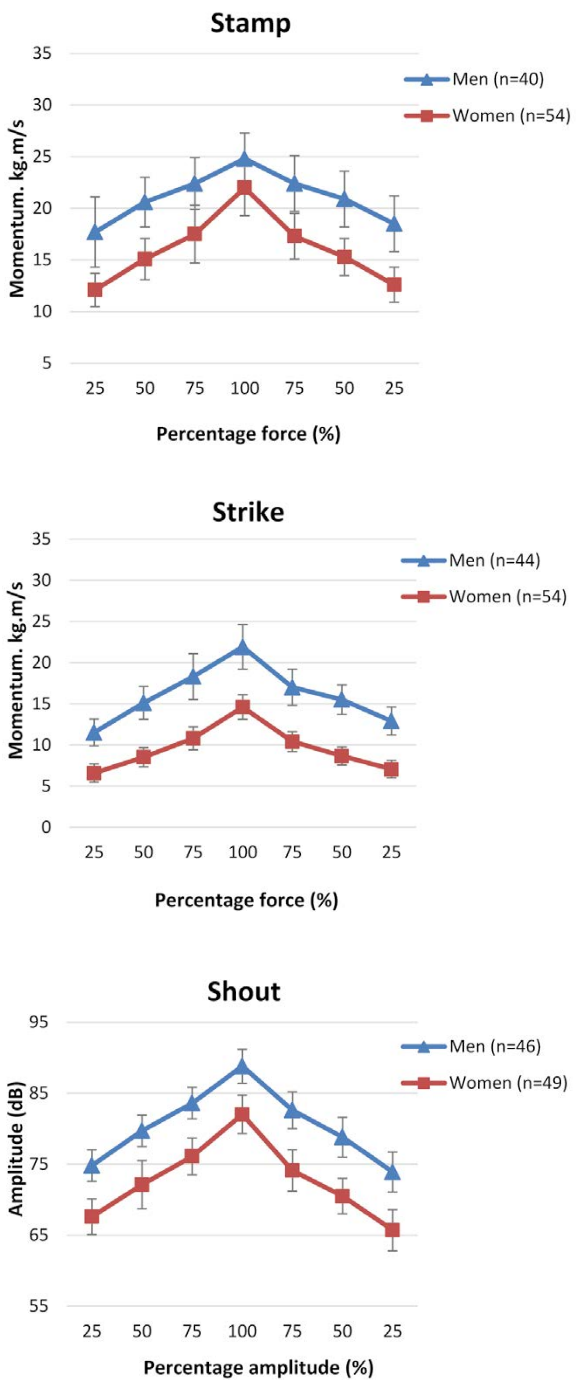

Figure 5.7. Force pyramids (mean, CI 95%) of sequential parameters of each subtest of the MSSS for men and women

Figure 5.7 presents the force pyramids of each subtest performed by men and women. Men and women were able to perform a pyramid-like performance of force production in all three subtests. For women performing the Stamp subtest it seems the step sizes around 100% force are relatively large.

Internal consistency

To measure Cronbach's alpha all parameters of each subtest were used as a scale. For the Stamp subtest α=0.98, for the Strike subtest α=0.97, for the Shout subtest α=0.98, indicating an excellent internal consistency.

Test-retest reliability

The ICC's between test and retest of 22 participants were high for the sequential parameters, indicating a strong test-retest resemblance in force production (Table 5.3). There were no significant differences between the mean scores on the second test of the 22 participants in the test-retest sample and the mean scores on the first test of the remaining 82 participants.

Table 5.3. Test-retest reliability for the parameters of the MSSS, assessed by the Intraclass Correlation Coefficient (ICC).[a]

	Stamp ICC	**Strike** ICC	**Shout** ICC
$p_{25\uparrow}$[b]	.82	.49	.84
$p_{50\uparrow}$	.91	.72	.90
$p_{75\uparrow}$	.92	.82	.88
p_{100}	.85	.72	.93
$p_{75\downarrow}$	.93	.82	.91
$p_{50\downarrow}$	.92	.79	.94
$p_{25\downarrow}$	.83	.58	.82
$\boldsymbol{p}_{\mathbf{SUM}}$	**.94**	**.89**	**.91**
Db_{short}			.80
Db_{long}			.83
T_{long}			.85
$\boldsymbol{A}_{\mathbf{SUM-extra}}$			**.91**

[a] Momentum *p* in kg·m/s for the subtests Stamp and Strike can be replaced by amplitude *A* in dB for the Shout subtest

[b] See section Measures: force parameters

Intra-test correlations

Table 5.4 shows that the sequential parameters were positively and very highly inter-correlated. Obviously, high correlations existed between the sequence parameters that succeed one after another within the increasing and decreasing part of the sequence. These correlations were somewhat less strong between 100% and the bottom force levels. High correlations also existed between the corresponding parameters of the increasing and decreasing part of the pyramid, for example between $p_{50\uparrow}$ and $p_{50\downarrow}$, especially very high for the Stamp test. The correlations confirm that most participants were able to increase force gradually to 100% and decrease force gradually to 25% again following a pyramid like sequence (Figure 5.7). For the Shout subtest, the extra correlations between the sequential parameters and shouting with short duration were high, as was the correlation between shouting with short and long duration. The correlations between the time span when shouting long and most other parameters were moderate.

Table 5.4. Intra-correlations (Pearsons r) Stamp (n=94), Strike (n=98) and Shout (n=95), controlled for gender and weight.

Stamp[a]	$p_{25\uparrow}$	$p_{50\uparrow}$	$p_{75\uparrow}$	p_{100}	$p_{75\downarrow}$	$p_{50\downarrow}$	$p_{25\downarrow}$
$p_{25\uparrow}$	-	.91	.81	.59	.79	.88	.94
$p_{50\uparrow}$		-	.93	.75	.91	.95	.93
$p_{75\uparrow}$			-	.87	.96	.93	.86
p_{100}				-	.89	.79	.68
$p_{75\downarrow}$					-	.95	.87
$p_{50\downarrow}$						-	.96
$p_{25\downarrow}$							-

Strike[a]	$p_{25\uparrow}$	$p_{50\uparrow}$	$p_{75\uparrow}$	p_{100}	$p_{75\downarrow}$	$p_{50\downarrow}$	$p_{25\downarrow}$
$p_{25\uparrow}$	-	.81	.71	.56	.74	.76	.81
$p_{50\uparrow}$		-	.83	.67	.81	.78	.75
$p_{75\uparrow}$			-	.77	.81	.79	.66
p_{100}				-	.79	.71	.60
$p_{75\downarrow}$					-	.84	.75
$p_{50\downarrow}$						-	.84
$p_{25\downarrow}$							-

Shout[a]	$A_{25\uparrow}$	$A_{50\uparrow}$	$A_{75\uparrow}$	A_{100}	$A_{75\downarrow}$	$A_{50\downarrow}$	$A_{25\downarrow}$	Db_{short}	Db_{long}	T_{long}
$A_{25\uparrow}$	-	.88	.81	.66	.77	.80	.80	.62	.41	.28
$A_{50\uparrow}$		-	.94	.82	.88	.87	.79	.60	.43	.28
$A_{75\uparrow}$			-	.87	.89	.86	.74	.65	.49	.34
A_{100}				-	.86	.75	.64	.53	.45	.31
$A_{75\downarrow}$					-	.91	.81	.58	.46	.45
$A_{50\downarrow}$						-	.89	.61	.45	.33
$A_{25\downarrow}$							-	.58	.45	.35
Db_{short}								-	.62	.29
Db_{long}									-	.06
T_{long}										-

[a] See section Measures: force parameters

Inter-test correlations

The sequence parameters of the subtests were moderately correlated between the tests (Table 5.5). Also the sum scores of sequential parameters were moderately inter-correlated.

Table 5.5. Inter-test correlations (Pearsons r) for all subtests, controlled for gender and weight.[a]

	Stamp & Strike (N=90)	Stamp & Shout (N=87)	Strike & Shout (N=90)
$p_{25\uparrow}$[b]	.48	.36	.27
$p_{50\uparrow}$	.41	.34	.28
$p_{75\uparrow}$	.33	.36	.30
p_{100}	.36	.26	.35
$p_{75\downarrow}$	.42	.40	.39
$p_{50\downarrow}$	.42	.31	.34
$p_{25\downarrow}$	.49	.33	.34
p_{SUM}	**.47**	**.37**	**.27**

[a] Momentum *p* can be substituted by amplitude *A*
[b] See section Measures: force parameters

Dicussion

This explorative study investigated the internal structure and reliability of the Method of Stamp Strike Shout (MSSS), a new performance-based measuring instrument for anger expression and control, tested in a sample of 104 Dutch students. The performance of the MSSS was quantified by measuring mean force levels that follow a pyramid-like sequence. Visual inspection of the tables and figures showed correlation patterns that tell us how the pyramids are shaped, the steepness of the slopes and their symmetry.

Internal consistency and reliability of the MSSS

The MSSS showed an excellent internal consistency of each subtest. Further, the test-retest reliability of the MSSS pointed towards a high degree of precision and reproducibility of the routine, with the test-retest resemblance in the bottom force levels of the Strike test the least high.

A period of five months between test and retest was chosen in order to reduce remembrance of the first performance. This is even more relevant in case the MSSS should elicit an emotional experience that would have a memory-enhancing effect.[34] Over such a long period there is a greater risk of personal changes that could affect the scores. Scores on the MSSS in this non-clinical sample, however, seem to reflect relatively stable personal characteristics of the participants.

Prior to the performance of the MSSS no familiarization sessions were carried out. In this stadium of testing the aim was to assess spontaneous interaction of force production and emotion, without interference of cognitive learning. Furthermore, little research has investigated the need of such trials to establish high degrees of test-retest reliability in force characteristics. For comparison, in a study on force measures with physically active men similar high degrees of test-retest reliability were achieved without the need for familiarization sessions.[35]

Within and between subtests correlations

In performing the MSSS, the Stamp test showed the highest correlations, followed by the Shout test. Striking the boxing bag may have been the most vulnerable for irregularities with less high correlations between different levels on both side of the pyramid. For all subtests the correlations between the 100% force level and some of the other parameters was somewhat lower. The maximum force level seems to be not totally dependent of all steps to get there.

The correlations found *between* the three subtests all remained under 0.50 (as was indicated as a strong correlation). So where there is a common factor in the different subtests, they measured force production in a different way and thus may complement each other. Particularly the Shout subtest seemed to measure a different aspect.

Limitations

The MSSS is a newly developed, custom-made performance-based measuring instrument. This is the first explorative study of the MSSS in a select student sample. Some of the procedures need to be refined to avoid as much disturbance as possible, for instance due to differences in shoe wear for the Stamp test, or to differences in punching zone used in the Strike test. The Stamp subtest is the most stable instrument. Regarding the Strike subtest it is hard to say whether the mean force levels and the within subject correlations are inherent in the produced force, or were also influenced by how the bag swings after the first stroke. The bag could be replaced by a free-standing bag on a base filled with water or sand to improve the stability. Such adaptations may enhance the reliability of measurements. The software for analysing the recorded test results will be further simplified in order to enhance the usability in practice.

Conclusion

This first explorative investigation of the MSSS showed that the students in our test were able to increase and decrease force production gradually following a pyramid-like sequence. Excellent internal consistency of the three subtests and high test-retest reliability were found for the sequential parameters. The correlations between the subtests were moderate, suggesting the combined outcomes to be complementary. As for now, no conclusion can be drawn as to which is the best subtest in performing the MSSS. The experiences in the laboratory setting and the relatively low amount of not interpretable data indicated that implementation was feasible. The MSSS was well accepted by participants.

In a follow-up paper (Part II) the results will be related to a self-report measure on anger coping in order to explore the test validity of the MSSS. The question is whether and how the three sub-routines of the MSSS converge into a coherent response system that matches with anger expression and control styles. Overall goal of the MSSS is to provide patient and therapist with feedback on body performance for diagnostic as well as treatment purposes, targeted on learning to apply expressive movement, use of voice and controlled force production as a vehicle for aggression regulation.

Acknowledgements

The authors wish to thank Prof. dr. L.H.V. van der Woude for his advice and for providing test facilities at the Center for Human Movement Sciences, University of Groningen; the team providing technical support at the Center for Human Movement Sciences; Ing. W.J. Jonker, Technical Support Unit, Faculty of Science and Engineering, University of Groningen, for building the Labview software programme; Dr. R.M. Bongers, Center for Human Movement Sciences, and Prof. dr. H. Hoijtink, University of Utrecht, for their methodological advice. The authors also acknowledge the Dutch Association for Psychomotor Therapy (NVPMT) for their support of the study. Special thanks to all the students who were willing to participate and to Els Satter, Willemijn Maas, Alie Bergsma, Florence Gramende, and Jasper Verheugt for their contribution to the accomplishment of the study.

References

1. Böddeker I and Stemmler G. Who responds how and when to anger? The assessment of actual anger response styles and their relation to personality. Cogn Emot 2000; 14: 737-762.
2. Mauss IB and Robinson MD. Measures of emotion: a review. Cogn Emot 2009; 23: 209-237.
3. Darwin C. The expression of the emotions in man and animals: University of Chicago press, 1965.
4. Frijda NH. The emotions. Cambridge, England: Cambridge University Press, 1986.
5. Tracy JL, Randles D and Steckler CM. The nonverbal communication of emotions. Curr Opin Behav Sci 2015; 3: 25-30.
6. Beatty GF, Fawver B, Hancock GM, et al. Regulating emotions uniquely modifies reaction time, rate of force production, and accuracy of a goal-directed motor action. Hum Mov Sci 2014; 33: 1-13.
7. Coombes SA, Naugle KM, Barnes RT, et al. Emotional reactivity and force control: The influence of behavioral inhibition. Hum Mov Sci 2011; 30: 1052-1061.
8. Coombes SA, Gamble KM, Cauraugh JH, et al. Emotional states alter force control during a feedback occluded motor task. Emotion 2008; 8: 104-113.
9. Davis PA, Woodman T and Callow N. Better out than in: the influence of anger regulation on physical performance. Pers Individ Dif 2010; 49: 457-460.
10. Marsh AA, Ambady N and Kleck RE. The effects of fear and anger facial expressions on approach-and avoidance-related behaviors. Emotion 2005; 5: 119-124.
11. Bresin K and Robinson MD. Losing control, literally: Relations between anger control, trait anger, and motor control. Cogn Emot 2013; 27: 995-1012.
12. Garfinkel SN, Zorab E, Navaratnam N, et al. Anger in brain and body: the neural and physiological perturbation of decision-making by emotion. Soc Cogn Affect Neurosci 2015; 11: 150-158.
13. Juslin PN and Scherer KR. Vocal expression of affect. In: Harrigan J, Rosenthal R and Scherer K (eds) The new handbook of methods in nonverbal behavior research. New York: Oxford University Press, 2005, p.65-135.
14. Owren MJ and Bachorowski J. Measuring emotion-related vocal acoustics. In: Coan J and Allen J (eds) Handbook of emotion elicitation and assessment. New York: Oxford University Press, 2007, p.239-266.
15. Bachorowski J. Vocal expression and perception of emotion. Curr Dir Psychol Sci 1999; 8: 53-57.
16. Johnstone T and Scherer KR. Vocal communication of emotion. In: Lewis M and Haviland-Jones J (eds) Handbook of emotions. New York: Guilford Press, 2000, p.220-235.
17. Trnka R and Stuchlikova I. Anger coping strategies and anger regulation. In: Trnka R, Balcar K and Kuska M (eds) Re-constructing emotional spaces: From experience to regulation. Prague: College of Psychosocial Studies Press, 2011, p.89-103.
18. Breakwell GM. Coping with aggressive behaviour: Universities Press, 1997.
19. Probst M, Knapen J, Poot G, et al. Psychomotor therapy and psychiatry: What's in a name? Open Complement Med J 2010; 2: 105-113.
20. Boerhout C, Swart M, Van Busschbach JT, et al. Effect of aggression regulation on eating disorder pathology: RCT of a brief body and movement oriented intervention. Eur Eat Disord Rev 2016; 24: 114-121.
21. Boerhout C, Swart M, Voskamp M, et al. Aggression Regulation in Day Treatment of Eating Disorders: Two-Centre RCT of a Brief Body and Movement-Oriented Intervention. Eur Eat Disord Rev 2017; 25: 52-59.
22. Golriz S, Hebert JJ, Foreman KB, et al. The reliability of a portable clinical force plate used for the assessment of static postural control: repeated measures reliability study. Chiropr Man Therap 2012; 20: 1-6.

23. Girodet P, Vaslin P, Dabonneville M, et al. Two-dimensional kinematic and dynamic analysis of a karate straight punch. Comput Methods Biomech Biomed Engin 2005; 8: 117-118.
24. Bolander RP, Neto OP and Bir CA. The effects of height and distance on the force production and acceleration in martial arts strikes. J Sports Sci Med 2009; 8: 47-52.
25. Mack J, Stojsih S, Sherman D, et al. Amateur boxer biomechanics and punch force. In: 28 International Conference on Biomechanics in Sports, ISBS-Conference Proceedings Archive (eds Jensen R, Ebben W, Petushek W, et al), Marquette, Michigan, USA, 2010. Wayne State University, Detroit, Michigan, USA: Biomedical Engineering Department.
26. Wooster M, Vock CA, Youngs P, et al. Real Time Boxing Sports Meter and Associated Methods. Patent 6,611,782, Washington, DC: U.S. Patent and Trademark Office, 2003.
27. Klapman M. Boxing glove accelerometer. Patent 5,723,786, Washington, DC: U.S. Patent and Trademark Office, 1998.
28. Yamagishi M and Miyaji C. Impulse force estimating device, impulse force estimating method, and medium storing impulse force estimation program. Patent 6,397,151, Washington, DC: U.S. Patent and Trademark Office, 2002.
29. Liu C, Fujimoto Y and Tanaka Y. Flexible Impact Force Sensor. J Sens Technol 2014; 4: 66-80.
30. Buśko K, Staniak Z, Łach P, et al. Comparison of two boxing training simulators. Biomedical Human Kinetics 2014; 6: 135-141.
31. Elderen T, Maes S, Komproe I, et al. The development of an anger expression and control scale. Br J Health Psychol 1997; 2: 269-281.
32. Neto OP, Silva JH, de Miranda Marzullo, Ana Carolina, et al. The effect of hand dominance on martial arts strikes. Hum Mov Sci 2012; 31: 824-833.
33. Cohen J. Statistical power analysis for the behavioral sciences . Hilsdale. NJ: Lawrence Earlbaum Associates 1988.
34. Kensinger EA. Remembering emotional experiences: the contribution of valence and arousal. Rev Neurosci 2004; 15: 241-252.
35. Moir G, Sanders R, Button C, et al. The influence of familiarization on the reliability of force variables measured during unloaded and loaded vertical jumps. J Strength Cond Res 2005; 19: 140-145.