Bachelor's degree

There is something about Mary… and Ted!

Training in mixed-sex groups makes you work harder. A study about the effort when training with the opposite sex.

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Kurskod: IH2020
Poäng: 15hp
Examinationsdatum: 2016-05-31

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Abstract

In many sport associations, regardless of level, women and men rarely practice together. Previous studies indicate that work groups are generally more efficient when there is an even distribution between the sexes. Could that also be the case in sports? This study aims to investigate whether the sex composition of a training group affects the effort and performance of the participants. Eleven volunteers participated in the crossover study consisting of three different 150-meter sprint conditions; individually, single-sex group and mixed-sex group. Sprint times, heart rate and RPE were recorded during all three trials. The result of this study suggests that there might be practical benefits in regards to physical performance and effort to exercise in a training group consisting of both sexes instead of training only with the same-sex or individually. The understanding could be useful in areas such as; training optimisation for both athletes and in patient- and rehabilitation groups, increasing efficiency in work environments, in schools and sports clubs striving for both athletic success and gender equality.

Key words

Single-sex, mixed-sex, effort, performance, training optimization
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Introduction

Throughout history sport has been an activity mainly dominated by men. In Europe it was not until the mid-20th century before women began to join sports clubs, and then it has mainly been in those with a defined female classification (Lindroth, 2011). Even in current times some of these differences persist – in many sport associations, regardless of level, women and men rarely practice together (Åstrom, 2011).

Studies indicate that work groups are generally more efficient when they have an even amount of males and females, compared to more homogenous groups (Badal & Harter, 2013; Myaskovsky, Unikel & Dew, 2005). One probable explanation for this effect is that a heterogeneous work environment stimulates innovation and creativity through the diverse ideas each different group brings to the team (Myaskovsky et al., 2005).

However, could there be more to it? Evolutionary psychology suggests that males and females are influenced by each other’s presence (Archer, 2006). This phenomenon is the result of billions of years of evolution which have fine-tuned our senses to the company of potential mates – inducing hormonal changes encouraging court-ship behaviour, thus improving our chances of reproductive success (Miller, 2000; Roney, Lukaszewski & Simmons, 2007).

From an evolutionary perspective there are good reasons for an individual to put in an extra effort to make the outcome as beneficial as possible when working in a group with potential partners, but few studies have investigated this relationship. A similar pattern seems to hold true in the sporting context. Although the effect of mixed-sex groups on sport performance has not been specifically addressed, one recent study investigating the relationship between sex-ratio and testosterone levels during a competitive ultimate frisbee tournament showed a positive correlation. Both male and female players showed increased testosterone concentrations when competing in a team with a more even distribution of males and females compared to when there were less of the opposite sex in the team (Miller, Maner & McNulty, 2012). There is a tight link between hormones and behaviour, where the environment affects a hormonal response which in turn brings about certain behavioural responses. In certain situation behaviours can also influence hormone release (Nelson, 2005). Therefore, could this rise in testosterone in the ultimate frisbee competitors bring about an increased amount of effort produced by the competitors (a behavioural response)? It’s certainly feasible
considering that testosterone boosts our competitive behaviour (Booth, Granger, Mazur & Kivlighan, 2006; Roney et al., 2007).

Understanding how mixed-sex groups influences the levels of effort can be useful in areas such as; training optimisation, efficiency of work place environments, patient and rehabilitation groups where physical fitness is a focus point, and in schools and sports clubs striving for both athletic success and gender equality. This study aims to explore whether the sex-ratio of a group influences the amount of effort produced by the participants, thereby increasing the training impulse and by doing so, exploring if there may be any benefits regarding training optimisation when being in mixed-sex groups.

**Background**

Few studies have investigated how the sex-ratio in a group effects the effort of each participant. A study aimed at determining how males and females differ in their response to competitive situations, in the form of a series of game/maze-like tasks, showed that females generally perform on a lower level when competing against men, than when competing by them self, or against other females – while the performance of men was more stable (Gneezy, Niederle and Rustichini, 2003). Similar responses have also been reported in sprint times in children and practical tasks in a work environment and (Gneezy & Rustichini, 2004; Myaskovsky et al., 2005). Interestingly, in the Gneezy et al 2003 study, the males showed a mean increase of 6,4% in performance (number of mazes solved) when they competed in a mixed-sex group compared to a single-sex group, while the females had a mean decrease 14,3% in performance in the two situations.

According to research in evolutionary psychology males and females are influenced by each other’s presence (Archer, 2006). In a mixed-sex environment people tend to show court-ship behaviours often, although not exclusively, aimed at finding a partner, thus improving our chances of reproductive success (Miller, 2000; Roney et al., 2006). Court-ship behaviour may be expressed in different ways by demonstrating certain abilities such as strength, fitness and courage (Ronay & von Hippel, 2010).
It has been suggested that there is a relationship between increased levels of testosterone and a display of courtship behaviour (Booth et al., 2006; Roney et al., 2007); this added to the fact that if a male interacts with a female he finds attractive there is an increase in his levels of testosterone (Miller et al., 2012; van der Meij, Buunk, Sande & Salvador, 2008; Roney et al., 2003; Roney et al., 2007), which suggests that testosterone facilitates the display of sexual behaviour in the presence of a potential mate. Therefore, there might be benefits to exercising in the presence of a potential partner when it comes to training optimisation due to testosterone being one of the most important hormones in the process of training adaptation, it is involved in the reparation and rebuilding of damaged muscle cells after training (Kraemer, Vingren & Spiering, 2008).

It is still debatable as to whether females are affected by the presence of males to the same extent. Some studies have reported changes in female’s competitive behaviour when exposed to photographs of males (McAlvanah, 2009), whereas other studies have not been able to show such changes (Baker & Maner, 2008). The reason is believed to be that females have not been exposed to the same level of intersexual competition as males, which in turn has not promoted their competitive behaviour to the same extent (Baker & Maner, 2008).

From an evolutionary biology perspective, courtship behaviour is aimed at trying to show that you would be a good mate by showing off your good traits to the opposite sex. The classic example is the peacocks’ tail – the bigger and more colourful the tail is the higher the male is rated by the females compared to his rivals. Humans are unique in this way compared to other animals – we have evolved countless alternative ways to express our mate value, e.g. different characteristics, abilities, and physical traits (Miller, 2000). It is reasonable to suppose that one such desirable character trait in modern sporting times would be athletic success. Therefore, there should be beneficial aspects with displaying that specific effort-related trait simply by increasing the effort whenever there is a possible mate nearby.

The fact that females seem to perform worse when competing against males shouldn’t be interpreted as the male presence impairing female performance in every context, as there is a difference between a real competitive situation and everyday life. In the maze experiments discussed previously, Gneezy et al. (2003) showed the performance of males drastically increased when the participants competed in a ‘winner takes it all’ tournament compared to a fixed reward from every maze solved. Both in the context of training and work, the
participants in a well-functioning group often strive towards the same goal, therefore it seems unlikely that females would react the same way and get discouraged as in a real competition.

Previous studies have mainly investigated how the performance of the sexes is effected by the competitive environment depending on the opponents. However, little attention has been directed towards how the participants’ levels of effort are affected by the gender composition in the group. In Gneezy et al’s (2003) experiment, the participants were asked to complete as many mazes as they could – which is a very cognitively demanding task. Although there was a 6.4% increase and 14.3% decrease in performance in a men and women respectively, the researchers concluded that this was statistically insignificant and did not provide enough detail in their paper to determine if these percentage differences where in fact meaningful differences. Taking their interpretation, it is possible that the participants where too focused on solving their mazes that they didn’t pay enough attention to the other participants for them to affect their performance. Given that the statistical approach has a clear bearing on the interpretation of this particular study, the relationship here seems unclear and warrants further investigation.

The literature pays little attention to how the presence of opposite-sex individuals influences the participants in a sporting context. In Miller et al’s (2012) study they investigated how the sex-ratio at an ultimate frisbee tournament affects the levels of salivary testosterone among the competitors. The results showed a positive correlation between the sex-ratio among competitors and their testosterone levels, however the study did not control for the amount of work the competitors were subjected to. It is possible that the teams with a higher proportion of females forced them to work harder, due to the physical differences between the sexes, which in turn increased their levels of testosterone.

The amount of training adaptation from a training session is dependent on the intensity by which the exercises are performed (McArdle, Katch & Katch, 2014). Thus by increasing the effort regardless of the performance outcome there should also be an increase in the intensity. If it is possible to bring forth a greater amount of effort when training in mixed-sex group, there are advantages to gain in terms of training optimisation. Therefore, the aim of this investigation is to explore if there are any possible benefits in regards of training optimisation when training in mixed-sex groups.
Aim and research questions

The aim of this study is to investigate the effects of the sex-composition in a training group, and how it may affect the effort produced by the participants in an exercise context. In order to achieve the aim of this study, the following research questions will be explored:

- How is the performance of males and females affected by the sex-compositions of the group?
- How is the perceived exertion of males and females affected by the sex-compositions of the group?
- Does males and females respond differently to the different sex-compositions of the group?

Method

Participants

11 participants (6 males & 5 females) consisting of students from Högskolan Dalarna and work colleagues (aged 20-35 years, mean age 24) participated in the study. The participants were recruited from classes, through fliers placed around the campus and the university’s Facebook group. One participant was excluded during the study due to unrelated injury. All participants answered a health screening survey (appendix 3) to meet the inclusion criteria of an average trained individual with good health and no injuries. All participants had verbal and written information and individually signed an informed consent (appendix 4) in line with World Medical Association (2012). Before the test sprints the participants performed a familiarization session by running practice laps around the course to ensure that the participants were fully familiar with the test procedure.

Procedure

Before each sprint test the participants performed a 10-minute standardized warmup consisting of 5 minutes’ low intensity jogging followed by three more moderately intense 150 meter runs with one minute’s rest in between each run. See figure 1 for a time line of the test procedure. The test consisted of a maximal 150-meter sprint performed under three different conditions. On one occasion they performed the sprint individually, another occasion in a mix-sex group (3 males & 3 females), and another occasion in a single-sex group (6 males or
6 females). The order of the conditions was balanced according to a latin square design for three conditions, this was to prevent the results of being affected by any order effect, by ensuring that every possible treatment order is represented. The sprints were performed at a similar time on separate days with at least one day's rest in between to allow sufficient recovery. The sprints were performed in an indoor sports hall, around a 75 meter plotted track. The sprint times were recorded with photocells (IVAR), the participants' heart rate was recorded with a heart rate monitor (Activio, Sweden) and a BORG-scale was used to estimate their perceived exertion. The results were immediately coded.

![Figure 1. Time line of the test procedure.](image)

The participants were instructed to start in a standing position with one foot on the starting line and on a starting signal perform a maximal sprint of two circuits of the track. They were asked not to slow down their pace until they reached a "false" finish line which was placed 5 meters after the real one, this was to discourage the participants from slowing down before reaching the goal (Australian institute of sport [AIS], 2013). Substitute runners were used when participants did not show up, the substitutes data wasn’t collected.

**Statistical analysis**

Mean effects of the conditions on sprint times and the 95% CL, were calculated with a made-for-purpose spreadsheet (Hopkins, 2003) which calculates an unequal-variances *t*-statistic.
computed for change scores between the three different sprinting conditions. Sprint times were log-transformed before analysis to get differences as percentages of the mean (coefficients of variation; CV), as this is the appropriate method for quantifying changes in most measures of athletic performance (Hopkins, Marshall, Batterham & Hanin, 2009). When entering a value for the smallest worthwhile change in performance, the spreadsheet provides the probability for the effects being substantial. A value of 0.65% was used for the sprint time measures, as it has been established as the smallest worthwhile change in sprint performance for non-athlete runners (Hopkins, 2001). The degree of the effects and their qualitative probabilities are interpreted and defined by the following scale: <0.25% - almost certainly not, <5% – very unlikely, <25% - unlikely, 25-75% - possibly/possibly not, 95% - likely (Hopkins, 2003). RPE measures were interpreted using effect size (ES). ES were reported and interpreted using the effect thresholds of 0.2, 0.5 and 0.8 for small, moderate and large effects based on the recommendations provided by Cohen (1988). Effect size values <0.2 were considered trivial. The analysis was performed on the test group as a whole, and for male and female separately.

**Ethical considerations**

A responsible conduct of research was used with emphasis on avoiding misconduct in terms of plagiarism and making up or skewing result (Horner & Minifie, 2011). The participants were either students at Högskolan Dalarna or work colleagues to the test leaders so consideration was given to keeping an objective mind, avoiding bias and not treating the participants differently because of their relation to each other (Vetenskapsrådet, 2011).

To minimize the risk of harm for the participants the inclusion criteria for the study was that they had to be physically active on a regular basis, this to ensure that they were well accustomed to the physical loads induced by the test. To ensure that the participants were of suitable fitness they were asked to complete a PAR-Q, those who did not meet the criteria were excluded from the study. A warm-up prior to each session minimised the risk of injury.

To guarantee confidentiality of the participants all data was coded and can only be traced back to an individual with a separately-stored coding system known only to the researchers (Vetenskapsrådet, 2011). The study was cleared by an ethics committee (Etikprövningsnämnden, Uppsala) before the recruitment started.
The participants consented to the study after receiving detailed written and verbal information about the study and were informed on their rights to withdraw their participation and results from the study (Vetenskapsrådet, 2011). Due to the study having a design which included partial deception to avoid behavioural bias, the participants assigned a second informed consent once they knew the complete aim of the study. The potential harm, both physical and ethical, versus benefit for the study was taken in consideration (Horner & Minifie, 2011; Vetenskapsrådet, 2011). The conclusion was that the potential benefit of gaining new knowledge from the study weighted over the minimal risk of potential harm in it.

**Validity and reliability**

Validity is associated with how appropriate the method chosen measures the matter that is to be examined and reliability means how reliable the measurement is (Hassmén & Hassmén, 2008). In the case of this study the matter that is being examined is the amount of effort produced by the participants depending on the sex-composition of the group. The word “effort” is in this paper defined as the perceived rate of exertion by an individual in physical work, and should not be confused with performance as it is related to the outcome. By assessing the relative amount of perceived rate of exertion for each participant between the three different sprint conditions it should be possible to determine if there are any differences in the amount of internal effort generated.

The RPE-scale was measured as an indicator of the participants internal perceived effort whereas sprint time as an external indicator of their performance. The RPE-scale has a high validity in measuring exercise intensity (Ritchie, 2012) and is a widely used scale in sport science research and teaching. To make it as reliable as possible the trials were identical every time, with the use of the same equipment, as well as matching the leader to the group being tested.

**Results**

11 participants (5 females & 6 males) completed all the three 150-meter sprint sessions with mean sprint times of 32,25 ± SD of 2,85 seconds (ranging from 28,15-37,5 seconds) with an overall average heart rate at the end of each sprint of 174 ± 18 bpm. The mean times (± SD) from each of the three different sprint are shown for males and females in figure 2.
How the sexes sprint times were affected by the different treatments are shown in table 1, together with a comparison of how the responses differed between males and females. Small to moderate worthwhile increases were observed in sprint performance for males and females when performing a mixed-sex sprint compared to an individual sprint. A slight possibility exists that there is a practical effect for males and females to sprint in a mixed-sex group instead of individually. The males experienced a small decrease in sprint performance in the single-sex group, while the females improved slightly compared to their individual sprints. It’s very likely that the males decrease in performance has a practical value, whereas the female’s improvement only shows to have a slight possibility of having a practical effect. A comparison between the sexes indicates small, but likely practically useful, tendencies that males are affected somewhat more by running in a mixed-sex group than females (table 2).
Table 1. Changes in sprint performance for males and females

<table>
<thead>
<tr>
<th>% change in measure (% 95CL)</th>
<th>Effect size for difference between conditions</th>
<th>Chance if true effect is practically worthwhile</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SS-In</td>
<td>MS-In</td>
</tr>
<tr>
<td>All</td>
<td>0,9 (3,5)</td>
<td>-2,5 (3,2)</td>
</tr>
<tr>
<td></td>
<td>(trivial)</td>
<td>(small)</td>
</tr>
<tr>
<td>Males</td>
<td>2,5 (1,8)</td>
<td>-2,2 (6,4)</td>
</tr>
<tr>
<td></td>
<td>(small)</td>
<td>(small)</td>
</tr>
<tr>
<td>Females</td>
<td>-1,1 (9,5)</td>
<td>-3,0 (3,9)</td>
</tr>
<tr>
<td></td>
<td>(small)</td>
<td>(moderate)</td>
</tr>
</tbody>
</table>

* Interpretation of effect size is based on Cohen’s (1988) effect size criteria.
** 95% CL; add or subtract number to mean effect to obtain the 95% confidence limits for the true difference.
*** Magnitude of the practical worthwhileness was based on a smallest worthwhile change of 0.65% in sprint time.
**** In = Individual, SS = Single-sex, MS = Mixed-sex
Table 2. Difference in effect between males and females in sprint times

<table>
<thead>
<tr>
<th>% change in measure</th>
<th>Difference males - females (%95CL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SS-In</td>
<td>MS-In</td>
</tr>
<tr>
<td>3,6 (7,1)</td>
<td>0,8 (6,7)</td>
</tr>
</tbody>
</table>

* 95% CL; add or subtract number to mean effect to obtain the 95% confidence limits for the true difference.
** In = Individual, SS = Single-sex, MS = Mixed-sex

The mean RPE (± SD) from each of the three different sprints are shown for males and females in figure 3.

Figure 3. Mean RPE for males and females.

On average the participants experienced a moderate increase (ES = 0,67) in perceived rate of exertion (RPE) from the individual sprint to the mixed-sex sprint, while the difference between the individual sprint and the single-sex sprint should be considered trivial (ES = 0,16). The perceived exertion of the different sprints of males and females can be seen in table 3. Both males and females experiences the mixed-sex trial as being the most strenuous.
Table 3. Changes in RPE for males and females

<table>
<thead>
<tr>
<th></th>
<th>% change in measure (% 95CL)</th>
<th>Effect size for difference between conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>In - SS</td>
<td>In - MS</td>
</tr>
<tr>
<td>All</td>
<td>6,2 (14,8)</td>
<td>26,3 (29,9)</td>
</tr>
<tr>
<td></td>
<td>0,16 (trivial)</td>
<td>0,67 (moderate)</td>
</tr>
<tr>
<td>Males</td>
<td>4,6 (21,3)</td>
<td>34,8 (72,9)</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>0,58 (moderate)</td>
</tr>
<tr>
<td>Females</td>
<td>8,2 (36,3)</td>
<td>16,8 (21,5)</td>
</tr>
<tr>
<td></td>
<td>0,85 (large)</td>
<td>1,41 (large)</td>
</tr>
</tbody>
</table>

* Interpretation of effect size is based on Cohens (1988) effect size criteria.
** 95% CL; add or subtract number to mean effect to obtain the 95% confidence limits for the true difference.
*** In = Individual, SS = Single-sex, MS = Mixed-sex

A comparison between males and females (table 4) indicates that females possibly perceives both the single-sex and mixed-sex trials as being more strenuous than males, whereas the differences in the single-sex trial are minor.

Table 4. Difference in effect between males and females in RPE:

<table>
<thead>
<tr>
<th></th>
<th>% change in measure</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Difference males - females (%95CL)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SS-In</td>
<td>MS-In</td>
</tr>
<tr>
<td></td>
<td>3,3 (29,0)</td>
<td>15,4 (66,9)</td>
</tr>
</tbody>
</table>

* 95% CI; add or subtract number to mean effect to obtain the 95% confidence limits for the true difference.
** In = Individual, SS = Single-sex, MS = Mixed-sex
Discussion

The aim of this thesis was to explore the effects of training in a mixed-sex group with regards to training optimisation. The key findings of this study is that both male and females experience a worthwhile increase in sprint performance when performing in a mixed-sex group compared to sprinting alone, to the authors knowledge the effect of mixed sex groups on sport performance has not yet been specifically addressed.

The fact that the male’s performance with regards to their sprint times decreased in the single-sex group might be because the equalness between the male competitors which caused them to run in a tight group. This may have slowed them down due to limited running space. At one point during the sprint one male participant physically pushed and pulled several of his counterparts and by doing so affecting their performance. In contrast, the females were more spread out during their trial and did not show such aggressive tendencies and improved during their single-sex run compared to running individually.

The pattern of the RPE that the participants reported after each trial mimics that of their sprint times. The mixed-sex condition was the fastest trial for both males and females, and it was also the condition the both sexes perceived as most exerting. It is important to note that an increased effort does not automatically result in an increase of performance, though it is a vital factor to performance, there are other essential mechanism at play, for example sufficient amounts of nutrition and recovery are needed. If they are not catered for, the performance will suffer, no matter the amount of effort produced by the person. The results indicate that the improved sprint times might spring from an increased amount of internal effort produce by the participants as a response to the different environmental settings.

In general, these results are in line with previous research which have investigated how environmental factors may affect the performance of males and females, but in contrast to other studies which have shown that female performance may be impaired by the presence of a males in certain environments (Gneezy et al., 2003; Gneezy & Rustichini, 2004; Myaskovsky et al., 2005), our evidence suggests that this might not be the general case, and that the effect might differ between different types of environments and situations.

One factor that might have contributed to the differences, with regards to the female’s performance in the presence of males, compared to some previous literature could be the size of the groups and that they contained an equal amount of both males and females. By having
enough female participants in a group it could allow them to not only compete solely against the males, but against the other females in the group – this may lead to them overlooking the male’s physical advantages, and instead focus on beating the other females and consequently avoid getting discouraged by the males, thus improving their performance.

In different scenarios a female's performance may be impaired due to her being a minority in that group and thus being discouraged by it, but when in with a group majority of females, they might find comfort in each other’s presence and therefore perform better. In sex-ratio studies it is found that the ratio can affect physiological responses (Miller et al., 2012) as well as in sociological setting, when women are in the majority they are more talkative than when being solo (Myaskovsky et al., 2005). So the question arises whether different sex-ratios during training would affect the performance in different ways or not.

Even though the sprints were not arranged as a competition there was a clear difference in competitive and aggressive behaviour between females and males, regardless of the setting being mixed-sex group or single-sex group. The males displayed a more physical aggressiveness towards each other, but not towards the females, whereas the females did not express such tendencies, at least not as strongly. The females lack of aggressive behaviour should however not be mistaken for an absence of competitiveness which instead may be displayed in subtler ways, without the aggressive tendencies (Coulomb-Cabagno & Rascle, 2006).

The difference in behaviour between the sexes goes in line with a study investigating how the display of aggressiveness may differ between different sports, and between males and females, where males show more aggressive behaviour (Coulomb-Cabagno & Rascle, 2006). These behavioural differences between the sexes may be more easily understood by the help evolutionary psychology and more specifically the process of sexual selection. Even though there were no females around during the males single-sex trial, the males were still exposed to the forces of the intersexual competition, it is probable that the need to assert oneself maybe even stronger in areas dominated mainly by males due to their natural tendency to be more competitive, thus promoting the competitiveness in the group even further, and by doing so impairing the group’s overall performance (Niederle & Vesterlund, 2008). The stronger need to assert themselves may be the reason why some of the male participants expressed that they sensed the single-sex sprint as being more tense and competitive than the mixed-sex sprint.
This study took place in an indoor sports hall, this has two benefits. First it forces the participants to stay close together during the whole test session having them exposed to each other’s presence throughout the whole test. Second, the experimenters were able to closely control the test environment, preventing external factors, like the presence of the opposite sex, to affect the results; thereto only an experimenter of the same sex as the participants attended during the singe-sex and individual trials. Even though the indoor sports hall has several benefits one drawback was the narrow corners which forced the participants to slow down before entering the corners, this may affect the intensity of their sprints in the group session due to less space. However, this applied to all of the participants and should therefore not affect the result.

The study design was based on a latin square design and ideally requiring 24 participants (Hopkins, 2006), but because of difficulties in recruiting volunteers, only 12 participants (of which 11 completed the whole study) were used. Unfortunately, the drop out causes the study to not be completely balanced as it now has an uneven number of males and females, added to that it now misses a certain treatment order for the females, which means that the treatment order cannot be taken in to complete consideration when interpreting the effect of the interventions. Due to the low number of participant, each individual has a large impact on the credibility of this study, therefore caution is advised when drawing conclusions. The studies small size is certainly of importance when interpreting the males single-sex results and comparing them to the mixed-sex trials, due to some males adopting a more aggressive tactic during the single-sex trial it caused the whole field to slow down. It is probable that with a larger sample size and a more spacious track these effects would have washed out.

The sexual activity levels of the participants were not controlled for which might have an effect on the results since a previous study indicates, although not reaching significant results, that males who have not had any sexual contact in the last month had slightly higher baseline levels of testosterone compared to men who have had sexual contact more recently (van der Meij et al., 2008). The linkage between testosterone levels and competitive behaviour (Booth et al., 2006; Roney et al., 2007) could have caused the more sexually deprived participants to work somewhat harder than their more sexually satisfied counterparts.

This study was conducted from and heteronormative standpoint, assuming all of the participants were attracted to members of the opposite-sex; making the results hard to generalize to people with different sexual preferences. Supposing that all members were
heterosexual also entails the chance of some of the participants actually being of a different sexual preference which might affect the result since they could respond differently to the groups sex-composition.

Considering the connection between environmental factors, behaviour, and hormonal response (Nelson, 2005), there could be additional benefits to the training optimisation apart from just the increased physical effort. Subsequently males, and to some extent even female’s, testosterone levels have been observed to increase in the presence of the opposite sex (McAlvanah, 2009; Miller et al., 2012; van der Meij et al., 2008; Roney et al., 2003; Roney et al., 2007), therefore there may perhaps even be pure physiological winnings in regards of the training optimisation stemming from possibly beneficial hormonal changes, since testosterone plays a major part in the processes of training adaptation (Kraemer & Ratamess, 2005), this could be an area of interest for future investigation. Though it is important to acknowledge that testosterone is not the only hormone involved in social interactions and training adaptation. The catabolic hormone cortisol for example, which is released during stress, might dampen the benefits of increased testosterone levels with its ability to breakdown muscle protein (Kraemer & Ratamess, 2005). Another hormone that is released during stress is oxytocin, but it is also released when interacting with friends and family and has an attenuate effect on stress (Shamay-Tsoory & Abu-Akel, 2016). Could oxytocin’s stress reductive effects lower the degree of competitiveness that is induced by the increased testosterone levels? Though it is only speculative, it raises the question if there are any differences in the response when training with strangers of the opposite sex, or with closer friends and family?

In conclusion, even though the studies small size and the wide range of individual variation within the test groups, the result suggests that there might be practical benefits in regards to physical performance and effort when exercising in a training group consisting of both sexes instead of training only with the same-sex of individually. The improvements appear to be similar for both males and females, though males appear to respond slightly more to the mixed-sex intervention than females. The understanding of how the physical effort of the members in a group may change between different factors in the environment could be useful in a variety of areas such as; maximizing training optimisation for both elite athletes but also in patient- and rehabilitation groups where any gain in physical fitness is of great value, increasing the efficiency in work environments, and in schools and sports clubs striving for both athletic success and gender equality.
References

Monography


Anthology


Journal article


Miller, S. L., Maner, J. K., & McNulty, J. K. (2012). Adaptive attunement to the sex of individuals at a competition: the ratio of opposite- to same-sex individuals correlates with changes in competitors' testosterone levels. *Evolution and Human Behavior, 33*(1), 57-63.


Appendix 1. Information ad test participants.

Vill du vara en testperson i en forskningsstudie?

Kan man optimera träning genom att träna ensam eller i grupp?

Det är många idag som utför fysisk aktivitet. Vissa gör det med sin partner, en vän, ensam eller i en grupp. Fördelarna med att träna i grupp är många, både på det sociala och fysiologiskaplanet. Studiens syfte är att undersöka effekten av att träna i grupp jämfört med att träna individuellt, samt att jämföra resultaten mellan kvinnor och män.

Vi söker dig som:

- 20-35 år
- Frisk
- Motionerar regelbundet

Om DU väljer att delta kommer du få börja med att genomgå en hälsoundersökning samt svara på en blankett angående din hälsa och civilstatus. Om du anses vara frisk nog att medverka som testperson så kommer du vid tre olika tillfällen (ca 60 minuter per tillfälle) springa 200m. Vi kommer ta fyra st saliva prover vid vardera tillfälle. All information och prover du lämnar är kodade så din identitet är skyddad.

Det är viktigt att DU inte ätit 3 timmar innan du kommer. Samt att DU INTE tränat hårt, druckit alkohol, snusat eller intagit koffein 24 timmar innan vardera tillfälle.

Ditt deltagande i studien är helt frivilligt. Du kan när som helst avbryta ditt deltagande utan närmare motivering.

För att anmäla intresse om att delta i studien eller vid frågor samt behov av ytterligare information kontakta nedanstående ansvariga

Forskare: Dr. Emma Hawke, ehw@du.se, 070-191 86 10, 023-77 86 10
Forskare: Prof. Michail Tonkonogi, mtn@du.se 070-820 64 35
Forskarassistent: Asia Mujkic, h13asimu@du.se, 072-358 21 35
Forskarassistent: Robert Rantala, h13robra@du.se, 073-622 61 93
Appendix 2. Information letter test participants.

Information om studien: Kan man optimera träning genom att träna ensam eller i grupp?

Du tillfrågas härmed om deltagande i denna undersökning.

Bakgrund / Syfte
Det är många idag som utför fysisk aktivitet. Vissa gör det med sin partner, en vän, ensam eller i en grupp. Fördelarna med att träna i grupp är många, både på det sociala och fysiologiskaplanet. Studiens syfte är att undersöka effekten av att träna i grupp jämfört med att träna individuellt, samt att jämföra resultaten mellan kvinnor och män.

Vad skulle ditt deltagande innebära?
Om du bestämmer dig för att delta i studien så behöver du komma in till LIVI-labbet fyra gånger, där du kommer behöva springa 200m samt lämna salivprover vid vardera tillfälle.

Vid vardera testtillfälle börjar du med en 10 minuters uppvarmning där du joggar. Därefter kommer du genomföra en 200m sprint på en löparbana och vi kommer mäta tiden det tar dig att genomföra den. Vid varje tillfälle kommer du ge oss fyra salivprov (innan allt börjar, efter uppvarmning, direkt efter 200m sprinten samt 20 minuter efter). Salivproverna tas med hjälp av en ”oral swab” vilket kan liknas med en bomullstuss. Du lägger den i munnen i ca 1-2 minuter och låter den suga upp saliven. Från denna ”oral swab” kommer vi få ut ca 0,2 cl av saliv. Du kommer genomföra denna proceduren (sprinten och fyra salivprover) vid tre olika tillfällen mellan klockan 15:00 och 20:00 (ca 60 minuter per tillfälle). Det kommer vara minst en dags vila mellan varje tillfälle. Vid ett tillfälle kommer du genomföra sprinten ensam, medan de andra två tillfällena sker i gruppen. Totalt kommer du då komma in fyra gånger vilket tar totalt 3,5 h.


Vad kommer vi mäta?
Förutom tiden tar vi mätningar av din hjärtfrekvens samt din upplevda ansträngning enligt BORG-skalan. Vi kommer även mäta hormonhalterna av testosteron och kortisol i dina salivprover. Förhållandet mellan dessa två hormoner visar oss effekten av utförd träning.

Hur hanteras dina biologiska prover?
Dessa prover kommer att bevaras i LIVis biobank (reg. no 880). Alla provsvar kommer att kodas och kan inte kopplas till en individ utan en kodnyckel. Dina prover kommer endast användas till analyser som du har godkänt. Om vi skulle vilja använda dina prover i framtiden kommer vi ansöka om ett nytt etisk tillstånd, samt om etikprövningsnämnden kräver kontakts du för nytt samtycke.

Eventuella risker
Du kommer få tvätta händerna innan varje salivprov för att minska eventuell smittorisk. Det kommer även finnas person/personer som är utbildade i första hjälpen i närheten samt ett första förband.

Vad får du ut av detta?
Efter varje test tillfälle kommer du bjudas på fika. Om du är intresserad finns det möjlighet att se dina egna resultat samt hela studiens resultat när den är färdig (i en skriven rapport och som muntlig presentation), vilket kan ge en vägledning för valet av din optimala träningsform. Du kan även be om att du inte får reda på dina egna resultaten.

DITT deltagande kommer bidra med den vetenskapliga förståelsen inom områdena:

1. Att förstå hur träning i grupp eller ensam kan påverka faktorer som är viktiga för träningseffekten - vi vill besvara frågan om vi kan optimera den hormonella signal som kroppen behöver för tillväxt samt reparations av vävnader såsom muskler genom att träna i grupp eller ensam.


Hur hanteras din personliga information?
All information förvaras i en dator samt kodas så det inte kan ske någon koppling tillbaka till dig. Denna information kommer inte delas med någon organisation, företag eller annat universitet. Efter tio år kommer all information förstöras. Under denna tid har du befogenhet att ta del av din information samt kräva ändringar av felaktig information. Dina resultat kommer att behandlas på så vis att ingen obehörig har tillgång till dem. Resultaten från studien kommer att publiceras i till exempel en tidsskrift. Men din identitet kommer vara skyddad. Personuppgiftsansvarig är Högskolan Dalarna. Enligt personuppgiftslagen (PuL) har du rätt till att få ta del av samtliga uppgifter om dig som hanteras och vid behov få eventuella fel rättade. Kontaktperson är Dr. Emma Hawke, ehw@du.se, tel 070-191 86 10 eller 023-77 86 10

Försäkring
Vid tester som genomförs vid LIVI, Högskolan Dalarna gäller särskilt personskadeskydd från Kammarkollegiet. Försäkringen gäller endast i den lokal där testet sker, ej under resa till och från testlokalen. Försäkringsskyddet gäller för personskada eller sjukdom som drabbat testpersonen under den tid försäkringsskyddet gäller, oavsett orsak eller vållande. Visar sig en personskada eller sjukdom först efter avslutat försök, eller kan det annars ifrågasättas om en inträffad personskada eller sjukdom har drabbat försökspersonen under den tid försäkringsskyddet gäller, skall en medicinskt sakkunnig bedömning ligga till grund för ställningstagandet i frågan.

Din rätt som deltagare

Vid frågor eller behov av ytterligare information kontakta nedanstående ansvariga

Forskar: Dr. Emma Hawke, ehw@du.se, 070-191 86 10, 023-77 86 10
Forskar: Prof. Michail Tonkonogi, mtn@du.se 070-820 64 35
Student: Asia Mujkic, h13asimu@du.se, 072-358 21 35
Student: Robert Rantala, h13robra@du.se, 073-622 61 93

Idrotts- och Medicin, Högskolan Dalarna
Appendix 3. Physical activity readiness questionnaire, LIVI.

Hälso- och personlig informationsformulär

Personupplysningar

Datum ________________
Namn ___________________________ Personnummer __________
Adress ___________________________ Postnr ____________________
Telefon ___________________________ E-mail __________________________
Mobil __________________________
Tel anhörig (ICE): __________________________

Har du eller har du tidigare haft någon av följande sjukdomar?

1. Ofta förekommande förkylningar  Ja    Nej
   Kraftig förkylningar
   Senaste behandling med antibiotika __________________________

2. Halsfluss eller annan halsinfektion   □  □

3. Hössnuva   □  □

4. Nässelfeber   □  □

5. Astma   □  □

6. Överkänslighet för föda, medicin, tvättmedel el dylikt?   □  □

7. Har du fått bedövning hos tandläkare?
   Har du fått någon reaktion på detta?
   Om Ja vilken ? __________________________

8. Diabetes (sockersjuka)   □  □

9. Lungsjukdomar   □  □

10. Hjärtsjukdomar   □  □

11. Högt blodtryck   □  □
   Lågt blodtryck   □  □

12. Magsår, mag- eller tarmkatarr
   Medicin mot magbesvär   □  □

13. Någon form av gulsot   □  □
14. Leversjukdomar? □ □ □

15. Ryggbesvär? □ □ □

16. Huvudvärk (ofta förekommande eller migrän) □ □ □
   Äter du smärtstillande medel mot huvudvärk? □ □ □

17. Använder du sömnmedel? □ □ □


19. Har du ordinerats medicin för långtidsbruk? □ □ □

20. Tar du medicinen fortfarande? □ □ □

   Vilket läkemedel? När? __________________________

Övriga upplysningar

21. Tidigare idrottsaktivitet/träning □ □ □

22. Nuvarande idrott/träning □ □ □

   Vad __________________________ och hur ofta: ______

23. Röker eller snusar du □ □ □

   Hur mycket: __________________________

24. Äter du all sorts mat? □ □ □

   Om inte precisera: __________________________

25. Äter du någon form av kosttillskott (vitaminer, proteiner etc) □ □ □

26. Känner du dig fullt frisk? □ □ □

27. Är du förnuvarande i ett förhållande □ □ □

Uppmätt blodtryck vila:_______________
Längd (cm):__________________________
Vikt (kg): ____________________________

Jag har läst och förstått HELA blanketten

Signatur:____________________________ Datum:________________________
Appendix 4. Informed consent.

Informerat samtycke

Projekt: ”Kan man optimera träning genom att träna ensam eller i grupp?”

Jag har muntligen informerats och har fått tillfälle att ställa frågor. Jag har tagit del av ovanstående skriftliga information och samtycker till deltagande i studien. Jag är medveten om att mitt deltagande är helt frivilligt och att jag när som helst och utan närmare förklaringar kan avbryta mitt deltagande.

……………………                   ………………………………………………………..
datum                   namnteckning och namnförtydligande

försöksledare:

………………………………………………………………

Denna blankett finns i två likalydande kopior varav försöksperson och försöksledare har var sin kopia