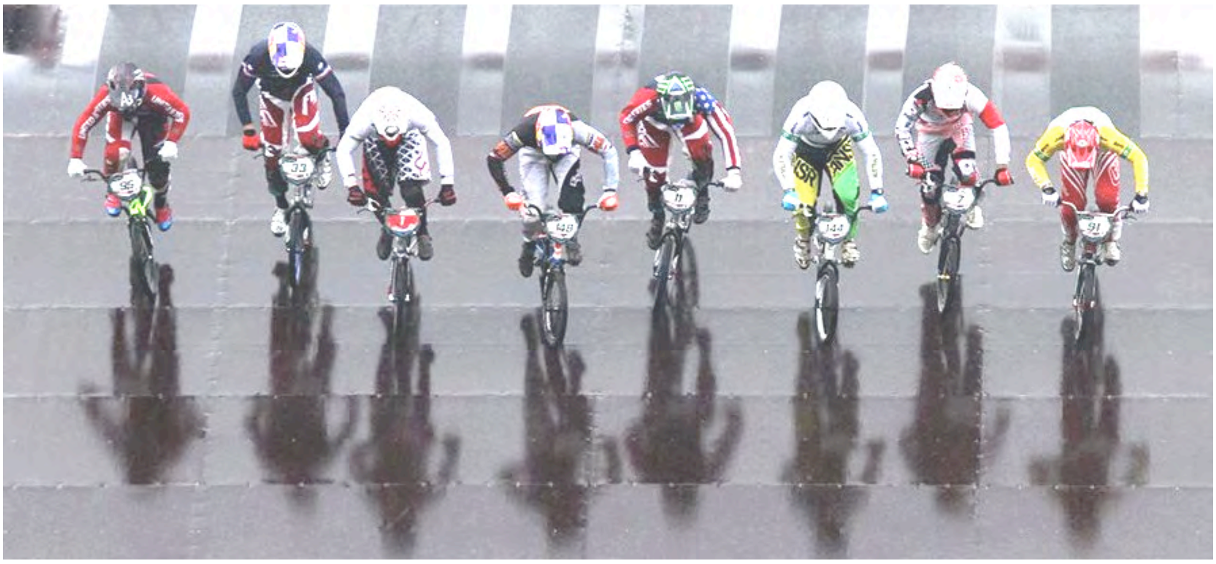

Social Facilitation in BMX Racing

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Index

Abstract

The following paper was set out to test social facilitation effects in the sport of BMX racing. Data from the 2013 World Cup Series, as well as the World Championships, were analyzed for these purposes. Comparing Time Trial and Head-to-head racing, results, albeit appearing weak and only partially, point to the possibility of the presence of the effect. This effect seems to emerge, in line with the literature, in the second part of the race. Furthermore, considered correlations between performance in Time Trials and racing, turned out to show a positive relationship between the two racing formats. This finding seems to contradict predictions emerging from research, although maybe reasonable for BMX racing. The last hypothesis tests whether the effect is due to practice effects and found arguments pointing to this not being the case. Limitations of this investigation as well as factors influencing and explaining the results are presented and discussed.

"[…] Time Trials and racing are two completely different things. It's not every time when the guy who wins the Time Trials is always gonna win the race… "

Connor Fields (Bmxlive.tv, 2014c)

It seems to be a widely spread belief that racing with others leads to better performances than racing alone against the clock, be it while running, walking, cycling or doing other sports. A belief that rose from experience and that has been supported by research until today. The following paper wants to give the reader an impression of the psychological concept of social facilitation, the underlying theory of better performances in social situations, and thereby bridging the gap between what we know about social facilitation in situations of everyday life, and the scientific encounters with social facilitation in the world of sports. Following, I would like to introduce the reader to the sport of Bicycle Moto Cross (BMX) racing, a young and exciting cycling discipline, and test it with regard to the presence of social facilitation effects. Using real data from racing competitions, the exploration focuses on whether facilitation effects can be found in this fast and sprint-like sport, how strong these effects are, and whether other findings from the literature also hold true for BMX.
But let me begin with an excursion into the world of psychology and how the fascination with social facilitation arose and developed.

I Social facilitation

"Man is by nature a social animal" *

Aristotle

Cockroaches do it (Zajonc, Heingartner & Herman, 1969)…Chickens do it (Keeling & Hurnik, 1993)…Turtles do it (Carr & Hirth, 1961)…Rats do it (Levine & Zentall, 1974)…and of course people do it (e.g. Zajonc, 1965; Zajonc & Sales, 1966; Hunt & Hillery, 1973; Grindrod, Paton, Knez & O'Brien, 2006)…
Social Facilitation: the oldest experimental paradigm in social psychology (Zajonc, 1965). Its first appearance is set to be in a highly discussed and cited paper at the end of the 19th century: "The dynamogenic factors in Pacemaking and Competition" (Triplett, 1898). Some believe it to be the first experiment in social psychology (Allport, 1954 as cited in Stroebe, 2012), although this opinion has been criticized (Haines & Vaughan, 1979, Stroebe, 2012). One thing however seems to be the case: it might be in fact, the first research paper in the at that time still unknown field of sport psychology (Davis, Huss & Becker, 1995) and the beginning of sport psychology in North America (Weinberg & Gould, 2011).

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* The original wording Aristotle used at his time said: "man is by nature a political animal". The meaning of the Greek word "politikus" can however be more precisely translated with "social" in today's understanding (Mulgan, 1974)

I.i The Concept of Social Facilitation

Triplett (1898), quite interested in cycling racing himself, investigated the phenomenon that different modes of racing result in different racing performances: riders had faster racing times in modes involving a pacemaker or other competitors, compared to unpaced races (Time Trial racing). This is what we today call social facilitation: “the changes that occur when individuals perform in the presence of others versus alone” (p.163, Aiello & Douthitt, 2001).

Triplett (1898) attributed this effect to a couple of possible theories:

- Suction theory, stating that the vacuum between two riders draws the one following closer;
- Shelter theory, which accounts for the advantageous effects of seeking shelter behind a leader against wind and air resistance;
- Encouragement theory, relating better performances to the presence of a friend for support;
- Brain worry theory refers to the fact that a leader has to think more than followers, is worrying more, and therefore more deprived of energy;
- Theory of hypnotic suggestion, which suggests a hypnotic effect from concentrating on a front man’s wheel and
- Automatic theory: this one tries to explain better performances as a result of the leader being more energy deprived and fatigued at the end of the race because followers only need to hang onto the leader. In a final spurt, the follower then has more resources left to win the race.

However, the theory on the effects of dynamogenic factors (also called Theory of Competition) seems most plausible to Triplett. This theory focuses explicitly on the psychological effects other riders bring, suggesting that the presence of competitors is arousing a competitive instinct, which works as an inspiration for greater effort. “A competitive situation may be defined as a situation wherein an individual’s success in achieving some goal is determined by some characteristic of his response relative to that of another individual – either present or implied.” (p. 428, Wankel, 1972). A situation where “[…] at least two individuals (present or implied) are seeking the same scarce goal, and thus what one gains the other loses […]” (p.428).

Furthermore, Triplett’s data also suggest that different riders favor either one of the two competition modes. He observed that riders good in racing competitions did not show particularly good results in Time Trial races, and vice versa. To test this hypothesis, in the second part of his paper, Triplett (1898) conducted an experiment using 40 children and the simple motor task of turning a reel for a sewed on flag to go around four times. He had the children perform the task either alone or together in the form of a competition, using two groups with varying line-ups of the two conditions (to rule out practice effects). His results had Triplett point toward there being three kinds of categories the children would fall into: a stimulated group, which showed faster times in competition trials, those that were little affected by the race and those that were negatively affected.

However, these results have been criticized (Stroebe, 2012) and should be interpreted carefully. Strube (2005) used current statistical knowledge and methods to reexamine Triplett's (1898) original data. Although he still calls Triplett's experiment "admirable" (p.281) his statistical analyses barely show hints of social facilitation effects as originally proposed.

Still, a new idea and paradigm had been set in motion at that time, and thankfully so, letting various research questions and hypotheses follow. Although not called that way by Triplett (1898) himself, Allport (1924), over twenty years later, was the first to coin this phenomenon the *Social Facilitation* effect and defined it as "consisting of an increase of response merely from the sight or sound of others making the same movements" (p.262, as cited in Lavallee, Williams & Jones, 2008). Together with the factor rivalry ("an emotional reinforcement of movement accompanied by the consciousness of a desire to win" Allport, 1924, p.262), social facilitation influences performance of the individual. This rivalry, doing better than others, might even be the leading motivational factor in competition (Wankel, 1972). Zajonc (1965) and Zajonc and Sales (1966) added that it is highly trained responses, or dominant responses, that are facilitated by others. Subordinate responses, those that are not highly trained, suffer in facilitation conditions. Whether the presence of others is beneficial or disadvantageous relies on the performed task. If the task is a highly trained and automated task to the subject, performance will be enhanced. If however the task is new, complicated or completely unknown, performance will suffer under conditions of others being present.

Within social facilitation, two experimental paradigms have emerged: using audience effects and co-action effects (Zajonc, 1965). Audience effects are due to passive spectators, whereas co-action refers to the presence of other individuals that are also engaged in the task (but without cooperation). Although the current paper focuses on the effects of co-actors, audience effects will be presented in parallel since its findings contribute to a more thorough understanding.

On a side note, not only actually present persons can induce social facilitation effects. Even favorite TV characters depicted on a screen can lead to altered behavior (Gardner & Knowles, 2008). Furthermore, Gamblers are affected when other player's wins are displayed (sound and sight, Rockloff & Dyer, 2007). The social influence in social facilitation effects therefore rather seems to resemble a "social feeling" instead of actual social situations (although the latter always automatically induces this social feeling).

I.ii The Search for an Explanation

How can social facilitation effects be explained? Triplett (1898) already offered several theories, some of which more plausible than others, with the most important one (from a psychological standpoint) certainly being the theory of dynamogenic factors. This approach, later represented by researchers favoring activation theories, is however not alone, but one of a couple of highly discussed explanations. Strauss (2002) summarized the to date existing theories trying to sort the effects of social facilitation into four categories: activation theories (generalized drive hypothesis, evaluation approaches, alertness hypothesis, monitoring hypothesis, challenge and threat), attention theories (distraction-conflict hypothesis, capacity model), self-presentation focused models and the cognitive-motivational model. The cognitive-motivational model is based on a theory by Paulus (1983, as cited in Strauss 2002) involving the processing of an easy/difficult task. Because of difficulties testing a model as such, appropriate research will not be presented here. The interested reader is however encouraged to study the before-mentioned references. Research findings concerning the first three theories will be presented in the following.

I.ii.a Activation Theories

Drive theory, as defined by Baron, Branscombe and Byrne (2008), describes how “the presence of others will improve individual’s performance when they are highly skilled at the task in question (in this case their dominant responses would tend to be correct) but will interfere with performance when they are not highly skilled – for instance, when they are learning to perform it (for their dominant responses would not be correct in that case)” (p.396).

Zajonc, Heingartner and Herman (1969) proposed that the presence of others is a source of general drive, acting by either directly influencing behavior or as a general energizer. They used cockroaches to test this hypothesis and a research design involving co-actors as well as an audience to rule out cueing effects by the cockroaches for each other. Still the cockroaches’ performance was enhanced when others were present.

Levine and Zentall (1974) used rats as their test population and also support the idea that a conspecific’s presence arouses drive.

Other researchers are convinced that the mere presence of others is sufficient enough to induce social facilitation effects (Hazel, 1978). Choosing a condition where participants were not aware of the fact that they were being evaluated, they concluded that evaluation apprehension is therefore not a necessary condition for social facilitation to occur. This hypothesis has also been supported by Schmitt, Gilovich, Goore and Joseph (1986): Having a spectator blindfolded and equipped with soundproof headphones, and therefore not being able at all to see, hear, and accordingly, evaluate the participant, also induced social facilitation effects in simple and complex tasks.

Although in favor of the increased arousal theories of social facilitation, Zajonc (1965) notes that other factors might still be present as well, e.g. imitation in the case of co-action conditions.

I.ii.b Attention Theories

The distraction-conflict idea behind social facilitation argues that “drive effects in social facilitation/impairment research are caused by species mates distracting the organism from the ongoing task activity thereby creating conflict between attending to the task and attending to the distractor” (Sanders, Baron & Moore, 1978, p.291-292). A distractor can be anything that is not related to the individual’s task. Hence, an audience or co-actor(s) can function as distractors (in these cases, social distractors). The individual is motivated to gain social comparison information, which distracts him or her from the primary task at hand. Their research pointed to results that the co-action condition only enhanced performance when comparison pressure was introduced; hence, the mere presence was not enough to induce social facilitation effects. Motivating participants to engage in social comparison therefore introduced distraction that led to increased drive, which resulted in increased performance. Furthermore, findings underlined the importance of co-actors working on the same task.

Even before Sanders (1978), Innes and Young (1975) already observed that an audience without explicit evaluative function did not show faster times in a 12-point star mirror tracing task. With an audience present, participants took more time and made fewer errors (as if expecting outcomes).

Other research has supported this idea (Groff, Baron & Moore, 1983). If there was no conflict between the social stimulus and the task at hand, no social facilitation effects were observed. Also, the distraction theory was supported using non-social stimuli. If participants had to choose between which of two tasks to do and when and for how long, they chose more dominant responses than participants who were not distracted that way, because this choice had been made for them (they were told what to do). Hence, drive-like effects arise when subjects are placed in conflict regarding how to allocate their attention and effort.

Using an illusory conjunction task, Muller, Atzeni and Butera (2004) also supported the attentional view of co-action effects: participants made fewer conjunctive errors (seeing a $-sign when actually only S and I were presented individually), but the co-action condition did not affect non-conjunctive errors. It therefore suggests that participants did not just use a response strategy when a co-actor was present (e.g. responding less often with a judgment of “present”). Furthermore, having a co-actor perform a similar task was not sufficient enough to induce social facilitation. The social status of that co-actor was important. Upward social comparison led to fewer errors made by the participant (who was told beforehand that the co-actor in that case scored better in a test trial). In the downward social comparison group however (co-actor performed worse), participants made just as many errors as in the alone condition. The researchers argue that we have a natural drive upward. Therefore, performing against someone better than us induces drive because we want to meet the other at his or her level. If however our co-actor/competitor is comparably weaker than we are, the drive upward is already met and our attentional focus is decreased. And according to distraction-conflict theory, without the attentional focusing, no social facilitation effects will occur.

I.ii.c Self-Presentation Focused Models

The self-presentation hypothesis states that the presence of others enhances performers' desires to look good (Sanders, 1984). For simple tasks it means that concentration is enhanced, which leads to improved performance. The self-presentation hypothesis' explanation for impaired performance on complex tasks is that the more difficult a task, the more frustrated the participant is at trying to solve/execute it. This magnification of frustration leads to embarrassment, withdrawal and excessive anxiety, which then affect performance negatively. Uziel (2007) called social presence (someone else being present besides us) an ambiguous but yet significant event. With ambiguity being something people react to quite differently, increased energy and enthusiasm on the one hand, or increased levels of apprehension and anxiety on the other hand can be the result. The former of course resulting in a positive boost of performance – social facilitation – the latter influencing performance negatively – social impairment.

Many scientists however, do not see this debate as an "either … or" discussion. Although certain hypotheses are favored by one or the other researcher it seems clear that no single hypothesis can be favored and stand as the only explanation for social facilitation effects. Rather, multiple factors should be considered (Schmitt, Gilovich, Goore & Joseph, 1986). Furthermore, they cannot even be always that sharply distinguished (Geen, 1981). Or in another vein, Sanders (1981) proposes, distraction-conflict, mere presence and learned drive are all three stages in the overall process of socially induced drive.

I.iii Different Effects on Different People – Moderators of Social Facilitation

Social Facilitation effects seem to develop with age (MacCracken & Stadulis, 1985). MacCracken and Stadulis (1985) tested children between four and eight years of age in a dynamic balance performance task. Conditions varied between alone, co-action and audience situations. Situational effects increase with age, meaning, as children get older, the positive effects of co-action also increase. The results only show better performances in the co-action condition for the six and eight year old children, but not in the youngest participants. Those four-year olds only showed social facilitation effects in the audience setting and only for easier tasks. Thus, it seems to be the case that the way we are influenced by audiences or co-actors develops as we develop through childhood. Interestingly, contrary to studies using older participants, the children were positively influenced by co-actors over both, high and low skill levels. In the audience condition however, this effect resembled adult-research studies, as to the negative influence (impairment) for low skill levels.

Individual differences are also seen with regard to a person's character (Graydon & Murphy, 1994). Introverts do not show positive social facilitation effects. They simply performed better under alone conditions. Extroverts on the other hand as we might expect, showed better performances when an audience was present.

Very early research by Anderson (1929) has investigated the effect of intelligence on the phenomenon. His results pointed toward normal-intelligent children being more influenced by the presence of others compared to more intelligent children.

The direction of social comparison, either upward or downward, influences social facilitation effects (Muller, Atzeni & Butera, 2004), with upward comparison inducing social facilitation, as discussed above.

On a related matter, the way people expect to be evaluated by an audience influences the appearance of social facilitation effects (Sanna & Shotland, 1990). If participants are given a high fake test score on a preliminary task, they enter the actual task with an expectation to be rated more positively by an audience. Consequently they also performed better. Comparably, those subjects who were given low fake test scores did not differ with their performance before an audience to being alone. The researchers concluded: "Whether the presence or absence of an evaluative audience improves or impairs performance depends upon the valence of evaluation that is anticipated from that audience" (p.89). That means, when a person expects to be evaluated positively, an audience can increase performance.

I.iv Social Facilitation Research in Sports and Motor Tasks

Having Triplett's original research (1898) be placed in a sport setting, following his example, Corbett et al. (2012) more or less replicated Triplett's cycling data by conducting an experiment having moderately trained participants perform either in a 2000m Time Trial or Head-to-head race. The Head-to-head races were simulated, showing participants a digitally added second rider, who in fact only represented the participants' own fastest time during a familiarization session. Head-to-head racing times were considerably faster than either Time Trials or familiarization trials. Twelve out of 14 athletes beat their own best times during Head-to-head racing.

In another experiment, participants had to walk as many 20m-long laps as possible within a six- minute time frame (Grindrod, Paton, Knez & O'Brien, 2006). The two experimental conditions were either participants walking alone, or in a group, whereas individuals in the group were instructed to walk their individual pace, and that the group did not necessarily had to stay together. As expected, results point to the social facilitation effect, with participants walking a longer distance when in a group compared to walking alone. This effect was apparent in both, male and female participants.

Also, children as young as four to eight years of age show social facilitation effects in a dynamic balance performance (MacCracken & Stadulis, 1985). Effects of age have been discussed above.
There is plenty of research on the influence of audiences on athletic performance. Affects pointing to the negative consequences of a supportive audience have been studied (Butler & Baumeister, 1998) as well as the big discussion around the Home Field advantage (or disadvantage; e.g. Baumeister& Steinhilber, 1984)

With this psychological background in mind, let's now turn to the sport that will stand in the present research's spotlight. Since the discipline is fairly new in the Olympic circle of sports, and recognition is only starting to kick in, I will present a short outline of the characteristics of the sport and what makes it interesting to explore. For the even more interested reader, references for further reading are made respectively.

II The Sport of BMX Racing

II.i Back to the Roots – A Short History

The sport of Bicycle Moto Cross (BMX) started in the late 1960s (Union Cycliste Internationale, 2013a). From this time on, the discipline evolved into a highly professional competition format. In 2008 it was included in the Olympic Summer Games for the first time. In Beijing 2008, Latvian Maris Strombergs, was the first male Olympic BMX Champion (International Olympic Committee, 2012). For the Elite Women, Anne-Caroline Chausson from France dominated her class. For the second appearance of BMX racing as an Olympic discipline, Maris Strombergs managed to defend his title. The reigning Olympic women's Champion is Columbian Mariana Pajon.

II.ii BMX Supercross – A World Class Event

BMX Supercross (UCI BMX SX) is the official World Cup Series of the Union Cycliste Internationale (UCI). Athletes race around a 300 to 400m track composed of a starting hill, turns and obstacles (Union Cycliste Internationale, 2012). World Cup Events are scheduled throughout the year, usually between March/April until September/October. Four to five events take place on up to three continents.

II.ii.a Racing

In Head-to-head racing (also referred to as "racing" in this text), the rider who finishes first out of eight, wins the race. A whole BMX race, the so-called main event, is made up of three parts: The Motos, the Qualifiers (Quarterfinals and Semifinals) and the Final.

II.ii.b Time Trials

„Each UCI BMX Supercross World Cup event will have a Time Trial qualification event. The Time Trial qualification will be a maximum of two single runs for each competitor where riders will be qualified for the main event based on their best lap time."

(Union Cycliste Internationale, 2012)

A second racing format used as qualifying rounds for the main event of a BMX Supercross, is the Time Trial. During Time Trials, riders individually race the track against the clock.

II.iii Competing Athletes

The Elite class of riders is open for athletes of 19 years and older, Junior class is made up of 17 and 18 year olds (Union Cycliste Internationale, 2012). The classes are combined for World Cup events. Men and Women are separated in racing and rankings.

II.iv Where it All Goes Down - The Track

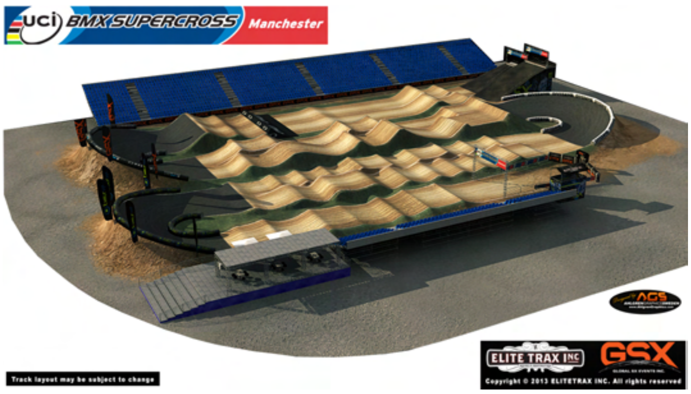


Figure 1 – A sketch of the Manchester track

According to UCI regulations (Union Cycliste Internationale, 2012; Union Cycliste Internationale 2013b) BMX tracks are between 300 and 400m long. However, current trends point to longer tracks. Tracks are composed of four straights, a starting hill, turns and other obstacles. All riders share a common eight-meter high starting hill (Union Cycliste Internationale, 2013b) and start gate, as well as the first straightaway. After the first turn, the track splits into a men’s and a women’s section for the second and third straight, after which the tracks are combined again for the last straight and finish. Figure 1 shows an example of a track (EliteTrax Inc., 2013). For a thorough review of the detailed track and characteristics of the different straights, please refer to Cowell, McGuigan & Cronin (2012).

II.v Physiology of BMX racing

BMX racing is a strength and power sport (Cowell, Cronin & McGuigan, 2011). During a main event of a World Cup race, riders have up to six laps around the track with approximately 30-minute breaks [however, those can be as short as 20 minutes] in between races (Zabala et al., 2008). BMX is furthermore very technical. Here is how one rider describes riding a technical straight: „Technical...maybe third straightaway. There’s two different lines you can take. You can take the stark, like pump, jump, jump. Or you can manual and hop off a few of the different gaps.” (Barry Nobles, Bmxlive.tv, 2014b)

II.vi Psychology of BMX racing

Up to date, there has been little research into the psychological underpinnings of the sport of BMX racing. A group of French researchers has used BMX athletes for investigating the influence of psychological variables on a test of physical resilience (Paquet, Bertucci & Hourde, 2006). Results show that attribution style, motivation and self-confidence have an impact on the results of a Wingate test, which resembles in part the real world circumstances of BMX racing.

III What are we looking for? – Hypotheses and questions

This concludes the theory-driven part. The current research was set out to replicate findings of social facilitation in a field setting using cycling data from the sport of BMX racing. Data from the 2013 season were analyzed with regard to hypotheses derived from the literature presented above.

III.i Hypothesis 1: Social Facilitation Effects are Present

The primary aim of this paper is to show statistically that riders actually do show faster times in racing compared to Time Trial.

III.ii Hypothesis 2: The difference lies in the second part of the race

In the Corbett et al. (2012) study on social facilitation in cycling (as introduced above), riders had to do a 2000m Head-to-head and Time Trial race. As expected and already presented, social facilitation effects did occur. The authors then also investigated where the cyclists made time up in the Head-to-head racing compared to Time Trials. And indeed they found a different pacing strategy for Head-to-head racing, where cyclists rode faster on the second/last 1000 meters.
Hence, we could hypothesize that there is a similar pattern for BMX racing, with riders making up time in the second half of the race.

III.iii Hypothesis 3: Riders categorize into either Time Trial type, or racing type

One of Triplett's (1898) results pointed to the fact that there is a certain specialty that riders show. To be more precise, a rider favors and excels in only one of the two disciplines. Hence, sticking to the literature, we would expect to see different riders succeed for Time Trials and racing.

III.iv Hypothsis 4: Effects are not due to practice effects

In order for the effect to actually work, we would expect riders to not only show this phenomenon in the last stages of racing (Semi-Finals and Finals). If however practice effects are the factor that led to faster times in racing, we would expect those fastest races to be achieved in the later stages of competition.

IV Methods

IV.i Considered data

Data from the 2013 UCI BMX SX Series, as well as the World Championships 2013 was considered for this analysis.

Data from the four stops (Manchester, Great Britain, Santiago del Estero, Argentina, Papendal, the Netherlands, Chula Vista, United States of America) was included in the analysis. Furthermore, the 2013 UCI BMX World Championships in Auckland, New Zealand, were considered.

Figure 2 shows a typical track design for the BMX World Cup (EliteTrax Inc., 2013).

Figure 2 – Sketch of the Papendal track

Table 1 gives an overview of the different track lengths (estimated; J.Lindström, T.Steinbach, personal communication May 2014).

The differences in lengths between the tracks make it difficult or almost impossible to compare track times directly with each other. Therefore, tracks are looked at individually.

The choice for the amount of events considered was made on the basis of different kinds of tracks that give room for comparisons on the presence of the effect. E.g. Indoor tracks, like Manchester (GBR) and Auckland (NZL), are usually smaller due to logistic boundaries. Santiago del Estero (ARG), Papendal (NED) and Chula Vista (USA) on the other hand, are outdoor facilities and the tracks are characterized by broad straights and wide turns, giving riders plenty of opportunities to race and overtake leading riders. The smaller the track, the more riders are bound to following the rider leading out of the first turn.

Track		Length
Manchester (GBR)	Women	310 m
	Men	
Santiago del Estero (ARG)	Women	380 m
	Men	
Papendal (NED)	Women	410 m
	Men	470 m
Auckland (NZL)	Women	270 m
	Men	
Chula Vista (USA)	Women	410 m
	Men	470 m

Table 1 – Track lengths for men and women

IV.ii The Timing System

Data (times, ranks, rider information) was taken from the Official Timekeepers Internet appearance www.bmx-results.com (TS Timing, 2014).

The timing data was obtained using one of two systems. For Time Trial races, an ALGE Timy watch (ALGE TIMING GmbH, Lustenau, Austria), triggered by two PhotoCells, type Cyclops, (SWISS TIMING LTD, Corgémont, Switzerland) were used. The ALGE Timy is synchronized via GPS, leaving it with an accuracy of up to 1/10,000 seconds (ALGE TIMING, 2010). For back-up and split times, a MyLaps ProChip Transponder system is used (MYLAPS Sports Timing, Haarlem, the Netherlands). As a second Back-up, a FinishLynx camera (EtherLynx Fusion; Lynx System Developers, Inc., Haverhill, USA) is used. For racing the MyLaps ProChip Transponder systems (MYLAPS Sports Timing, Haarlem, the Netherlands), together with two FinishLynx cameras (FinishLynx Fusion and FinishLynx Professional; Lynx System Developers, Inc., Haverhill, USA) are used.

IV.iii Outliers

The sport of BMX racing is mainly focused on finisher places, rather than on time. Except for Time Trials, where riders race against the clock, time is rather of secondary importance, since it is only used for seeding purposes. During qualification rounds (Motos 1/2/3), riders gather points for their finishing places (first place – one point, second place – two points etc.). From the Quarterfinals on, racing continues in a single elimination format. Hence, riders finishing first to fourth qualify on to the next round, riders fifths to eighth are eliminated. Here again, time for those who qualify only influences seeding and gate pick in the following round. So, once riders are fairly sure about their final placing, they might reduce efforts to save energy for following rounds. Furthermore, if riders crash or fall clearly behind, efforts might also be reduced. Therefore all racing times that exceeded a mean time by more than five seconds for the men and seven seconds for the women (the here applied mean time is the mean of all Time Trial times; personal communication M.Cluer/T.Steinbach, May 2014) were excluded from the analysis to prevent skewed data. A discussion on the problem of outliers can be found in Appendix 1 (page 40).

IV.iv Analysed data

For the analysis, all male and female riders that qualify for the main event out of Time Trials are considered subjects. Due to different tracks and ability levels, men and women are considered separately.

Each rider is matched with a Time Trial time which is determined by their first Time Trial run, or, for those that raced the Time Trial Superfinals, the fastest of the two times. Then, of all the races (excluding Time Trials), each rider is also matched with one fastest racing time. This time is the respective fastest time this rider has achieved in one of the racing rounds (3 Qualification runs, Quarterfinals, Semifinals, Finals). After elimination of outliers though, a rider might not be left with a single racing time. In these cases, the riders are eliminated from the analysis.

IV.v Additional Information

Furthermore, for each racing event an overall rank is added for each rider. This overall rank is determined by the overall standing after the event. Hence the rider finishing first in the Final is ranked one, the third place receives rank three overall. From the Semifinals on, for those with the same placing in the last race (two Semifinals gives to fifths places), time is the tie-breaker used in these cases.
With respect to the before determined "Fastest Race", the respective round (Motos, Quarterfinals, Semifinals or Finals) is determined.

IV.vi Subjects

IV.vi.a Manchester, Great Britain

The 64 qualified men and 32 qualified women were part of the analysis. After elimination of outliers (as explained above, TT μ(male)=30.508: all races above 35.508s were removed, μ(female)=35.442: all races above 42.442s were removed), 63 men and 30 women proceeded to further analysis. The following descriptives refer to the 63/30 subjects.
Male riders had a mean age of 21.78 (*SD*=2.848), female riders 21.53 (*SD*=3.192). The distribution of participating nations (of those 63 men) was in descending order of number of riders (in brackets): FRA (15); NED (10); USA (8); GBR (7); AUS, BRA (4); ITA, LAT (3); GER, SUI (2); ARG, CAN, COL, DEN, NOR (1). Female: FRA (6); USA (5); GBR, NED (3); BRA, CZE (2); ARG, AUS, BEL, DEN, ECU, GER, LTU, RSA, THA (1).

IV.vi.b Santiago del Estero, Argentina

64 men and the 32 women that were qualified were included in the analysis. After elimination of outliers (cut-off-score: μ(male)=33.499: 38.449s; μ(female)=39.104: 46.104s), 63 men and 30 women were considered in more detail.
Male riders had a mean age of 22.7 (*SD*=3.509), women a mean age of 21.33 (*SD*=3.8). The distribution of nations for male riders: ARG (12); BRA (9); COL, FRA (7); NED (6); USA (5); ITA (4); AUS, DEN, ECU, RSA (2); CHI, GBR, JPN, MEX, SUI (1); for female riders: BRA (5); ARG (4); COL, ECU, USA (3); CHI (2); AUS, CZE, DEN, FRA, GBR, LTU, MEX, NED, RSA, THA (1).

IV.vi.c Papendal, the Netherlands

64 men and the 24 women that were qualified were included in the analysis. After elimination of outliers (cut-off-score: μ(male)=40.153: 45.153s; μ(female)=43.617: 50.617s), all 64 men and 22 women were considered in more detail.

Male riders had a mean age of 21.94 (*SD*=2.905), women a mean age of 21.32 (*SD*=2.95). The distribution of nations for male riders: FRA, NED (12); USA (6); GBR (5); ARG, AUS, COL, GER, ITA, LAT (3); NOR, RUS, SUI (2); BRA, DEN, ECU, JPN, RSA (1); for female riders: NED (4); FRA, USA (3); GER (2); ARG, AUS, BRA, COL, CZE, DEN, GBR, RSA, RUS, THA (1).

IV.vi.d Auckland, New Zealand

64 men and the 29 registered women that were qualified were included in the analysis. After elimination of outliers (cut-off-score: μ(male)=24.422: 29.422s; μ(female)=26.539: 33.539s), 57 men and 27 women were considered in more detail.
Male riders had a mean age of 22.0 (*SD*=2.79), women a mean age of 22.63 (*SD*=3.295). The distribution of nations for male riders: NZL (6); AUS, FRA, NED, USA (5); ARG, LAT (3); DEN, ECU, GBR, GER, JPN, NOR, RSA, SUI (2); BRA, CAN, CHI, COL, CZE, ITA, MEX, PHI, RUS (1); for female riders: AUS (4); USA (3); ARG, CZE, FRA, NED (2); BEL, BRA, CAN, CHI, COL, GER, LAT, LTU, NZL, PUR, RSA, VEN (1).

IV.vi.e Chula Vista, California

Again, the men (64) and women (32) qualified were included in the analysis. After elimination of outliers (cut-off-score: μ(male)=40.89: 45.89s; μ(female)=44.34: 51.34s), 62 men and 27 women were analyzed more thoroughly.
Male riders had a mean age of 21.73 (*SD*=2.87), women a mean age of 20.74 (*SD*=3.058). The distribution of nations for male riders: USA (14); AUS, FRA, NED (6); NZL (5); ARG, CAN, COL, GBR (3); BRA, DEN, ECU, JPN, NOR (2); ITA, RUS, SUI (1); for female riders: USA (6); CAN (3); AUS, ECU, NED, RUS (2); ARG, BRA, COL, FRA, GER, JPN, LTU, RSA, THA, VEN (1).

IV.vii Statistical Analyses

SPSS Statistics 17.0 (IBM Corporation, Armonk, NY, USA, 2008) was used for the statistical analysis.
For the first Hypothesis, t-tests were used to test differences between racing modes, with accompanying Confidence intervals. The significance level was set at α=.05. To properly interpret significant results, an effect size in the form of Cohen's *d* (Kenny, 1987) is also added, whereas .2 is considered small, .5 medium and .8 a large effect.
To test the second hypothesis, I looked at those races that showed a significant difference between Time Trial and racing. To test for differences between men and women, one case each was chosen with a social facilitation effect, as well as one each for the opposite situation when Time Trial produces faster times compared to racing (social impairment).
There are usually between one and three split times on a track, normally at the entrance of each turn. To test the hypothesis whether riders make up time in

the second half of the track, I will only look at the split time in the second turn, which roughly corresponds to the middle of the track. Again, Cohen's *d* for a proper interpretation of the results will be provided.

The third hypothesis called for simple correlation analyses. Graphs will be presented additionally.

For the final hypothesis, in order to determine whether those faster times in racing are due to the riders being more familiar with the track, an analysis of the "Fastest Race" variable will be presented. This explores in which races (Qualifying Motos, Quarterfinals, Semifinals or Finals) the riders had their fastest lap. Graphs showing the distribution thereof for each event will be provided as well as percentages. However, only World Cup events will be considered here, since the racing format for World Championships differs slightly and is therefore inconvenient for a comparison.

V Results

V.i General Characteristics

Event	Gender	TT	HH
Manchester (GBR)	Female	1.789	1.837
	Male	.442	.928
Santiago del Estero (ARG)	Female	2.747	2.818
	Male	.674	.882
Papendal (NED)	Female	2.598	2.113
	Male	.859	1.118
Auckland (NZL)	Female	.907	.835
	Male	.524	1.103
Chula Vista (USA)	Female	3.194	3.145
	Male	1.063	1.366

Table 2 – Standard Deviations for TT and HH racing means, for different events, separated for men and women

V.ii Hypothesis 1

To test the hypothesis whether riders are faster in Head-to-head racing compared to Time Trials, t-tests were used comparing the fastest race and Time Trial.

V.ii.a Manchester (GBR)

Female riders did show a significant difference between Time Trial and Head-to-head racing, with racing producing faster times (μ_{TT}=35.556, μ_{HH}=35.242, $t(29)$=2.263, p=.031, d=.173).
For male riders, this difference was significant for Time Trial being faster than racing (μ_{TT}=30.512, μ_{HH}=30.872, $t(62)$=-3.993, p=.000, d=-.495).

V.ii.b Santiago del Estero (ARG)

Time Trial times did not show a significant difference to racing for the Women (μ_{TT}=38.893, μ_{HH}=38.963, $t(29)$=-.352, p>.05).
There was a significant difference for male riders, with faster times during Time Trial compared to racing (μ_{TT}=33.498, μ_{HH}=34.062, $t(62)$=-8.327, p=.000, d=-.719).

V.ii.c Papendal (NED)

Female riders rode significantly faster times in racing compared to Time Trials (μ_{TT}=42.194, μ_{HH}=41.331, $t(21)$=3.134, p=.005, d=.364).
The small potential difference male riders show however, failed to reach significant levels (μ_{TT}=40.153, μ_{HH}=39.975, $t(63)$=1.525, p>.05).

V.ii.d Auckland (NZL)

There was a significant difference for female riders, with faster times during Time Trials compared to racing (μ_{TT}=26.583, μ_{HH}=26.836, $t(26)=-2.429$, $p=.022$, $d=-.29$).
The same pattern holds true for male riders (μ_{TT}=23.882, μ_{HH}=24.731, $t(56)=-6.248$, $p=.000$, $d=-.983$).

V.ii.e Chula Vista (USA)

Female riders just missed out on a significant difference between Time Trials and racing (μ_{TT}=43.36, μ_{HH}=42.244, $t(28)=1.775$, $p>.05$).
Male riders however, did show a significant difference, with Head-to-head racing being faster than Time Trials (μ_{TT}=40.85, μ_{HH}=40.411, $t(61)=3.413$, $p=.001$, $d=.359$).

Results are summarized in Table 3. Detailed results can be found in Appendix 2 (page 42).

Event	Gender	TT	HH
Manchester (GBR)	Female	35.556	35.242**
	Male	30.512**	30.872
Santiago del Estero (ARG)	Female	38.893	38.963
	Male	33.498**	34.062
Papendal (NED)	Female	42.194	41.331**
	Male	40.153	39.975
Auckland (NZL)	Female	26.583**	26.836
	Male	23.882**	24.731
Chula Vista (USA)	Female	42.981	42.228
	Male	40.85	40.516**

Table 3 – Overview of means for TT and HH-racing over the different events; **- difference significant at the .05 level

V.iii. Hypothesis 2

Table 4 shows the means for Time Trials and racing for the split time and again, as already presented above, for the finish for male (Chula Vista, USA) and female riders (Papendal, NED).

	M-TT	M-HHracing	W-TT	W-HHracing
Split	21.132	21.041	25.266	24.915
Finish	40.85	40.411**	42.194	41.331**

Table 4 – Means comparing TT and HH racing at different points in the race for men (right two columns, data from Chula Vista, USA) and women (left two columns, data from Papendal, NED), during a race where social facilitation effects were present

Using a paired t-test for the split time ($\mu_{S\text{-}TT}$=21.132, $\mu_{S\text{-}HH}$=21.041, $t(61)=.1.192$, $p>.05$), there is no significant difference between Time Trials and

Head-to-head racing at the intermediate split time. This means that until the second turn (roughly half the track already done), riders are equally fast riding Time Trials and Head-to-head racing. As already presented above, at the Finish line, there is a significant difference though (μ_{TT}=40.85, μ_{HH}=40.411, $t(61)=3.413$, $p=.001$, $d=.359$). Hence, riders make up time in the second half of the course as predicted by experiments in Road racing.
For the women (Papendal, NED) we can find a similar pattern. With a p-value of .133 at the second split ($\mu_{S\text{-}TT}$=25.266, $\mu_{S\text{-}HH}$=24.915, $t(21)$=.1.562, $p>.05$) riders reach the appropriate midpoint of the track in Time Trials and Head-to-head racing at the same time. It is from this point on that riders gain time until the Finish line, where the difference, as noted above, is significant (μ_{TT}=42.194, μ_{HH}=41.331, $t(21)=3.134$, $p=.005$, $d=.364$).

Results for the social impairment condition are presented in Table 5.

	M-TT	M-HHracing	W-TT	W-HHracing
Split	15.284**	15.583	12.336**	12.622
Finish	30.512**	30.872	26.583**	26.836

Table 5 – Means comparing TT and HH racing at different points in the race for men (right two columns, data from Manchester, GBR) and women (left two columns, data from Auckland, NZL), during a race where social impairment were present

In this case however, there was a significant difference at the split time for men ($\mu_{S\text{-}TT}$=15.284, $\mu_{S\text{-}HH}$=15.583, $t(62)=-6.052$, $p=.000$, $d=-.808$) and for women ($\mu_{S\text{-}TT}$=12.336, $\mu_{S\text{-}HH}$=12.622, $t(26)=-5.344$, $p=.000$, $d=-.656$) which held on to the Finish line (men: μ_{TT}=23.857, μ_{HH}=24.978, $t(58)=-4.842$, $p=.000$, $d=-.495$; women: μ_{TT}=26.583, μ_{HH}=26.836, $t(26)=-2.15$, $p=.023$, $d=-.29$). Hence, during Head-to-head racing, riders were already slower after half the track and no pattern similar to that for social facilitation races can be found.
Both effects presented above, riders gaining time in the second half of the race during faster Head-to-head races compared to Time Trial, and riders being slower throughout the course when racing is slower than Time Trials, can be found across both sexes.

V.iv Hypothesis 3

For the analysis, a correlation between the times achieved in Time Trials was correlated with the overall rank after racing. Results are summarized in Table 6.
All correlations were satisfactorily high and reached significant levels. Graphs showing the relationships between Time Trials and Overall Rank for the different races can be found on page 25-26, Figure 3.

Event	Gender	Correlation
Manchester (GBR)	Female	.830**
	Male	.639**
Santiago del Estero (ARG)	Female	.831**
	Male	.741**
Papendal (NED)	Female	.806**
	Male	.570**
Auckland (NZL)	Female	.684**
	Male	.466**
Chula Vista (USA)	Female	.651**
	Male	.613**

Table 6 – Correlation between TT and Overall Rank; all correlations are significant at the .001 level

V.v Hypothesis 4

Figure 4 (page 27-28) shows the distribution of race-stages, i.e. Motos 1/2/3, Quarterfinals, Semifinals and Finals for each event.
Table 7 gives the reader an impression of the percentages of riders that either had their fastest lap in the first three races (that are done by all the riders) or in single-elimination races (Quarterfinals, Semifinals or Finals; whereas the women usually do not ride Quarterfinals).

Event	Gender	Percent of riders that have their fastest race in the first three races	Percent of riders that do their fastest lap in single-elimination races
Manchester (GBR)	W	83.333% (25 out of 30)	31.25% (5 out of 16)
	M	85.714% (54 out of 63)	28.125% (9 out of 32)
Santiago del Estero (ARG)	W	80.0% (24 out of 30)	37.50% (6 out of 16)
	M	85.712% (54 out of 63)	28.125% (9 out of 32)
Papendal (NED)	W	59.091% (13 out of 22)	56.25% (9 out of 16)
	M	89.063% (57 out of 64)	21.875% (7 out of 32)
Chula Vista (USA)	W	74.074% (20 out of 27)	43.75% (7 out of 16)
	M	82.258% (51 out of 62)	34.375% (11 out of 32)

Table 7 – Percentages of riders that either had their fastest lap during the first three races or the last 2/3 races respectively

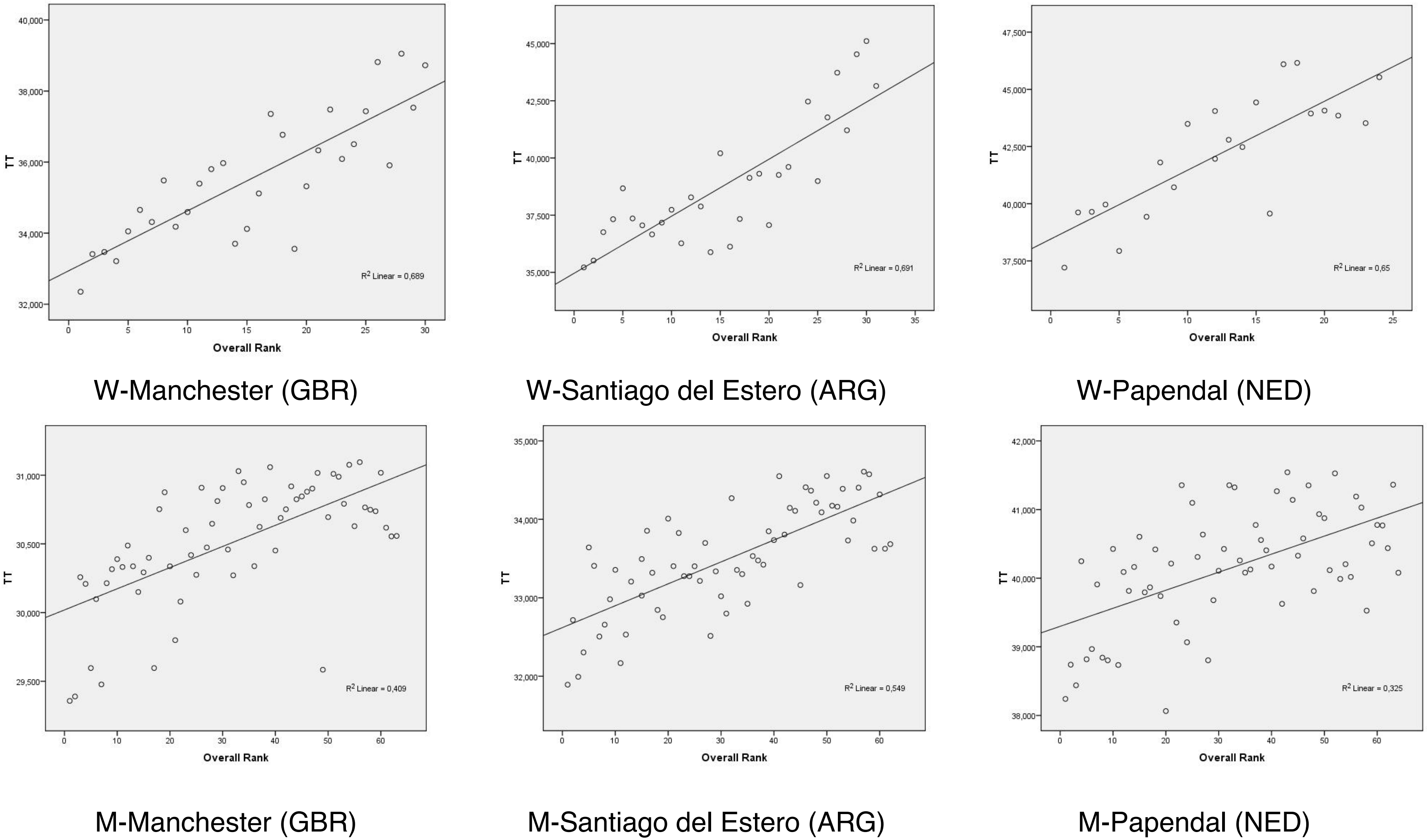
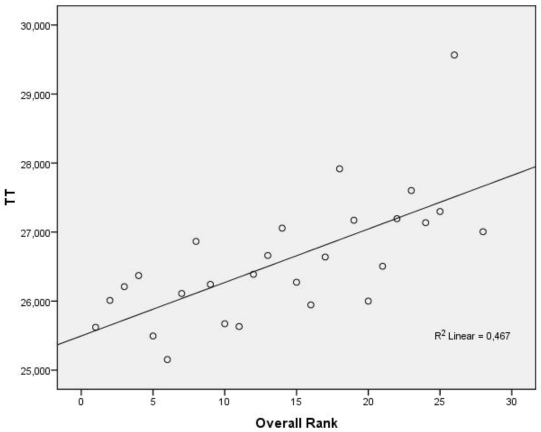
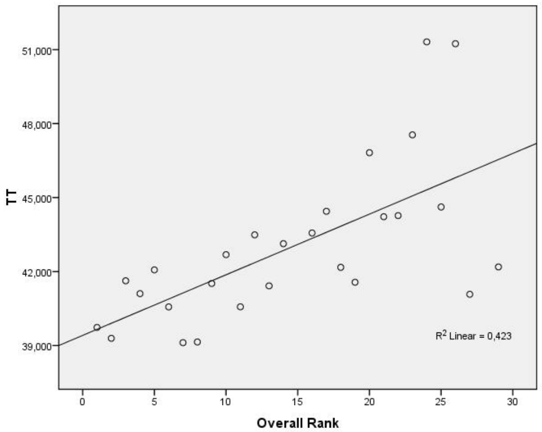


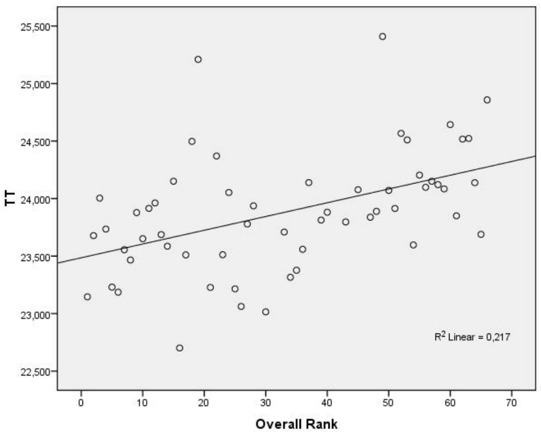
Figure 3 – Overview of correlations between TT and Overall Rank



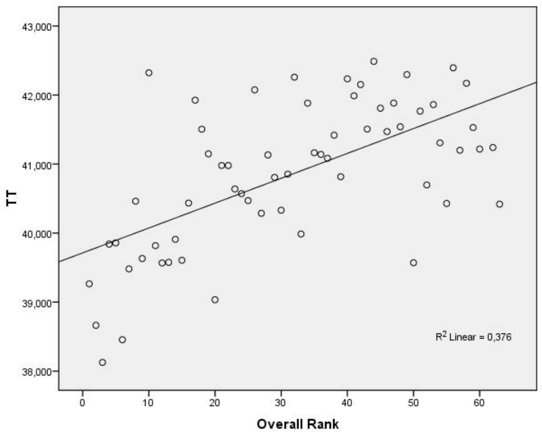
W-Auckland (NZL)



W-Chula Vista (USA)



M-Auckland (NZL)



M-Chula Vista (USA)

Figure 3 continued - Overview of correlations between TT and Overall Rank

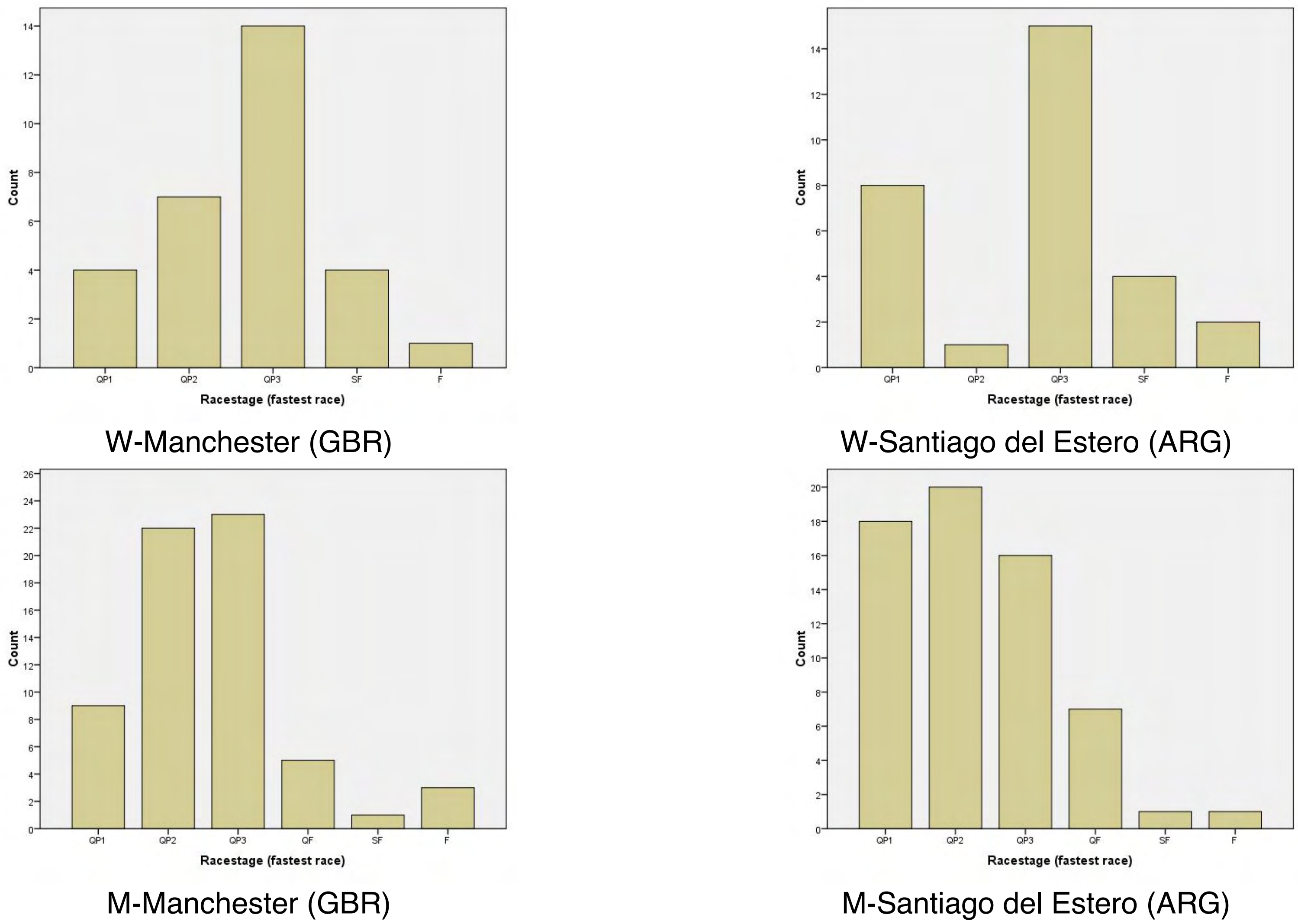
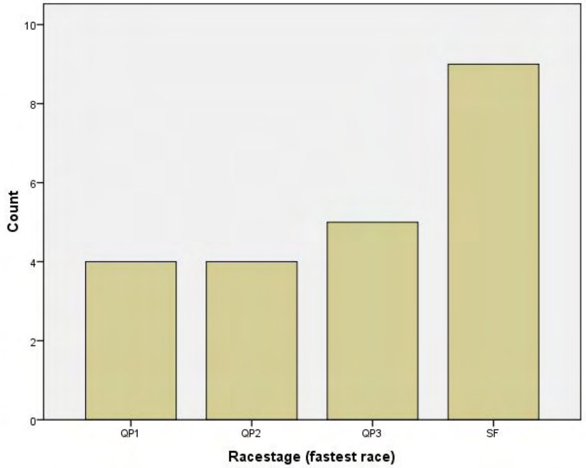
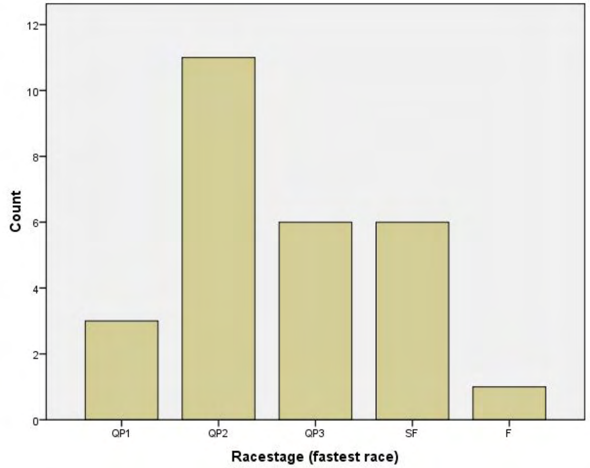


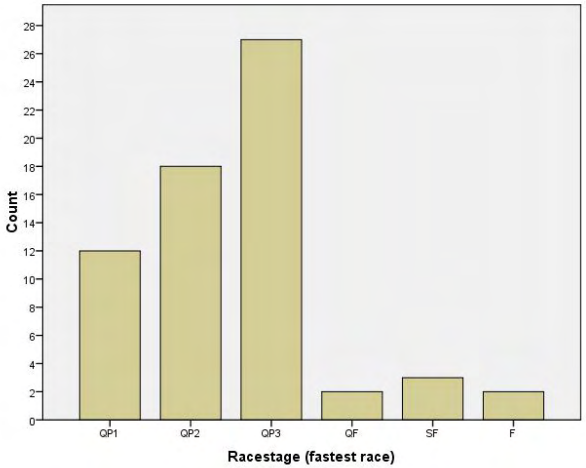
Figure 4 – Frequency distribution of the fastest race over different race stages



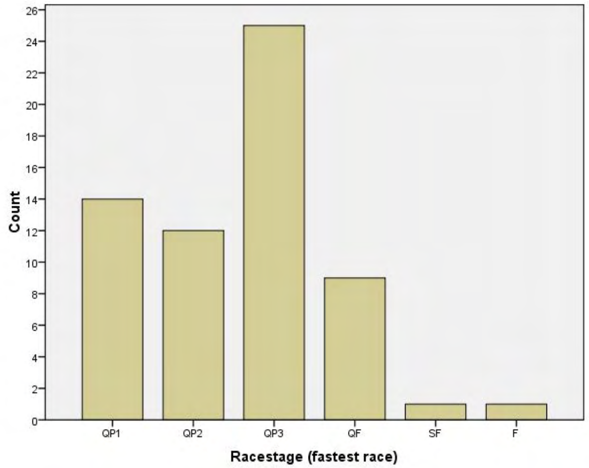
W-Papendal (NED)



W-Chula Vista (USA)



M-Papendal (NED)



M-Chula Vista (USA)

Figure 4 continued - Frequency distribution of the fastest race over different race stages

VI Discussion and Interpretation

"[…] I've won the Time Trial, but that's just on your own, you know. [In racing, author's note] There's obviously seven other people on the starting gate."
Shanaze Reade (Bmxlive.tv, 2014a)

The following pages will try to give an interpretation of the statistical results presented above.

VI.i Why we would expect to find social facilitation effect

With whomever I talked about this research question, the unified answer was that sure, riders are faster in racing than in Time Trials (P.Dylewski, T.Ritzenthaler, T.Nyhaug, S.André, A.Dean, personal communication, May 2014). It is those other people that push you, adrenaline and a desire to race (T.Nyhaug, personal communication, May 2014). There is more on the line, more energy, it is a chasing and pushing, and the motivation to race is higher (A.Dean, personal communication, May 2014). What you concentrate on might influence your performance. It might be harder to only concentrate on the track and jumps, as you would do in Time Trials, compared to focusing on the track and the other riders; you might even feel the pain more when being by yourself (S.André, personal communication, May 2014). Riders can also function as a standard you can measure yourself by. Whether you are fast or slow is hard to estimate when going around the track by yourself, because there are no other riders to show you that you are slow (S.André, personal communication, May 2014). The rider in front also pulls the others behind him/her, because it is "easier to ride fast, if you follow someone fast" (Godet, D., personal communication, May 2014). And with the progressing competition, the intensity increases, which might lead to higher motivation and effort. The way riders approach and think about the two racing modes is very different. Here's an example of how two riders described Time Trials: "In first Time Trial I just relaxed. Just trying to get a clean lap, which I did" (Anthony Dean, Bmxlive.tv, 2014b); "I would say that I'm a decent Time Trial-er. And therefore can just focus on breaking the lap down into sections and nailing each section and putting a good lap together." (Liam Phillips, Bmxlive.tv, 2014a). Now this is how a race was commentated afterwards by the rider himself: "When I saw that I had gate one, you know and Daudet [Joris Daudet, French BMX rider, author's note] was riding fantastic all day and we were almost identical in our Time Trials. So I knew that I would have to have a perfect lap to get out in front of him. I just got down the hill and hit the bottom of the hill clean and kind of just saw the light. Took a big, deep breath in the first turn and just concentrated on getting to that finish line. I figured that Joris [Joris Daudet, French BMX rider, author's note] would be behind me because he was riding really well and he was in gate two and I knew that I would have to have a really clean lap to stay in front of him.

Because one mistake by me and boom, he would be right there to capitalize on it. […] I couldn't see anyone but then I thought, you know instantly, 'oh my goodness, he's like right next to me, I can't see him because he's like right there'. So within a matter of like one second, like a million thoughts went through my head 'it's Norway all over again, photo finish, you gotta get to the line, you gotta get to the line…' " * (Connor Fields, Bmxlive.tv, 2014b).

VI.ii Why we could possibly not find the effect

As has been already mentioned before, times are not too important during racing. It is only important for the start gate pick in the next round. Here is an example of how this fact has been experienced by a rider: "I completely forgot that in Supercross racing, it's times in the Semifinals. So in the Semifinal I was just doing enough in each round, just to get by, to win the laps, and I completely forgot it was a timed lap. And then I got up and looked at the sheet, and I was like 'pick 4, how does that work? I won my semi'. And then I remembered what Supercross racing was about." (Shanaze Reade, Bmxlive.tv, 2014b).

VI.iii Hypothesis 1

My first hypothesis stated that the effect of social facilitation is, as the literature has proven for many different areas of life and sports, present. It is the thing that riders would expect (T.Nyhaug, S.André, A.Dean, personal communication, May 2014). But can I back this belief up with actual data? Are riders actually faster in racing compared to Time Trials?

I therefore examined all the World Cup events from 2013, as well as the World Championships 2013. This leaves us with five races for male riders, and five races for female riders. Out of these races, we find a statistical difference between racing and Time Trials in four out of five races for men and three out of five races for women. This difference however, is only in favor of our hypothesis in one out of four cases for men, and two out of three cases for women. So, taken together, we can say that in three out of ten races (one out of five for men and two out of five for women), a social facilitation effect was present. For those races where Time Trials led to faster times than racing, we can conclude that in thoee four out of ten races, social impairment might have been at work. For the remaining three races, there was no statistical difference between Time Trials and racing. Hence, riders were as fast during racing as during Time Trials.

Although effect sizes point to quite a small effect (.173 - .364, considered small by Kenny, 1987) and a hit quote of three out of ten is everything but a strong effect, I belief it is safe to say that these results at least point to there being the possibility of the presence of social facilitation effects in BMX racing.

* Randaberg, Norway, 2012, Fields, C. finished first with an advantage of .002 seconds (the closest finish in a final in SX history so far)

Factors that influence the outcomes of these statistical analyses as well as the nature of the sport of BMX racing will be discussed in paragraph VI.viii.

VI.iv Hypothesis 2

But where do riders loose time in those races in which a difference was apparent? This was set out to test by the second hypothesis adding a split time comparison to the results of hypothesis 1 for four cases.

Looking at the two cases of social facilitation (one men and one women), the analyses show that there is no statistical difference at the split time. The difference only becomes significant at the Finish line. This pattern holds true for men and women alike. This means that riders are as fast during Time Trials as during racing up to the second turn, which roughly corresponds to the middle of the track. It is only for that second part of the race that riders seem to make up enough time for us to spot a significant difference at the Finish line.

This result however, is at odds with what coaches and riders might expect (K. Cools; S. André, personal communication, May 2014). André, French professional rider, explained that during racing, you have to focus much more on the very first part of the race: from the gate to the first jump (personal communication, May 2014). Having a bad gate in Time Trials is something you can make up for on the rest of the track, but not necessarily during racing, having up to seven other riders around you. Additionally, research has found positive effects of co-actors on reaction time (Bell, Loomis & Cervone, 1982), a skill important for the gate start in the beginning of the race.

However, seeing the finish line can act as an extra motivator, which might lead to riders putting in more effort at the end. As one rider put it after winning a Supercross round: “And then coming into that last turn, it was that home straight. Heading to the finish line, I could see that medal. […] You’ve done all the work by then. You’ve put the effort in on the gate, you’ve got the Holeshot, you’ve done the work around the track, by that point you don’t want to give it away. You’re on the last straight, you can see it, you can feel it…” (Caroline Buchanan; Buchanan, 2014a)

Furthermore, since racing is all about the place you finish, chasing someone down to the finish line for a better placing might be another reason why the results turned out in this way (remember that only one fastest lap around the track was considered for each rider, hence possibly the one where the rider showed the most effort).

For the second part of this hypothesis, to look at the matter from both sides, I also analyzed races where social impairment, rather than social facilitation, might have been at work. Looking at the split times for those races, we can already see a significant difference between Time Trials and racing (in favor of Time Trials) at the split time in the second turn. This difference then continues to be significant until the finish line. Hence, when riders show slower times in racing than Time Trials, they do so during the whole race.

VI.v Hypothesis 3

The third hypothesis was based on Triplett's findings (1898) that racers specialize either on Time Trials or Head-to-head racing. Therefore, I looked at the relationship between the time for Time Trials and the overall rank after racing. The overall rank was chosen because it gives us a measure of how well a rider did in racing. As we can see from the correlations and graphs, there is a positive relationship between the time a rider needs in Time Trials and his result in racing. This means that the faster a rider is in Time Trials, the smaller his overall rank. The faster the time in Time Trials, the better the rider, and the smaller the overall rank, the better the rider is in racing. Additionally, in Appendix 3 (page 43) I added the list of winners in Time Trials and racing for the 2013 World Cup Series, as well as for the past three World Championships. As can be seen from Table 11, in five out of eight World Cup events, the winner for Time Trials also succeeded in racing, finishing first place. Although this pattern has not been present in World Championships, it gives a strong case for there not being completely different top riders in the two disciplines.

We can conclude that for the sport of BMX racing, a specialization for either one type of racing, i.e. Time Trials or Head-to-head racing, cannot be found in the considered data. We therefore did not find support for the stated hypothesis.

Although a progression for specializations has been found in the past for many sport disciplines (Epstein, 2014), this is unlikely to happen in BMX racing. So far, to qualify for head-to-head racing, the Time Trial qualification stage had to be successfully finished by the riders. Therefore, the rider was motivated to do a good Time Trial lap in order to race the next day in Head-to-head racing. The new format though, in place since 2014 (Union Cycliste Internationale, 2014), only uses Time Trials for the top 16 men and top eight women according the UCI BMX SX rankings. All other riders qualify through a Qualifications stage (3 motos). The Time Trial is only used for seeding purposes and therefore looses value with regard to having two different "racing" types. In World Championships though, a Time Trial World Champion is still going to be crowned. How this new format will be influenced by this, is to be seen in the future.

VI.vi Hypothesis 4

The last hypothesis was put to the test in order to find out, whether practice effects might explain the results of social facilitation. It would sound reasonable to expect riders to gain expertise on the track throughout a competition weekend. The UCI rulebook (Union Cycliste Internationale, 2012) states: "At least **one official practice session** must precede the racing at any event. […] Each group shall have as a minimum time allowance that period which will allow all its riders to **complete at least four laps including practice gate starts.**" (p.5) Usually during a Supercross Event, riders have two practice sessions (e.g. see Chula Vista Schedule, USA BMX, 2013). Hence, riders had between two and three hours of actual practice on the track at the event before riding Time Trials (track walks are allowed at any time). Competition day one then involves one or two Time Trial runs (depending on whether riders qualify for Super Finals, a second run is possible in that case). The second competition day then involves three rounds of qualifying Motos for all riders that qualified out of Time Trials (for this analysis, only those riders were considered). Come Quarterfinals (Semifinals for women), riders have then had additional four to five laps on the track. We would therefore expect for them to know the track, and the best line and ways to master the track, better from that point on than for their Time Trial run.

In order to test whether those practice effects might be involved in the outcome of this study, I looked at when riders had their best lap around the track in racing. If we look at the left data column of Table 7, we can see the percentages of riders that had their fastest lap in the qualifying Motos. Now, since half the riders qualify on to single-elimination races, we would expect those percentages to be close to 50% (since naturally those riders that do not qualify on, have to have their fastest lap in one of these three races). Percentages however, range from 59.091% (Papendal, Women) to 89.063% (Papendal, Men). We can conclude that some of the riders who also rode single-elimination-races still had their fastest race in those first three races.

To look at this from a different perspective, the second column rearranged the data to only show the percentages of riders that did qualify for single-elimination-races that had their fastest race in one of those last races. The range here reaches from 21.875% (Papendal, Men) to 56.25% (Papendal, Women; this constellation comes naturally since it was also those two cases looking at all the rider from an event). The conclusion here is the same that usually, not even half the riders that have the chance to ride from the Quarterfinals on, use this extra riding time to do their fastest lap in one of these last races.

We can therefore summarize that riders do not reach their peak performance in the last few, probably most important, races. Of course, factors like fatigue play a role here. Those will be discussed in more detail next.

VI.vii Comparing Women and Men

I recommend the reader not to directly compare the results between women and men. First of all, women and men have different tracks they ride. Although the women's straights (straight 2 and 3 is usually split between men and women) become more and more challenging as the ability level of the riders increases (Buchanan, 2014b), there are still differences. Secondly, the performance density is probably not as tight as it is for male riders. This can be seen in Table 2 that shows the standard deviations for Time Trial and racing means for the events. The standard deviation, hence the variance in the data, is always bigger for women than for men. This could mean that in a race, female riders are more spread out than men (who one could try picture more in a “bundle”). Riders might therefore have more space to individually structure the race in their best way.

VI.viii Factors influencing the data

Obviously, the data I have used for this research were not manufactured in a laboratory. They were taken from actual competitions and not gathered with the present hypotheses and questions in mind. Hence, riders were never instructed to give it all their best during racing and during Time Trials. They were naturally motivated in a way they always are for competitions. Therefore, the data I have used for the analysis is very noisy. I will try to present factors that make this data noisy, and how they can, and maybe have, influenced the results.

VI.viii.a The choice of season

Choosing the 2013 World Cup Season was done as a matter of temporal proximity. Additionally, data from the current season cannot be used due to rule changes, where Time Trial racing as we have known it until last year, is not part of the program any more. However, the 2013 season was the first year after the Olympics. This could mean that some athletes decided to “take a gap year”, or some riders might have participated for the fun of it. It probably did not affect the data too much, but should be kept in mind. Comparisons with other years might point to actual differences.

VI.viii.b BMX as an outdoor sport

BMX is an outdoor sport. Weather conditions can influence racing to a high degree. This might be wind coming from either direction that has an impact on the style of riding. But, since the track has three 180° turns, wind coming from one direction does not influence the riders throughout the track on a constant level. Since no race has been cancelled due to windy conditions in the season, we can only assume that wind might have not skewed the data too much. Since all Time Trial racing is completed in one day, as well as all Head-to-head racing also on one day, the differences within one racing mode might not be too significant.
Another factor playing a role is rain, since a wet track can slow riders down. However, this too did not lead to any race cancellations on any of the events and might therefore not be too significant.
Temperature as a last influential climate-related factor could be considered. Dealing with heat in for instance California challenges the riders to a different degree than chilly weather in the Netherlands.

VI.viii.c Timing equipment

Although the time keeping equipment and software is extremely accurate, deviations from the “real” time can arise through the finishing style of the rider.

During Time Trials, as previously described, photocells measure when the rider crosses the finish line. Any movement triggers these photocells that are aligned at the line. If the rider finishes with the front wheel down, the foremost part of that front wheel works as the trigger. However, if the rider lifts his front wheel while finishing, the front wheel in relation to the back wheel is further back compared to when the wheel is on the ground. Hence, the photocells are activated later. This finishing style is not prohibited (and cannot be identified by the raw data) but for the current analysis it might theoretically lead to slightly altered times.

VI.viii.d Uncontrollable competitors

The level of load riders go through during a competition day in Head-to-head racing is not equal for all riders. Of course, the goal is to have the strongest racers not compete against each other until the final rounds. However, since Heat seeding is determined by qualification times from Time Trials, the actual composition of the Heats cannot be influenced from outside. A rider having to race other very good riders from the Moto's stage on, might be more fatigued come Semifinals/Final than someone who has had "easier" heats.

VI.viii.e Riders' motivation to "power through"

I already mentioned the "problem" with these hypotheses that we would ideally want to look at racing times (be it Time Trials or racing) where riders gave it all they have. In a laboratory experiment, we could try to enforce this through giving certain instructions to induce a special motivational framework in the riders. The data that was considered for this paper though, is how riders actually race in competition. For example, during Time Trials, the motivation for a rider might be to just qualify for race day, the next day, or to actually qualify for the Superfinals (second run of Time Trials). The difference between the two could not be bigger. Whereas the former means being among the best 64 riders that are registered (32 for the women), the latter motivational standpoint means being among the best 16 (eight for the women) riders of all competitors. For a track as narrow as Manchester for example, the top 16 male riders that qualified for Superfinals, were less than a second apart in their first run (.81 seconds; for all 64 qualified riders the differences rises to 1.63 seconds). Riders might just do what is needed to qualify on (R.Hollows, personal communication, May 2014). Other riders simply prefer racing better, and might find it difficult to motivate themselves to race the clock, or might not be willing to risk everything they have just to win Time Trials but would put this effort in come racing (A.Dean, personal communication, May 2014). For Head-to-head racing, this matter becomes even more difficult. As already mentioned, the actual finishing time during racing is only of secondary importance. During Moto's as well as single-elimination races, finishing places are what count. Hence, a rider who can be certain to finish first unless he crashes (without outside impeding) will probably take it easy, bring home the win, and safe resources for later races.

VI.viii.f Audiences

In my introductory psychology discourse I mentioned two paradigms that are usually used in social facilitation research: co-actor effects and audience effects (Zajonc, 1965). What I have focused on here would be classified as co-actor effects, because this was the variable that differs between Time Trials and racing. However, since I was looking at actual competition data, naturally, an audience has always been present. This audience does not necessarily mean full stands, but can mean the medical, track, and commissaries crew on the track during races, TV people, organizers, coaches, and of course spectators. The spectator-audience is furthermore nor equally big, nor equally enthusiastic for all events. Having events in different countries (on different continents) also means meeting different cultures and BMX backgrounds. How much of a home advantage, or disadvantage, that makes, might be something worth considering in a future research project.

VI.viii.g All kinds of tracks

Every event has its individual track. Its size depends on factors such as what the purchaser has in mind, or local/regional restrictions. We are therefore left with five different tracks, each one with an own character and specials/features. Some tracks are narrow, some wide, some long, others short, bigger jumps, smaller turns etc. Can the results be explained with regard to differences in the tracks?

Some tracks might be better for Time Trials than racing (T.Ritzenthaler, personal communication, May 2014). But also, some riders favor tight and short tracks, others, wide and long tracks (T.Ritzenthaler, May 2014). The length of a track might make the difference for Time Trials and racing (S.André, personal communication, May 2014).

Some opinions and characteristics of the single tracks:

Manchester (GBR)

The Manchester track is “a littler tighter than some Supercross tracks but it’s really smooth.” (Sam Willoughby, Bmxlive.tv., 2014a). “It’s indoor, so it’s limited in space. It’s not a track where you can just hit everything full out.” (Bas de Bever, Bmxlive.tv, 2014a). “The track is definitely I think catching people off guard. Everything is smaller than people would expect with most things we ride.” (Alise Post, BMXlive.tv, 2014a). The track is about 310m long (J.Lindström, personal communication, May 2014) and narrow due to its spatial limitation. Passing might be complicated as riders described it: “I hope for some decent starts, some decent gates, because it’s the most important […]. If you have a good line in the first turn, you got top three in the first turn, it’s alright. Because after that there’s not much passing any more I think.” (Twan van Gendt, Bmxlive.tv, 2014a); “I would feel confident if I come out of the first corner in first and didn't make any mistakes on the track. Then I think it would be difficult to pass, you know the track is quite small and therefore to actually pass somebody you almost have to gain a full bike length on one straight." (Liam Phillips, Bmxlive.tv, 2014a). Still, the women did show a social facilitation effect on this track, whereas for the men social impairment might have rather been at work here. As discussed earlier, the women's results should however not directly be compared to the men's, since performance differences might play a big role. The result for the men though, might have turned out that way, because riders did not have enough space to ride as fast as they can during racing. Not being in first position might mean that a rider does not have enough space to pass or otherwise hold the speed he could, compared to being alone on the track.

Santiago del Estero (ARG)

With 380m in length (J.Lindström, personal communication, May 2014), the Santiago track corresponds to a usual BMX venue, a "full-size BMX track" (Bas de Bever, Bmxlive.tv, 2014b). „It looks pretty similar to […] Manchester. But unlike it, a bit of a larger scale. Everything seems to be a little stretched out." (Shanaze Reade, Bmxlive.tv, 2014b). Although the track is much wider than the Manchester track, we can still find a social impairment effect for the male riders' class. So other factors than a small track might have been of influence here. For the women however we at least find racing and Time Trials to be the same, hence nor social impairment, nor social facilitation effects occurred.

Papendal (NED)

The Papendal track is one of the biggest and longest tracks in the World Cup Series. Together with Chula Vista (USA) the women's track is an impressive 410m long, the men's track 470m. "It's a big, long track […], it's going to make for some good racing.", "It looks like you can really open up and you don't have to hit your brakes…"(Connor Fields, Bmxlive.tv, 2014c). Racing on this track led to the appearance of the social facilitation effect for the women, and no difference between Time Trials and racing for the men.

Auckland (NZL)

The Auckland track was the smallest and shortest in the international 2013 Season. With a length of only 270m, and small straights and turns, it comes with no surprise that we could only find social impairment effects for both sexes.

Chula Vista (USA)

The Chula Vista track is also one of the biggest in the circuit. With 410m and 470m for women and men respectively, it creates a lot of open space for passing and good racing. Therefore, the presence of the social facilitation effect for men, and the absence of social impairment for women could be traced back to this fact.

VI.ix Social Facilitation – good or bad?

Riding, running, swimming faster when others are around … that sounds like a good thing doesn't it? To facilitate is defined by the English Oxford Dictionaries as "Make (an action or process) easy or easier" (Oxford University Press, 2014). What this means with regard to social facilitation and sports, is that we find it easier to perform on a higher level, e.g. running quicker or riding faster. And the athlete that under extreme exhaustion suddenly feels like something is easier in competition will probably go for it. It is this "exciting effect of competition" (Karpovich, 1937) that all athletes strive for. But as Karpovich (1937) also points out, there are drawbacks: A runner that gets excited by the competition, the other runners around him and the audience, over paces and cannot keep this fast pace up for the whole of the race. What are the things that could happen in BMX? Overjumping big jumps, making risky moves in corners, or being too fast for certain rhythmic parts of the track, just to name a few. It is an effect that is advantageous, but at the same time bears the possibility for risks. Riders and coaches should therefore be aware of the advantages and disadvantages thereof, and try to benefit from it as much as possible.

VII Conclusions

This paper was set out to test the presence of the social facilitation effect in the sport of BMX racing. Although results are not as strong as hoped for, the data point to there being the possibility of the presence of the social facilitation effect. Albeit noisy real life data and various factors influencing these (tracks, outdoor conditions, the nature of racing), the effect did emerge in three out of ten races considered.

However, if we consider the nature of BMX racing, where crashes, tight corners and outdoor conditions are what make the sport what it is, the statement that racing will always be faster than Time Trials, is one that the data considered here actually does not support. As I have pointed out several times now, there is the possibility of social facilitation, we therefore cannot say that the effect never appears in BMX racing. And certainly, single riders beat their Time Trial times constantly during racing. But in order to generalize it, we would need much bigger support from the data. Furthermore, removing the outliers as described, was of course necessary in order to properly analyze the data for the effect. However, this too is something that theoretically is part of racing. Someone who crashes and then decides to finish the race anyways did still act according to the rules. A big factor that moderates the presence of the effect is the kind of track, as has become clear from the discussion hopefully. For male riders, small tracks will probably not show the effect (for the women other factors might play a role, which is why track size might not be as limiting as for male riders). The bigger the track, the higher the possibility of the effect to occur, although it does not seem to be the only criterion playing a role.

So, what does this mean for athletes and coaches? Maybe that for the sole purpose of training speed, riding in groups might actually be more disadvantageous compared to training individually. Of course, this only refers to concentrating on speed, since there are numerous other things that have to be trained in a group.

So the sport of BMX racing seems to be one of those disciplines, where we cannot unconditionally say that racing directly with others would lead to faster times. There are a lot of influencing variables that would have to be considered first before we could claim something like that. However, with the fast progression of the sport we might find different results on that matter in a few years.

"It's definitely a good confidence booster going in, knowing you've ran the quickest lap today. But Time Trials and racing are two completely different things. It's not every time when the guy who wins the Time Trials is always gonna win the race. So […], just take it for what it is, take the confidence, take it for number one seed and just go into racing tomorrow."

Connor Fields (Bmxlive.tv, 2014c)

VII Appendices

VII.i Appendix 1 - Outliers

The idea to look for Outliers in the data, was to only consider times where I can be quite sure that athletes really tried, put in the effort and wanted to do a fast lap. When first approaching the problem with outliers, I did so quite conservatively. After initially using μ_{TT}+10s as a cut-off score, I consulted with two knowledgeable persons in BMX racing and came to the conclusion that μ_{TT}+5s for men and μ_{TT}+7s for women is a more accurate measure of effort (M.Cluer & T.Steinbach, personal communication, May 2014).
However, knowing that this might lead to critics pointing to manufactured results, I would like to give a quick comparison of the two approaches and their respective results.

VII.i.a Differences in Subject-characteristics

Table 8 contrasts how many participants were included in the actual analysis and their characteristics, with regard to age. Differences are marked in bold.

Event		Participants		Age (SD)	
		10s	*5s*	*10s*	*5s*
Manchester (GBR)	Female	30	30	21.53 (3.192)	21.53 (3.192)
	Male	63	63	21.78 (2.848)	21.78 (2.848)
Santiago del Estero (ARG)	Female	**31**	**30**	**21.26 (3.759)**	**21.33 (3.8)**
	Male	63	63	22.7 (3.509)	22.7 (3.509)
Papendal (NED)	Female	22	22	21.32 (2.95)	21.32 (2.95)
	Male	64	64	21.94 (2.905)	21.94 (2.905)
Auckland (NZL)	Female	27	27	22.63 (3.295)	22.63 (3.295)
	Male	**59**	**57**	**22.0 (2.748)**	**22.0 (2.790)**
Chula Vista (USA)	Female	**28**	**27**	**20.64 (2.95)**	**20.74 (3.058)**
	Male	**63**	**62**	**21.76 (2.861)**	**21.73 (2.87)**

Table 8 – Comparison between subject characteristics for different outlier-cut-off scores

As can be seen in table 8, differences only arose in 4 out of 10 cases, with regard to considered subjects.

VII.i.b Differences in results

Table 9 shows the comparison between results that are obtained with the respective subjects. Again, differences are marked in bold.

Event		10s		5s	
		TT	HH	TT	HH
Manchester (GBR)	Female	35.556	35.242** (p=.031)	35.556	35.242** (p=.031)
	Male	30.512** (p=.000)	30.872	30.512** (p=.000)	30.872
Santiago del Estero (ARG)	Female	**39.133**	**39.230**	**38.893**	**38.963**
	Male	33.498** (p=.000)	34.062	33.498** (p=.000)	34.062
Papendal (NED)	Female	42.194	41.331** (p=.005)	42.194	41.331** (p=.005)
	Male	40.153	39.975	40.153	39.975
Auckland (NZL)	Female	26.583** (p=.023)	26.836	26.583** (p=.023)	26.836
	Male	**23.857** (p=.000)**	**24.978**	**23.882** (p=.000)**	**24.731**
Chula Vista (USA)	Female	**43.36**	**42.244**	**42.981**	**42.228**
	Male	**40.877**	**40.516** (p=.019)**	**40.85**	**40.411** (p=.001)**

Table 9 – Comparison between results for different subject groups on the basis of different outlier-cut-off scores

Naturally, we will only find differences in those cases, where different subjects have been considered for the analysis. As can be seen in those cases (marked in bold) although means for Time Trial and Head-to-head racing have changed, the overall results with regard the differences being statistically significant have stayed constant. The level of significance has changed though in the case of Chula Vista (USA) men from .019 to .001. Furthermore the effect sizes have changed for the two significant results from -.879 to -.983 for the male riders in Auckland (NZL) and for Chula Vista (USA) from .266 to .359. Hence the effects we have found are stronger when using the 5s cut-off rule.

VII.ii Apendix 2 – Detailed results Hypothesis 1

Table 10 shows a detailed listing of the statistical results for Hypothesis 1.

		TT	SD_{TT}	HH	SD_{HH}	T	df	p	CI (95%)		Cohen's d
Manchester (GBR)	Female	35.556	1.789	35.242**	1.837	2.263	29	.031	.03	.599	.173
	Male	30.512**	.442	30.872	.928	-3.993	62	.000	-.539	-.18	-.495
Santiago del Estero (ARG)	Female	38.893	2.747	38.963	2.818	-.352	29	-	-.474	.335	-
	Male	33.498**	.674	34.062	.882	-8.327	62	.000	-.699	-.428	-.719
Papendal (NED)	Female	42.194	2.598	41.331**	2.113	3.134	21	.005	.291	1.437	.364
	Male	40.153	.859	39.975	1.118	1.525	63	-	-.055	.413	-
Auckland (NZL)	Female	26.583**	.907	26.836	.835	-2.429	26	.022	-.468	-.039	-.29
	Male	23.882**	.524	24.731	1.103	-6.248	56	.000	-1.12	-.578	-.983
Chula Vista (USA)	Female	42.981	3.194	42.228	3.145	1.413	26	-	-.342	1.838	-
	Male	40.85	1.063	40.411**	1.366	3.413	61	.001	.182	.696	.359

Table 10 – Detailed results for Hypothesis 1; **Difference is significant at the .05 level

VII.iii Appendix 3 – Time Trial and racing winners

Table 11 and 12 show the winners of the 2013 World Cup Season in Time Trial and racing respectively, and the Time Trial and Racing World Champions over the past three years.

		TT	Racing
Manchester (GBR)	Women	Shanaze Reade	Shanaze Reade
	Men	Liam Phillips	Liam Phillips
Santiago del Estero (ARG)	Women	Shanaze Reade	Shanaze Reade
	Men	Connor Fields	Connor Fields
Papendal (NED)	Women	Mariana Pajon	Mariana Pajon
	Men	Connor Fields	Jelle van Gorkom
Chula Vista (USA)	Women	Felicia Stancil	Mariana Pajon
	Men	Connor Fields	Sam Willoughby

Table 11 – Time Trial and racing winners of the 2013 World Cup Season

Year (Event)		**TT**	**Racing**
2013 – Auckland (NZL)	Women	Mariana Pajon	Caroline Buchanan
	Men	Connor Fields	Liam Phillips
2012 – Birmingham (GBR)	Women	Caroline Buchanan	Magalie Pottier
	Men	Connor Fields	Sam Willoughby
2011 – Kopenhagen (DEN)	Women	Shanaze Reade	Mariana Pajon
	Men	Andre Fossa Aguiluz	Joris Daudet

Table 12 – World Champions in the Time Trial and Racing disciplines over the past three years

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X Personal communications and citations

I would like to thank the riders, coaches, officials and other helpful people who have supported me with ideas, guidance, and answers. Following is a list of the personal references listed in the text for people who do not know about the sport of BMX racing and people involved in the World Cup Series.

André, Sylvain	FRA	BMX rider
Buchanan, Caroline	AUS	BMX rider
Cluer, Max	RSA	Official Announcer of the SX World Cup Series
Dean, Anthony	AUS	BMX rider
De Bever, Bas	NED	Coach
Dylewski, Pete	USA	TV commentator – Bmxlive.tv
Fields, Connor	USA	BMX rider
Godet, Damien	FRA	BMX rider
Hollows, Ryan	NZL	Coach
Lindström, Johan	SWE	CEO of GSX events (organizing party of the SX World Cup)
Nobles, Barry	USA	BMX rider
Nyhaug, Tory	CAN	BMX rider
Phillips, Liam	GBR	BMX rider
Post, Alise	USA	BMX rider
Reade, Shanaze	GBR	BMX rider
Ritzenthaler, Tom	USA	President of EliteTrax Inc. (track builder)
Steinbach, Torsten	GER	Official Timekeeper of the SX World Cup Series (TS Timing)
Van Gendt, Twan	NED	BMX rider
Willoughby, Sam	AUS	BMX rider

XI Tables, Figures and Pictures

XII Declaration of academic integrity

I, Anna Brigitte Steinbach, herby assure that I have written this paper individually. I have done the proper research and exploration of the literature myself, and referred to the appropriate references when used. Any information I had based on personal information is cited in the text as such.
If the reader, be it a fellow researcher, a coach, an athlete, or another interested party, is interested in the used and compiled data, please contact me via the below mentioned channels. Furthermore, if you have any additional questions please do not hesitate to send me an email or give me a call.

Best regards,
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