Moving in the presence of others – a systematic review and meta-analysis on social facilitation

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Social facilitation is an old research topic in psychology with diverse results: Performance in cognitive or motor tasks is either facilitated, inhibited or not affected, argued to be a function of task complexity. In his narrative review, Strauss, B. (2002). Social facilitation in motor tasks: A review of research and theory. *Psychology of Sport and Exercise*, 3(3), 237–256. [https://doi.org/10.1016/S1469-0292\(01\)00019-X](https://doi.org/10.1016/S1469-0292(01)00019-X)) found the presence of others to positively affect condition-based tasks (general drive hypothesis, Zajonc, R. B. (1965). Social facilitation. *Science*, 149(3681), 142–146. <https://doi.org/10.1126/science.149.3681.269>), and to negatively affect coordination-based tasks (capacity hypothesis, Manstead, A. S. R., & Semin, G. R. (1980). Social facilitation effects: Mere enhancement of dominant responses? *British Journal of Social and Clinical Psychology*, 19(2), 119–135. <https://doi.org/10.1111/j.2044-8260.1980.tb00937.x>). This systematic review and meta-analysis focused exclusively on movement-based tasks, identifies the prevalence and magnitude of social facilitation, moderated by condition- and coordination-demands. Through forward searches (Scopus, PsycINFO, Web of Science, Academic Search Premier, ProQuest Dissertations, OvidSP) and backward searches, we identified $N = 82$ human studies (7,008 participants) over 100 years. In the systematic review, condition-based tasks are generally facilitated, while results of coordination-based tasks performed under time and precision pressure differed (cf. Bond, C. F., & Titus, L. J. (1983). Social facilitation: A meta-analysis of 241 studies. *Psychological Bulletin*, 94(2), 265–292. <https://doi.org/10.1037/0033-2909.94.2.265>). The meta-analytic moderator analysis of coordination- and condition-based tasks aligned with the systematic review. The experimenter's influential presence was emphasized. We support the capacity hypothesis and draw conclusions for the state of the theory and experimental limitations specific to social facilitation research.

Data, analysis code, & supplementary material: <https://osf.io/tvk24/>

Keywords: Social influence; social inhibition; experimenter presence; capacity hypothesis; coordination

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Version 2 of this pre-print includes more details on the history and development of social-facilitation theories than the published article (<https://doi.org/10.1080/1750984X.2022.2111663>). Throughout the peer-review process, additional (unpublished) studies have been included, which is why the results and analyses have changed slightly. The data and script are provided in this OSF: <https://osf.io/tvk24/>. Please cite this pre-print only with the authors' approval.

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‘Social Facilitation’ goes back to Allport (1920, 1924) and describes ‘an increase in response merely from the sight or sound of others making the same movement’ (Allport, 1924, p. 262). The term goes hand in hand with Robert Zajonc, who published the highly influential paper “Social Facilitation” in “Science” in 1965. In this seminal review, Zajonc (1965) summarized more than 60 years of research that referred directly (or indirectly, before 1924) to social facilitation in humans as well as in animals (e.g., dogs, chickens, cockroaches, monkeys). Zajonc was the first to identify a consistency in the until then very diverse findings that ranged from inhibited to facilitated performances: well-learned responses were facilitated and newly acquired responses inhibited. This breakthrough was followed by research “directly testing his position, elaborating upon it, or suggesting alternatives” (Geen & Gange, 1977, p. 1268). Social facilitation studies following this

school have examined *whether* and *how* a person's performance is impacted when others are (a) merely present (Allport, 1924), or (b) co-acting with the performer (Gates, 1924). According to Allport's definition, social facilitation does not cover all possible effects of the presence of an observer on a performer (cf., competition, rivalry, cheering, booing or other behaviors), and can be considered as the minimal experimental paradigm of social presence. It is there different to social influence (Latané, 1981; see e.g., Park et al., 2022) and focuses on the impact on performance rather than for example attentional or shared experiences in social presence (cf., Steinmetz & Pfattheicher, 2017).

The start of social facilitation research has often been dated at the end of the 19th century (Féré, 1887; Triplett, 1898). Triplett's (1898) archival pace-maker analysis and subsequent so-called "competition machine" experiment with children were the first to distinguish between the diverging effects of (a) a desire to win, (b) rivalry or competition, and (c) the sight and sound of another person who performs the same movement. However, more recently, criticism regarding the experimental task, the results and the importance to the field of social psychology has been raised (Martin, 2020; Stroebe, 2012). After differentiating social facilitation from competition effects, more attention was given to the underlying mechanisms for facilitated and inhibited performances.

Theories of social facilitation

Theories of social facilitation have been developed predominantly between 1965 and 1985. At the heart of most theories is the *generalized drive hypothesis* proposed by Zajonc (1965; Figure 1A). On the basis of the Hull-Spence Behavior Theory (Hull, 1943; Spence, 1956), he suggested that the presence of others from the same species (both true for humans and animals) affects the subject's generalized, non-directive drive, which in turn increases the probability of executing the dominant reaction to the task. A drive state is the increased arousal and motivation to reach a certain goal by choosing the behavior that most effectively meets the requirements, i.e., the dominant reaction (Spence, 1956). Tasks are simple and well-learned when the dominant reaction is correct, whereas complex or unknown tasks do not have a dominant reaction yet. Hence, if the dominant reaction is enforced, an easy task is assumed to be facilitated. Consensus was – to a degree – reached that the presence of others impacts the state of activation of the performing subject, resulting

in an increase of the dominant response. However, the mediating conditions as to why drive increases, constitute the main differences between the theoretical frameworks. Cottrell (1968, 1972) and Henchy and Glass (1968) proposed a model, claimed to be valid only in humans, that – supposedly – opposed the *generalized drive hypothesis* by suggesting that social facilitation is learned from socialization and that a possible evaluation would have an energizing effect (Figure 1B). Subsequently, Guerin and Innes (1982) proposed the *social monitoring theory* (Figure 1C), where drive increases from the anticipated threat/unpredictable behavior of others. This potential mediation was picked up by Blascovich and colleagues (1999): In the *biopsychosocial model*, challenge and threat are motivational states that arise from the increased appraisal demand (e.g., presence of a spectator). Threat is experienced when one believes their personal resources to be insufficient to meet the unknown demands, hence, situational novelty is hypothesized to increase threat (Blascovich et al., 1993) and to consequently trigger physiological fight-or-flight responses.

After several years of experimental testing, no final proclamation regarding the importance of evaluation apprehension could be made: Zajonc (1980) found mere presence to be sufficient for a change in the subjects' level of drive, while Sanders (1981) concluded that the mere presence explanation was the least applicable of all theories. By 1982, the *mere presence hypothesis* could not reliably be accepted nor rejected (Guerin, 1993; Guerin & Innes, 1982). Consequently, scientists suggested other cognitive, motivational and affective mechanisms to explain social facilitation in the early 1980's. The distracting potential of others and subsequent attention-capacity restrictions resulted in a new branch of theories (Figure 2A). In five experiments on the *capacity hypothesis*, Manstead and Semin (1980) identified that the direction of the social facilitation effect was moderated by the cognitive demands of the task, a different operationalization of task difficulty. If observers tax the attentional capacity, then the performance of complex tasks should be impaired, whereas the automatic processing during simple tasks is unhindered in case of limited attentional capacities (Shiffrin & Schneider, 1977). This was further developed by Baron (1986, overload hypothesis, Figure 2B) and Sanders (1981, distraction-conflict hypothesis, Figure 2C). These branches of theories have been looked at as mutually exclusive, however, e.g., Strauss (2002) has suggested an integrated framework based on different task demands.

Figure 1. Activation-based theories. (A) Generalized drive theory (Zajonc, 1965); (B) evaluation-apprehension hypothesis (Cottrell, 1968; Hency & Glass, 1968); (C) monitoring hypothesis (Guerin & Innes, 1982); (D) cognitive-motivational model (Paulus, 1983).

Figure 2. Attention-based theories. (A) Capacity model (Manstead & Semin, 1980); (B) overload hypothesis (Baron, 1986); (C) distraction-conflict hypothesis (Sanders, 1981).

Empirical evidence on social facilitation

The influence of a member of the same species has been researched both in humans and non-human animals (see e.g., Zajonc et al., 1969). Until Dashiell (1930), every increase in behavior in the presence of other humans was coined as social facilitation (Guerin, 1993). Later, these were distinguished as social learning, imitation or social loafing (Clayton, 1978). Throughout the theoretical discussions between 1965 and 1982, animal studies became more popular: if mere presence effects can be found in non-human populations, evaluation apprehension or other cognitive theories are incomplete (cf. Guerin, 1993).

The majority of tasks used in human experiments are cognitive tasks (e.g., pseudo recognition, list learning, word association; see Geen & Gange, 1977; Guerin, 1993), but also motor tasks (e.g., Pursuit Rotor Task, finger maze, balancing, rowing; see Landers & McCullagh, 1976; Oviatt & Iso-Ahola, 2008; Strauss, 2002). The most common experimental social facilitation paradigm constitutes a 2 (alone vs spectator/co-actor) x 2 (simple vs complex task) design. A classic example is the study by Miyamoto (1979), who asked students to complete either a simple finger-maze task (only 12 cul-de-sacs) or a complex finger-maze task (24 cul-de-sacs). Half of the participants completed the maze alone, while the other half was carefully observed

by another student. These types of research designs are sometimes accompanied by manipulation of the evaluative potential held by the other person(s), by their behavior (working on another task/blindfolded vs watching the subject intently), the instructions by the experimenter (e.g., “[This student] will be sitting here watching and evaluating your performance”, Groff et al., 1983, p. 364) or their expertise at the task (novice vs expert). To test for potential attentional explanations, researchers compared performing alone or in front of a human audience to the effect of distracting non-social or self-attention stimuli (mirror, mannequin; e.g., Rajecki et al., 1977).

Several reviews between 1965 and 1985 do not align to support one theory. In the first comprehensive review, Geen and Gange (1977) concluded that the *generalized drive theory* (Zajonc, 1965) was the most parsimonious theory after 12 years of research. According to the authors, social facilitation appears to result from “emotional arousal” (p. 1283). Furthermore, evaluation apprehension was found to elicit both the hypothesized responses as well as the opposite: no difference between high-evaluation and low-evaluation conditions. Overall, however, Geen and Gange (1977) described it as an “immediate antecedent of socially induced drive” (p. 1268), but not a necessity. This distinction had not been made in the original paper in 1965, but after the increasing discussion around the anticipation of positive and negative consequences, Zajonc (1980) clarified that the audience need not engage in any sort of behavior to facilitate or inhibit performance.

The renowned meta-analysis by Bond and Titus (1983) systematically summarized 241 studies on human social facilitation, encompassing both cognitive and motor tasks in the presence of audiences or co-actors. Until 1982, a total of $N=23,970$ subjects had been investigated. The overall social facilitation effect was found to be small, explaining only 3.1% of the variance in complex and 0.3% in simple tasks. In addition, the authors categorized effects by the dependent measure (physiology, performance quantity/speed, performance quality/accuracy, miscellaneous). They confirmed one of the prevailing assumptions: in the presence of others, subjects perform complex tasks less accurately or more slowly and experience higher arousal, while simple tasks are executed more quickly. The social facilitation during simple tasks was more prominent in measures of speed as compared to measures of accuracy (cf. Bond & Titus, 1983, p. 273). This was more recently

confirmed in an experiment with rats who had to run (speed-task) and pull a lever (accuracy-task) while in the presence of another rat or alone (Sekiguchi & Hata, 2019b). Speed improved while accuracy decreased in the mere presence of a conspecific.

The seminal book “Social Facilitation” by Guerin (1993, 1st edition) provides a unique in-depth review of the entirety of the highly diverse social facilitation research. Here, Guerin (1993) distinguished between studies investigating the effects of mere presence, of the experimenter, or of a passive or active observer. He summarized that social facilitation appears to be possible without evaluation or social conformity. In a meta-analysis of 11 studies, Uziel (2007) additionally identified a difference in expecting positive or negative consequences and thereby experiencing an increase in enthusiasm or anxiety, respectively. A positive orientation (reflecting extraversion) helped improve performance in the presence of others, while a negative orientation (reflecting neuroticism) led to impairment.

Social facilitation during motor tasks

Special attention in the field of social facilitation has been given to contexts in which a motor response is required (see already Moede, 1920). Movement or physical activity are all motor tasks primarily aimed at, and relying on, the activation of skeletal muscles (Welk, 1999). Several hierarchical taxonomies of motor skills/abilities have been proposed (see e.g., Fleishman, 1957; Lämmle et al., 2010; Newell, 2020). Fleishman (1957) split these motor abilities into (1) physical-proficiency abilities (strength, speed, endurance, flexibility, balance, gross-motor coordination), which predominantly require energy, and (2) perceptual-motor abilities (e.g., control precision, reaction time and accuracy, manual and finger dexterity), which predominantly require efficient and accurate information processing and translation. Similarly, the model of motor abilities by Bös (1987; see Lämmle et al., 2010; cf. Utesch et al., 2019) differentiates motor tasks based on their condition-oriented (energy-/effort-based) abilities (e.g., strength, endurance, speed) and coordination-oriented (information-based) abilities (e.g., coordination under time pressure, coordination under precision pressure, also referred to as skill-based; see Figure 3)¹. Perceptual-motor tasks are characterized by a higher cognitive load. These tend to be considered more complex in nature. Tasks with high demands on energetic processes

¹ Despite similar ideas, the models by Fleishman (1957) and Bös (2017) classify balancing and gross-motor coordination differently,

emphasizing their ambiguous character. However, a complete comparison of both approaches exceeds the scope of this article and is not the aim of this investigation.

Figure 3. Model of motor abilities (derived from Bös, 1987).

or condition (relying on physical-proficiency abilities), on the other hand, require little learning (but rather continuous extensive exercising) and are considered simple.

Some movements, especially during sports games, require more than one motor ability and cannot be classified as either physically or perceptually dominant. This often leads to the necessity to handle a speed-accuracy trade-off (Fitts & Posner, 1967), depending on the task requirements (Schmidt & Wrisberg, 2000, p. 156). Motor tasks that do not have a heavy reliance on either coordination or condition will in the following be considered as “mixed tasks” (Strauss, 2002).

The effects of social presence on motor task performances vary from (mostly marginal) improvements to no difference to substantial decrements (Landers & McCullagh, 1976; Strauss, 2002). In the first comprehensive summary of empirical evidence on motor tasks, Daniel Landers and McCullagh (1976) summarized 84 studies, highlighting that speed of performance (referred to as “quantitative aspects”, cf. p. 130) appear to be facilitated by (competitive) co-action, whereas accuracy (referred to as “qualitative aspects”) remained unaffected or the operationalization was poorly executed, invalidating the findings. Co-action effects were most pronounced in discrete or serial tasks (with an identifiable endpoint; Fitts & Posner, 1967), as opposed to continuous tasks (e.g., Pursuit Rotor Tracking). Daniel Landers and McCullagh (1976) also contended that in most studies, the passive audience or co-actor was influential enough to elicit an inhibition of the correct response during a novel task. Accuracy performance during well-learned tasks, however, seems to increase significantly in several experiments.

Oviatt and Iso-Ahola (2008), synthesized research on any social-presence effect (mere presence, co-action, evaluation, social loafing, choking) during motor

tasks from 1982 to 2004, running separate meta-analyses for each type of social influence. They found a very small overall mere presence effect in 18 studies. When controlling for the type of task, performance appeared to be facilitated in laboratory tasks ($ES=0.65$), while sports- or exercise-related tasks remained unaffected ($ES=-0.12$). However, the distinction between sports- and laboratory tasks is not stated clearly does not align with previous definitions (cf. e.g., Strauss, 2002).

Strauss (2002) approached the distinction of speed and accuracy outcomes differently. Rather than comparing speed- and accuracy-dependent motor tasks, he hypothesized parallels between the model of motor abilities by Bös (1987; Figure 3), the *general drive hypothesis* (Zajonc, 1965) for condition tasks, and the *capacity hypothesis* by Manstead and Semin (1980; Figure 2) for coordination tasks. Joining the motor and social facilitation models, motor tasks with high cognitive demands (i.e., information-based/coordination) should be inhibited, while motor tasks with low cognitive demands (i.e., energy-based/condition) should be facilitated. Based on Bond and Titus (1983) and Landers and McCullagh (1976), time and precision pressure as the subcategories of coordination-based tasks should be affected differently. He thereby expanded on the idea already proposed in Moede’s seminal book in 1920 (see e.g., Danziger, 2000) that energy-based tasks appear to be facilitated, in contrast to cognitively determined tasks. These effects can be further sub-categorized into coordination-based tasks performed under time pressure (“as quickly as possible”) or under precision pressure (“as accurately as possible”). In Strauss’ (2002) narrative summary, coordination-based tasks were either facilitated when well-learned (Landers et al., 1978; Martens, 1969b), remained unaffected by the presence of others (Wankel, 1972), or were inhibited (Martens, 1969a), especially when apprehending evaluation

(Haas & Roberts, 1975). Tasks requiring endurance and some forms of strength were commonly facilitated (Beckmann & Strang, 1992; Strube et al., 1981; Worringham & Messick, 1983). No conclusive statement could be made regarding exercises with mixed requirements (e.g., tennis). This may be due to the speed-accuracy trade-off: task performances are a composite of both requirements, and the trade-off could cancel out potential effects.

Is this observation true across all motor tasks performed in the presence of others? Oviatt and Iso-Ahola (2008) studied several social-influence phenomena, however, they did not distinguish between the different motor task types on account of the task demands (Bond & Titus, 1983; Strauss, 2002). To our knowledge, social facilitation research mostly looks at cognitive performance (see Guerin, 1993), but the peer-reviewed evidence on social facilitation (mere presence and co-acting) on motor tasks has not been reviewed systematically. A few literature syntheses published as papers or in books (Burnham, 1910; Guerin, 1993), reviews (Hollingworth, 1935; Zajonc, 1965) or meta-analyses (Bond & Titus, 1983; Uziel, 2007) addressed cognitive tests as well as motor tasks, while previous narrative reviews by Strauss (2002) and Daniel Landers and McCullagh (1976) focused on social facilitation during motor tasks. We conducted a joined systematic review as well as a subsequent meta-analysis to expand on the motor-task related findings by Bond and Titus (1983) as well as to test the hypotheses proposed by Strauss (2002). It is thereby the first systematic qualitative and quantitative summary of social facilitation during motor tasks to cover the entirety of research since Triplett (1898), distinguishing between condition and coordination demands on the one hand and, within coordination, between accuracy-reliant and speed-reliant tasks on the other hand. We aim to quantify the magnitude and direction of the social facilitation effect under certain requirements and discuss how the available (cognitive) theories generalize to the field of sports and movement performances. Methods

The review and meta-analysis follow the guidelines from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Statement (Moher et al., 2009; Shamseer et al., 2015) and was updated using the 2020 guidelines (Page et al., 2021).

The literature search was conducted on December 6th, 2019, by systematically searching multiple electronic search engines based on the definitions by Allport (1924) and Zajonc (1965): Scopus, PsycINFO, Web of Science and Academic Search Premier. For unpublished work, the databases ProQuest Dissertations and OvidSP were searched on February 8th, 2022, while limited to the original date.² Databases were scanned for “social facilitation”, coaction, co-action, “mere presence” or audience, crossed with “motor task”, athletic, sport, physical, exercise or movement (for the search strategy per database, see Supplement 1). Backward searches of the meta-analysis by Bond and Titus (1983), the reviews on social facilitation during motor performances by Daniel Landers and McCullagh (1976) and Strauss (2002), and the unpublished master’s thesis (review and meta-analysis on social facilitation, choking under pressure and home advantage) by Oviatt (2005)³ were conducted on December 11th, 2019.

Screening was conducted using the web software Rayyan (Ouzzani et al., 2016). Two reviewers completed the screening of the titles and abstracts independently. Disagreements were discussed and resolved by consensus or by third-party arbitration.

Eligibility criteria

Studies were included into the qualitative review if they met the following criteria:

- a) The article examined social facilitation during a movement task;
- b) The experimental design had at least one alone and one social presence condition;
- c) Analyses were conducted with original empirical data;
- d) Subjects were limited to humans;

To compute the meta-analytic effect, one criterion was added:

- e) The article provided sufficient information to compute effect sizes.

Studies could assess any age range or level of participation but were excluded if they investigated animals or if the tasks were primarily cognitive or included competition. We did not reach out to known authors for additional unpublished studies, since this would only have been possible for half of the considered research

² We thank the reviewers for their recommendation to exclude possible biases and to avoid overlooking strong unpublished studies that should be included. Finally, we added 7,260 additional studies to the screening.

³ This unpublished master’s thesis (retrievable under <https://www.proquest.com/docview/304997041?>) was in parts published (without data on e.g., home advantage or choking literature) as a book chapter (Oviatt & Iso-Ahola, 2008).

period and known authors. Articles without original data, i.e., reviews, meta-analyses or book chapters were not considered. The results of each step are presented

in Figure 4. All articles that met the inclusion criteria are listed in Supplement 3-5.

Figure 4. PRISMA 2020 flow chart.

Quality assessment and information coding

The quality of each experiment, i.e., their internal validity was assessed by two independent judges blind to the aim of the systematic review. They followed the eight criteria determined by the authors, alluding to the Quality Assessment of Controlled Intervention Studies (NHLBI, 2020; Supplement 2). Criteria were either evaluated as (a) *met*, (b) *not met*, (c) *could not be determined*, or (d) *not reported*. Disagreements were checked and resolved by third-party arbitration.

Characteristics and variables of each study were extracted from the articles by one researcher and confirmed afterwards by a second, guided by the Cochrane Handbook for Systematic Reviews (Higgins & Green, 2011). The selection of attributes followed Bond and Titus (1983). To characterize each experiment, we coded information relating to (a) the article's characteristics (metrics, publication year), (b) the quality assessment (quality criteria, experimenter's presence), (c) the sample's characteristics (age, sex distribution, subject's level of anxiety, initial skill level of the subject), (d) the task's characteristics (qualitative or quantitative performance assessment, task difficulty, task familiarity, movement categorization: coordination under precision pressure, coordination under time pressure, endurance, strength, speed, cf. Bös et al., 2015, measure), and (e) the audience's characteristics (number of others, sex distribution, role & status of others, familiarity of others, evaluative potential). Whenever no or insufficient details were provided, it was recorded as "not reported" (nr).

Statistical analysis

The protocol, data, scripts, and supplementary analyses are available on the Open Science Framework: <https://osf.io/tvk24>. All analyses were conducted using RStudio (R Core Team, 2019, version 3.6.0) and the Hands-On Guide by Harrer et al. (2019b). Agreement of inclusion and quality assessment was calculated using the *irr*-package (Gamer et al., 2019). The meta-analysis was conducted using several R-packages: *meta* (Balduzzi et al., 2019), *metafor* (Viechtbauer, 2010) and *dmetar* (Harrer et al., 2019a). Standardized mean differences between the alone and the social facilitation conditions (Hedges & Olkin, 1985) were calculated from sub-sample sizes, means and standard deviations or main-effect analyses (e.g., *F*- or *t*-statistics, adjusted error term when hierarchical/factorial design, cf. B. T. Johnson & Eagly, 2014). If several social facilitation conditions in line with the theories were analyzed, they

were treated as separate tests and the sample size of the alone condition was divided by the number of conditions (recommended by Higgins & Green, 2011). The non-theoretically backed conditions (e.g., gender-conditions) were collapsed (see Becker, 1988; Higgins & Green, 2011). In case of additional manipulations (e.g., a competitive condition, cf. White, 1991), only the theoretically justified comparison was included.

To calculate effect sizes for repeated-measures designs, correlations between measurements or the pre-test *SD* are required (cf. Morris & DeShon, 2002). Cohen's *d* was calculated by dividing the *t*-value by $\sqrt{n}$ (B. T. Johnson & Eagly, 2014). The sampling variance was derived following Becker (2009, described in Koenig et al., 2011). Whenever more than one dependent variable was assessed (e.g., Miyamoto, 1979; Pessin & Husband, 1933: # of trials and error rate; Martens, 1969a: arithmetic error and intra-variance of error; Bowman & Dunn, 1982; El Baden, 1984: multiple measures of fitness), each outcome was considered as an individual effect. Measures of learning (e.g., number of trials until criterion) were excluded to focus primarily on performance rather than learning. The effect of audience or co-actor presence on learning is discussed in the systematic review.

The dependent variables were either measures of skill (e.g., time on target, number of sit-ups) or measures of failure (e.g., number of errors). Accordingly, all effect sizes were transformed to provide a meaningful standardized mean difference *d* (esc-package, Lüdtke, 2019) between the alone-conditions and the (pooled) social facilitation conditions. A negative effect indicates an inhibition of performance (i.e., a decrease in a measure of skill in the presence of an audience or co-actor, or an increase in a measure of failure), whereas a positive effect indicates a facilitation (i.e., an increase in a measure of skill in the presence of an audience or co-actor, or a decrease in a measure of failure). Effect magnitude was classified according to Cohen (1988).

The assumption of independence of effect sizes is critical when multiple outcomes, intervention types or time points are assessed (Cheung, 2014, 2019; Fernández-Castilla et al., 2020; in sport psychology: Gucciardi et al., 2021). In the present meta-analysis, effect sizes may be nested within studies with different social facilitation conditions compared to the same control group, multiple experiments, or multiple tests. Hence, a three-level meta-analysis was conducted, modelling sampling error (level 1), within-study heterogeneity (level 2) and between-study heterogeneity (level 3; Assink & Wibbelink, 2016). This addresses

potential dependencies among effect sizes (Hagger, 2022).

High heterogeneity between the studies was expected since the experiments vary greatly regarding the population, tasks, and audience manipulations. It is therefore unlikely that the true effect size is the same across all studies. Restricted Maximum Likelihood Estimation (REML) was used to estimate the parameters in the model. Statistical heterogeneity of the effect sizes was explored using I^2 , σ^2 , and Q -statistic. Publication bias was modeled with the weight function model (<https://vevealab.shinyapps.io/WeightFunctionModel/>; Vevea & Woods, 2005). The weight-function model uses the weighted average of effects, a measure of heterogeneity among effects, and a selection parameter to assess and correct for publication bias. This method is preferred due to its advantages with small sample sizes, higher power (McShane et al., 2016) and good fit when heterogeneity is high (Carter et al., 2019).

To answer the hypotheses, moderator analyses were conducted by pooling the effect of each subgroup. Mixed-effects models were applied when the subgroups at hand were not randomly chosen but represented fixed levels of the moderator of interest (Borenstein & Higgins, 2013): motor abilities, experimenter's presence and the role of others. Meanwhile, the pooling within the subgroups was conducted using a random-effects model. Due to a lack of sufficient information and a large enough pool of studies, other moderators (e.g., audience size, date of publication) as well as potential interactions between them could not be evaluated.

Results

The forward literature search on December 6th, 2019, yielded $N=18,030$ articles (see PRISMA 2020 Flow Diagram; Figure 4). After including the records found in unpublished work ($N=7,260$) and the backward searches ($N=489$), duplicates were identified. The two independent raters agreed on 99.4% of all studies ($\kappa=0.59$, $p<.001$, moderate agreement). After screening the titles, abstracts and then full-texts, $N=82$ studies ($N=92$ experiments) were included into the systematic review (sr, see Supplements 3-5, meta-analytic studies highlighted in bold). A list of excluded studies and the reasoning process can be found in Supplement 6. The included studies were published between 1924 and

2019, with a spike of interest around 1970 (Figure 5), coinciding with the three main theoretical schools⁴. Both the systematic-review and meta-analytic sample are described by their main characteristics in Table 1. The meta-analytic sample was representative regarding most variables. Additional experimental manipulations are listed in Table 2. Overall, $n=39$ experiments compared one social facilitation condition to the solitary condition. All other experiments added at least one more condition to test different theories.

Figure 5. Publication development

Quality characteristics

Agreement on the quality criteria between the two independent judges was moderately high (agreement: 79.2%, $\kappa=0.66$, $p<.001$). The overall quality was deemed as fair, yet many articles did not report sufficient details to determine the fulfilment of the criteria, especially regarding criterion 3 and 6 (Supplement 2). In $n=42$ studies, the experimenter was physically present (cf. Guerin, 1993), while another $n=20$ articles did not provide sufficient information to exclude the possibility (documented in Supplements 3-5). The meta-analytic effect was not affected by any of the quality criteria individually (not considering criterion 3, which was not fulfilled by any study, and criterion 7, because only one study reported a power analysis), $F_{all}<1.9$, $p_{all}>.160$. Generally, a lack of quality (e.g., no adequate randomization) over- or under-estimated the effect in the expected direction (e.g., slightly stronger effect without randomization).

The systematic review synthesizes all studies by distinguishing first between coordination- and condi-

⁴ Whenever the sum of experiments reported does not add up to 82 studies/92 experiments, information in the studies was missing to provide the information and categorize them.

tion-oriented tasks to crystallize any trends of inhibition due to reduced attentional capacity in the former and facilitation due to increased drive in the latter. It is

supplemented by a meta-analysis of the social facilitation effect and a moderation analysis of the different motor task demands.

Table 1. Overview of all effect characteristics of the systematic review and meta-analysis.

	Systematic review (<i>n</i>=82 studies, 92 experiments)	Meta-analysis (<i>n</i>=28 studies, <i>k</i>=47 effects)
<i>Article characteristics</i>		
Year of publication	1924 – 2019	1924 – 2019
Experimental location	<i>N</i> 79 (86%) North America (71% USA), 8 (9%) Europe	39 (83%) North America (81% USA), 5 (11%) Europe
Experimental design	<i>N</i> 61 between subjects (66%), 31 within subjects (34%)	24 between subjects (51%), 23 within subjects (49%)
<i>Sample characteristics</i>		
Sample size	12-312 (<i>M</i> =76.17, total = 7,008)	12-181 (<i>M</i> =58.66, total = 1,907)
Gender distribution	male: 65% (12 experiments nr)	male: 65% (6 effects nr)
Sample age	<i>M</i> =17.48 (range: 6-52 years)	<i>M</i> =20.62 (range: 6-52 years)
Sample population	<i>N</i> 53 students (mostly p.e. or psychology), 22 minors, 12 (recreational) athletes	20 students, 14 minors, 10 (recreational) athletes
<i>Audience characteristics</i>		
Role of the other person present	<i>N</i> 70 audiences (76%), 18 co-actors (20%), 4 role of others manipulated	40 audience (85%), 7 co-actors (15%)
Physical presence	<i>N</i> 3 mediated (camera)	1 mediated (camera)
Number of others present	<i>Mdn</i> =2, <i>M</i> =3.01 (<i>SD</i> =3.62, range: 1-27) 6 experiments manipulated number	<i>Mdn</i> =2, <i>M</i> =4.28 (<i>SD</i> =4.49, range: 1-27)
Gender of others	<i>N</i> 21 experiments entirely female (23%), 23 experiments entirely male (25%), 5 experiments investigated gender (5%), 30 no info (33%)	3 studies entirely female (6%), 6 studies entirely male (13%), 2 studies investigated gender (4%), 26 no info (55%)
Familiarity of others	<i>N</i> 22 familiar, 27 unfamiliar, 37 no info, 6 manipulated	17 familiar, 11 unfamiliar, 19 no info
Experimenter present	<i>N</i> 47 present (51%)	27 (57%)
<i>Task characteristics</i>		
Skill- or condition-based	<i>N</i> 18 condition (20%), 63 coordination (69%)	16 condition (34%), 19 coordination (40%)
Dependent variable	<i>N</i> 82 performance outcome (90%) 9 performance quality (10%)	38 performance outcome (81%) 9 performance quality (19%)
Familiarity of task	<i>N</i> 37 familiar task, 14 unfamiliar task, 3 manipulated, 30 no info	29 familiar task, 13 unfamiliar task, 5 no info
Difficulty of task	<i>N</i> 21 simple (25%), 14 difficult (17%), 31 no info (37%), 19 manipulated (22%)	21 simple (45%), 13 difficult (28%), 13 no info (27%)

Table 2. Count of studies with additional experimental manipulations.

subject characteristics	N	audience characteristics	N	evaluation apprehension	N	task difficulty	N
gender	17	audience size	6	anxiety	13	trial/block/learning	41
age groups	4	co-action design	7	evaluation	12	task difficulty	10
IQ	2	coaction size	1	familiarity of audience	9	skill level	9
extraversion	1			status of audience	8	practice	2
locus of control	1			gender audience	5	task familiarity	2
self-esteem	1			skill level audience	4		
self-consciousness	1						

Additional factors (e.g., consequences, failure of a prior task, reinforcement, stereotype presentation): $N=5$

Review of research on coordination-based tasks

Coordination-based exercises have been hypothesized to have high cognitive loads and should thus be negatively affected by distractions like spectators or co-actors. Coordination-based tasks can be further subdivided into tasks with precision- or time pressure (Bös, 1987; Roth, 1982). This is often determined by the given instructions and dependent variable. There is a variety of tasks and social situations that cause substantial variability between the studies. Tasks performed under precision pressure, thereby requiring predominantly accuracy, are computer-based tracking ($n=15$), gross-motor balance ($n=12$) and object manipulation with the instruction to be as accurate as possible ($n=6$). Tasks performed under time pressure, thereby requiring speed while being coordination-based, are manual dexterity tasks ($n=12$) or the Coincident Timer ($n=3$). The blind maze task ($n=9$) and hot wire task ($n=1$) were often conducted under time pressure and precision pressure ("try to be as fast as possible without making any errors"). Another $n=3$ other coordination-based, yet highly distinct exercises were identified (musical performance: Abrams & Manstead, 1981; getting dressed: Markus, 1978; driving simulation: Maxwell et al., 2008). The Pursuit Rotor Tracker (hand-eye coordination; Koerth, 1922) was used most frequently ($n=12$) due to evidence of motivational influences and because most subjects did not have prior experience with the task.

Coordination under precision pressure. According to the *capacity hypothesis* (Manstead & Semin, 1980; see also Sanders, 1981), the performance of tasks with precision pressure (characterized by a high cognitive load) should suffer due to the limited attentional capacity. At the beginning of practicing computer-based tracking (Pursuit Rotor Task; Koerth, 1922), the presence of others appeared to be inhibiting (cf. Butki,

1994; not sign.: Haas & Roberts, 1975; Lombardo & Catalano, 1978; Martens, 1969a, 1969b; Martens & Landers, 1969), whereas towards the end of learning or during a retention test (Sawyer & Noel, 2000), the subjects that learned or performed in the presence of an observing (cf. Iso-Ahola & Hatfield, 1986) or evaluative (e.g. Martens, 1969a) audience compensated or outperformed the control-group subjects (Butki, 1994; Haas & Roberts, 1975; Hollifield, 1982; Kieffer, 1977; Travis, 1925), supporting the *capacity hypothesis* (Manstead & Semin, 1980). A mirror was not sufficient to cause performance changes (Guerin, 1986; cf. Innes & Gordon, 1985), refuting the idea that simple distraction may lead to deterioration (Wicklund, 1975). Moreover, interaction effects were found for the participants' sex (Corston & Colman, 1996; White, 1991), the spectators' status and evaluative potential (F. Miller et al., 1979), whereas Wankel (1977), Martens (1969b) and Martens and Landers (1969) reported no significant main (audience size) or interaction effects (task difficulty, anxiety).

Similarly, balancing, a gross-motor coordination-based task (Bös, 1987), appeared to be facilitated across studies, although affected by a few limitations. Balance was investigated using stabilometers (Crabbe, 1973; K. M. Johnson, 1974; Kozar, 1973; J. F. Murray, 1983; Singer, 1965; Wankel, 1975), balance boards (Lau et al., 2019) or beam/line walking (MacCracken & Stadulis, 1985). Another apparatus, inducing higher levels of anxiety/drive and thus a suitable tool to test Zajonc' hypothesis (1965), is the free-standing balance ladder developed by Bachman (1961; see Landers, 1975; Landers & Landers, 1973; Livingston et al., 1974; Simensky, 1991). Subjects performed better when another human was present (intermittently irrespective of their initial ability; Landers & Landers, 1973; J. F. Murray, 1983), which would be in line with Zajonc' drive hypothesis rather than Manstead and Semin's capacity hypothesis. Contradictory results

were presented by MacCracken and Stadulis (1985), who found the social condition to be facilitating when balance ability was high and inhibiting when ability was low, and by Singer (1965), who found athletes with sports experience to be inhibited, while non-athletes were facilitated. Preschoolers performed better alone, as opposed to second-graders (Crabbe, 1973). Nonetheless, in several other experiments, the groups did not differ significantly (Kozar, 1973; Lau et al., 2019; Livingston et al., 1974; Simensky, 1991; Wankel, 1975), however, Livingston et al. (1974, p. 315) and Wankel (1975, p. 214) critically reviewed their own experimental set-up that may have led to the null-findings.

Object manipulation can be examined both under precision and time pressure, depending on the task set-up, the instructions, and the dependent variables. Tasks like the “roll-up” game (Martens & Landers, 1972, p. 350; McCullagh & Landers, 1976; Sasfy & Okun, 1974) require high fine-motor skills and precision without any time pressure. Several experiments found no significant difference between the social facilitation and solitary condition (Hall & Bunker, 1979; Martens & Landers, 1972; McCullagh & Landers, 1976), whereas performance decreased in the presence of expert (Sasfy & Okun, 1974) or evaluative (Martens & Landers, 1972; Sasfy & Okun, 1974) others, and when anxiety was high (Hutchinson & Cotten, 1973; Innes & Gordon, 1985). This was independent of task difficulty (cf. Martens & Landers, 1972), aligning with our hypothesis that the additional attentional load negatively affects the cognitive performance in precision-pressure coordination tasks. Co-actors elicited opposing effects in Burwitz and Newell (1972), Hall and Bunker (1979), and Martens and Landers (1972), even though their samples, experimental designs and motor tasks were nearly identical.

Coordination under time pressure. Given the presented theoretical arguments, time pressure during coordination-based tasks may result in controversial findings, because increased drive should facilitate the speedy response, while the attentional load should impair coordination performance. The previously discussed empirical evidence suggests that speed-related tasks are facilitated (Bond & Titus, 1983; Kaczmarek et al., 2022; Sekiguchi & Hata, 2019b, 2019a). Time pressure was induced in small-object manipulation tasks by instructing participants to act as fast as possible, either in the presence of a single co-actor (Bird, 1973; Carment, 1970; Carment & Latchford, 1970; Q. L. Miller, 1989; Wankel, 1972), a small/large (Gates, 1924), same-/opposite-sex (Fouts, 1980; Kenyon & Loy, 1966), familiar/unfamiliar (Cox, 1966, 1968) or

common/prestigious audience (Kenyon & Loy, 1966). While some were unaffected by their presence (Bird, 1973; Cox, 1966, 1968; Kenyon & Loy, 1966; Wankel, 1972), others worked faster when paired with a second participant (Q. L. Miller, 1989) or observed by spectators (of the same sex; Fouts, 1980; cf. Wankel, 1972, p. 434; Cox, 1966, 1968). The difference between performing alone or with a co-actor was larger than with an audience (e.g., Bird, 1973; Carment & Latchford, 1970; El Baden, 1984).

While several experiments used similar versions of the “blind maze” (Hunt & Hillery, 1973), their social facilitation situations and thus results differ substantially due to their diverging theoretical approaches. Performance scores of the “blind maze” are mainly time-based (speed measure), but some studies have added number of errors (accuracy measure) as additional dependent variable. Pessin and Husband (1933) found direct and indirect observation by familiar or unfamiliar spectators to result in small yet insignificant performance decrements compared to solitary performance, while Shaver and Liebling (1976) reported an interaction effect between task difficulty and others’ presence (cf. Landers et al., 1977). Rajecki and colleagues (1977) tested activation- and attention-based theoretical approaches with additional conditions (mirror, mannikin/human spectator with/without blind-fold; cf. Innes & Gordon, 1985) and found human and especially, but not exclusively, evaluative audiences to be facilitating (cf. Miyamoto, 1979). Additionally, Griffith et al. (1989) presented evidence that several drive-manipulating factors “influenced individual performance in the presence of others in a manner generally consistent with Paulus’ (1983) [cognitive-motivational] model” (p. 268).

The study by Markus (1978) is noteworthy: the author asked participants to change out of and into familiar and unfamiliar clothing while either no one, an incidental or an attentive audience was present. This unobtrusive design has high internal validity, as it prevented evaluation apprehension by the experimenter, which strongly resembles the social facilitation effect as hypothesized by Cottrell et al. (1968) and Henchy and Glass (1968). Markus (1978) found a mere presence effect moderated by task difficulty, which is in line with both of Zajonc’s assumptions (1965). The attentive audience produced even stronger effects.

Overall, the experiments on motor tasks that rely primarily on information processing (i.e., coordination-based) differ regarding their samples, tasks, audience conditions and evaluative priming. Most studies on

both audience and co-action effects did not find a significant difference. In the presence of an audience, the distribution of facilitating and inhibiting effects was fairly balanced. Additionally, the moderating effect of participants' ability level (i.e., learning stage, initial ability, task familiarity) stood out (Haas & Roberts, 1975; Markus, 1978; Martens, 1969a). Those studies that looked for differences between men and women regarding their response to someone being present ($n=17$), did not find a significant interaction effect ($n=13$). A trend of social inhibition can be observed for object control with precision pressure, whereas time pressure may result in a facilitation of an already learned skill. While this has most often been interpreted in the framework of the *generalized drive theory* (Zajonc, 1965), it does comply with the arguments made by Manstead and Semin (1980): a task performed under precision pressure that is not well-learned yet, requires more cognitive attention and might thus be impaired in the presence of others.

Review of research on condition-based tasks

Zajonc' drive hypothesis suggests that condition-based tasks should be facilitated because an increased drive would benefit performance in energy-/effort-determined tasks. The cognitive load of spectators, on the other hand, should not affect the energy-determined tasks that are discussed in the following.

Endurance. Bös (1987) distinguishes between several subcategories of condition-based tasks (see Figure 3). To date, social facilitation experiments have only investigated endurance, strength and strength endurance ($n=1$ on speed, Ben-Ezra et al., 1986). The results show considerable variability in their methodological and qualitative characteristics. However, there appears to be a facilitating trend in tasks involving sustained performance (endurance & strength endurance, see Figure 3), in line with the present hypothesis and the results summarized by Strauss (2002). More specifically, Worringham and Messick (1983) found a significant inter-condition and intra-subject increase in running speed when an attentive female was observing the male and female participants (cf. Strube et al., 1981). This is also in line with the *learned drive hypothesis* by Cottrell et al. (1968). Other endurance-based performances (Shuttle Run: Bowman & Dunn, 1982; Chevrette, 1968) found a facilitating effect, despite highly confounded control conditions, or a non-significant trend (Thielemier, 2014; unpublished master's thesis). Moreover, performance relying on strength-endurance im-

proved significantly when executed with a single (digital) co-actor (Feltz et al., 2011; E. Murray et al., 2016), three co-actors (Kamal, 1980; Martens & Landers, 1969) or a passive audience (Bowman & Dunn, 1982; El Baden, 1984; cf. Moede, 1920), whereas Chevrette (1968) did not find a facilitating effect of audience presence on vertical hang performance in a sample of children, and Kenyon and Loy (1966) reported no changes in performance when undergraduate students exerted a submaximal wrist force for as long as possible. El Baden (1984) found co-actors to be more facilitating than a passive audience when doing sit-ups for 60 seconds (although it is worth noting that females achieved nearly as many sit-ups in the co-action condition as the male participants, cf. p. 63).

Strength. Strength determines performance in throwing fastballs (Weinstein et al., 1987), standing broad jump (Bowman & Dunn, 1982), power exertion towards the ground (Piché & Sachs, 1982), grip or wrist dynamometer tests (Chevrette, 1968; Kenyon & Loy, 1966), as well as bench press (Sheridan et al., 2019) and leg extension (Beckmann & Strang, 1992; Martens & Landers, 1969). While Bowman and Dunn (1982), Chevrette (1968), and Piché and Sachs (1982) did not find an effect of any type of audience or co-actor presence on performance, maximal lifted weight improved in the leg press (Beckmann & Strang, 1992) or when lifting a box while being watched by a similar or superior spectator (Selan, 1986). Bench press performance improved significantly for a large majority of participants (Sheridan et al., 2019). Nonetheless, caution needs to be practiced when interpreting the results by Sheridan and colleagues (2019): the strength parameters may improve not only due to social facilitation, but also a changed perception of safety.

Review of research on tasks with coordination- and condition-based aspects

Tasks requiring both coordination and condition are subject to the speed-accuracy trade-off (Fitts & Posner, 1967; see also Landers & McCullagh, 1976), hence, any inhibiting or facilitating effects as expected for condition- or coordination-based aspects, respectively, might cancel each other out. Overall, studies did not find a social facilitation effect. The present experiments tested the social facilitation paradigm in a "natural situation" (Forgas et al., 1980) with mostly unfamiliar observers. Performance was either rated by quality criteria or indicators of accuracy or correct execution. While in gymnastics a social inhibition effect was found (Paulus et al., 1972; Paulus & Cornelius, 1974;

however, this can be critically reviewed on the correlating initial scores of the performance changes, see Strauss, 2002), the absence of an audience affected introverts positively when hitting table tennis serves (Graydon & Murphy, 1995), whereas extroverts improved under observation. Meanwhile, the presence or absence of an audience failed to cause any significant effect on the penalty accuracy for intercollegiate soccer players (Navarro et al., 2013) or basketball free-throw accuracy (Krendl et al., 2012; Welch, 2005). Similarly, skilled karate students were not affected by an audience, whereas lesser skilled students performed worse when not alone (Bell & Yee, 1989).

Dube and Tatz (1991) evaluated tennis match performance of children, and Forgas et al. (1980) assessed novice and expert squash players. Forgas et al. (1980) specifically described the unobtrusive nature of their experimental setup, whereas during the tennis matches, a referee who was scoring the players' shots, was always present. Both studies investigated and rejected the skill-hypothesis: Dube and Tatz (1991) reported a significant interaction effect between audience presence and the subjects' skill level for all quality measures of performance, whereas Forgas et al. (1980) found no moderating effect of skill level on the social facilitation effect. Nonetheless, it is debatable whether these experiments fully comply with the social facilitation paradigm since both match situations may hold competitive influences. Furthermore, Forgas et al. (1980) discuss the possibility of "automatic matching" (p. 46) to show the audience a good match rather than one's individual best performance.

Meta-analysis

Only a small proportion of the eligible studies could be included in the meta-analysis (Supplement 3-5). The first three-level random-effects model indicated a small, positive, significant effect, $N=28$, $k=47$, $d=0.29$, 95% CI [0.03; 0.55], $p=.030$, $AIC=107.49$. The heterogeneity within the model was substantial, $Q(45)=380.39$, $p_Q<.001$, justifying the choice of a random-effects model. $I^2=87\%$ of the variance was not attributable to sampling error. Within-study variance, $k=47$, $\sigma^2_{\text{level } 2}=0.25$, $I^2_{\text{level } 2}=41.25\%$, and between-study variance was high, $N=28$, $\sigma^2_{\text{level } 3}=0.23$, $I^2_{\text{level } 3}=45.52\%$. An inspection of the residuals and Cook's distance (cut-off: $4/n$) per effect did not show any outliers. Figure 6 visualizes all included effects sorted by motor ability: condition ($n=16$), coordination ($n=19$) and mixed ($n=12$).

To check whether the nested data structure improved the model fit, level 2 and level 3 were removed respectively, indicating a significant decrease of model fit when removing level 2, $d=0.27$, 95% CI [0.03; 0.51], $p=.031$, $\sigma^2_{\text{level } 3}=0.32$, $AIC=142.37$, $\chi^2=36.88$, $p_{\text{fit}}<.001$. When removing level 3, the model statistics resembled the full model, $d=0.33$, 95% CI [0.10; 0.56], $p=.006$, but the model fit again decreased significantly, $\sigma^2_{\text{level } 2}=0.52$, $AIC=112.26$, $\chi^2=6.77$, $p_{\text{fit}}=.009$. Hence, the multilevel model is justified.

Moderator analyses

Moderator analyses were conducted to identify clusters of individual effects that systematically explain the between-study heterogeneity. All coded variables have been argued to moderate the social facilitation effect in previous studies, however, the eligible studies often did not provide (ample) details (e.g., age, audience sex, audience & task familiarity). Thus, only reasoned variables with sufficient study samples were tested for their moderating effect (Supplement 7). A meta-analytical interaction effect for social facilitation and gender was not possible due to a lack of studies and statistical information.

To answer the hypothesis whether motor tasks with high cognitive demands (coordination under time or precision pressure) are impaired while tasks with high energy demands (condition) or presumably equally high demands (mixed tasks) are affected differently by the presence of others, a mixed-effects model was run. Results showed a significant difference between the estimates of the pooled effects, $F(3, 43)=4.18$, $p=.011$, with $Q(42)=244.92$, $p<.001$, $\sigma^2_{\text{level } 2}=0.26$, $\sigma^2_{\text{level } 3}=0.1$ (Table 3), indicating that the mixed-effects model was justified. Variability was highest for timed coordination tasks. Additionally, the confidence intervals indicate high inconsistency in all pooled effect sizes except for condition-based tasks.

Sensitivity analysis

Publication bias was assessed using the weight-function model for publication bias (McShane et al., 2016; Vevea & Woods, 2005). Results in the robustness of the meta-analysis are displayed in Table 4. χ^2 -tests indicated no severe publication bias, $\chi^2_{\text{all}}<7.1$, $p_{\text{all}}>.05$. The moderate one- and two-tailed model, effect sizes and variances were similar to the unadjusted estimates.

Figure 6. Forest plot of the results of the multilevel model (d = Cohen's d, CI = confidence interval).

Table 3. Results of moderator analysis based on motor task categories.

Motor ability	<i>k</i>	<i>d</i>	<i>SE</i>	95% CI	<i>p</i> _{condition}
condition	16	0.84	0.17	CI [0.46; 1.23]	
coordination under					
- precision pressure	14	0.03	0.24	CI [-0.88; 0.95]	.004
- time pressure	5	0.12	0.34	CI [-1.01; 1.26]	.061
mixed	12	-0.05	0.26	CI [-1.07; 0.97]	.007

Table 4. Effect size estimations for various publication bias scenarios.

Moderator	Publication bias scenario				
	Unad-justed estimate	Severe one-tailed	Moderate one-tailed	Moderate two-tailed	Severe two-tailed
Variance component	0.32	0.30	0.33	0.34	0.45
Condition (intercept)	0.84	0.90	1.02	0.96	0.78
Coordination under					
- precision pressure	0.03	0.09	0.11	0.02	-0.39
- time pressure	0.12	0.07	0.20	0.11	-0.25
Mixed	-0.05	0.00	0.11	0.02	-0.27
Likelihood ratio test	$\chi^2(1)=7.02, p=.867$ $\chi^2(1)=6.13, p=.180$ $\chi^2(2)=6.68, p=.704$ $\chi^2(2)=4.21, p=.059$				

Note: Effect sizes for the moderator meta-analysis are provided as Cohen's *d* per motor tasks category. *p*-value cut-offs are at .01 & .05 (for two-tailed selection methods: .005 & .995, .025 & .975, respectively).

Discussion

The present investigation synthesizes the evidence on human social facilitation during motor tasks to test whether condition- and coordination-requirements led to diverging effects due to the hypothesized cognitive-load differences, and whether time and precision pressure during coordination-based tasks are affected differently. The results indicate that coordination-based tasks are not systematically inhibited. While object manipulation performed under precision pressure seems to be inhibited more often than not (at least when the task is not well learned), object manipulation performed under time pressure (and balancing) appear to be facilitated (cf. Bond & Titus, 1983; Guerin, 1993). Nevertheless, a considerable portion of the experiments did not find a significant difference between executing coordination-based tasks in solitary or in the presence of others, only sometimes moderated by task difficulty/skill level. During condition-based tasks, we found a consistent trend for tasks involving sustained performance to be facilitated through the presence of others. Both running and strength exercises like plank-

ing (Feltz et al., 2011) were facilitated through co-actors and spectators. The meta-analysis generally aligned with the systematic review: The subgroup-effect for the condition-based exercises was strongly positive, indicating that (strength) endurance performance was facilitated. The lack of other significant sub-group effects may result from the high heterogeneity of experimental methods, audiences, and motor tasks.

Our findings are support for both the *generalized drive theory* (Zajonc, 1965) and the *capacity hypothesis* (Manstead & Semin, 1980). High performance in condition-based tasks results from high amounts of available energy, which, according to the *generalized drive theory* (Zajonc, 1965) increase through heightened drive (cf. Strauss, 2002). Contrary to this, coordination-based task performance is determined by the information uptake and available cognitive resources. The *capacity hypothesis* suggests that these tasks are therefore affected differently, which is supported by the present results. Additionally, Bös (1987) and Roth (1982) find similarities between coordination-based tasks performed under time pressure and condition-based tasks. The observed non-significant trend of facilitation during speed-reliant coordination tasks is similar to the

condition-based findings, suggesting that an energy/information-oriented distinction between tasks seems more appropriate to cluster social facilitation effects than a simple/complex distinction. Generally, as proposed by Strauss (2002) and systematically quantified in this review, activation-based models (Zajonc, 1965; Cottrell et al., 1968; Guerin & Innes, 1982) seem to be applicable for energetically determined tasks (condition), while attention-based models (Manstead & Semin, 1980; Baron 1986) seem more appropriate for some information-determined tasks (coordination). Hence, future research should target the operationalization of activation and attention processes, e.g., by using condition and coordination exercises rather than simple and complex tasks.

In the studies with tasks requiring both coordination and condition in similar parts, no trend of social facilitation or inhibition was found, potentially because condition-based facilitation was cancelled out by coordination-based inhibition. I.e., certain tasks that are classified as predominantly condition-based may be affected differently due to coordination-demands (cf. timing during standing long jump, Bowman & Dunn, 1982). Accordingly, a more precise operationalization of condition- and coordination-based motor tasks might be warranted to establish the mechanisms underlying social facilitation.

Our findings generally align with those of previous systematic reviews. Other meta-analyses have had a broader focus (Bond & Titus, 1983: motor and cognitive tasks; Oviatt & Iso-Ahola, 2008: more diverse social situations, synthesizing motor tasks). Bond and Titus (1983) reported that in the presence of others, the subjects performed complex tasks less accurately or more slowly and experienced higher arousal, while simple tasks (especially quantitative measures) were executed more quickly (no meta-analytic effect on accuracy or arousal was reported; for recent results, Kaczmarek et al., 2022; Sekiguchi & Hata, 2019b, 2019a). Strauss (2002) also concluded that while social facilitation effects remain weak throughout the literature, a motor-task taxonomy may help partition the effects – a hypothesis that was supported by the present systematic review and moderator analysis. Additionally, in an interesting archival analysis, Heinrich et al. (2021) compared results from biathlon world cups prior to and during the covid-19 pandemic, looking specifically at the difference between the condition-based and coordination-accuracy based elements. Their analyses found the relationship between motor tasks and social presence to be moderated by gender. This is particularly noteworthy since previous studies did not find such a gender-

interaction effect. In our sample of $N=92$ experiments, 17 included gender as an additional factor, however, only four indicated gender-based differences. Since none of the theories provides an explanation for this surprising effect, future analyses are warranted. It should be considered that just because no spectators were physically present during covid-19 competitions, the biathletes were not alone: there are still other athletes co-acting and competing as well as TV audiences and others like coaches or staff, who occasionally gave feedback or support.

Limitations of the evidence included in this synthesis

Although this review applied strict inclusion and exclusion criteria, it is constrained by the poor to fair quality of most of the screened articles, as assessed by current standards (NHLBI, 2020). These quality ratings should be interpreted with caution: the criteria of the Quality Assessment of Controlled Intervention Studies (NHLBI, 2020; Supplement 2) are fairly strict for older studies (e.g., power analyses only gained in consideration after the seminal review by Cohen, 1962). While this review is a comprehensive summary across 100 years, most studies do not provide sufficient information to neither reject nor assume the fulfillment of the criteria. Future studies should ensure that these modern quality criteria (randomization, blinding, power analysis, quality tests) are met and reported (good example: Krendl et al., 2012). Covering 100 years of research is a strength of the systematic review but may also introduce some bias into the meta-analysis towards more recent evidence: only 11% of the studies included in the meta-analysis were published before the seminal paper by Zajonc (1965), while 41% of the included studies were published after Bond and Titus (1983). Hence, there might be a bias in the meta-analytic effect in comparison to the systematic review, and they should only be considered together.

Additional issues more specific to social facilitation research include introducing rivalry (cf. Allport, 1920, 1924; for a historical classification, see Dashiell, 1935; Guerin, 1993) or wanting to make an impression (Burnham, 1910) into the experimental paradigm. Stronger effects can be expected in those studies that did not control for these influences. However, it may very well be that the absence of a mere presence effect stems from the inherent complications of social facilitation research. It is highly difficult to create an experimental situation in which the subject does not feel

monitored or observed. Markus (1978) provided a pioneering method by using an incidental task (dressing into familiar and unfamiliar clothing) whilst either being alone, with a confederate facing away, or with a confederate watching the dressing. Future research should replicate unobtrusive experimental designs like this to prevent the dilution of the effect. This could for example be achieved with technologies like GPS tracking systems or camera-based motion tracking to create more natural, unobserved scenarios for the subjects. Similar systems have been applied and assessed in electronic monitoring (Laird et al., 2018; however, for individual responses to electronic monitoring, see Ravid et al., 2020).

A major limitation in conducting the experiments is the experimenter's presence during the alone-condition (Dashiell, 1930, 1935). Guerin (1993) had already systematically listed the articles that violated this principle of social facilitation research. In the present meta-analysis, the social facilitation effect was half as strong when the experimenter was reportedly in the same room as the subject during the alone-condition, which further amplifies the importance to reduce the experimenter's physical and potentially evaluative presence in this field of research to establish a true mere presence or audience effect. Additionally, the lack of protocols to control for other influences and the low comparability of the study designs (cf. Aiello & Douthitt, 2001) are backed by our quantitative analyses (cf. Guerin, 1993).

Additional complications of synthesizing the present studies arise from the high heterogeneity of active and passive others, their evaluative potential, and how task difficulty was operationalized. The original idea (dichotomic: "well learned", "novel"; generalized drive theory; Zajonc, 1965) was soon shifted to task complexity ("simple" vs "complex"). However, authors only rarely provide reasonable arguments as to which version of a task was considered simple or complex (e.g. Pursuit Rotor Task speeds of 30rpm or 60rpm, F. Miller et al., 1979), or to whom the task may appear simple or complex (subjectively and a posteriori defined experts vs. novices, for a critical discussion, see Strauss, 2002). These operationalizations complicate the comparability of the included studies and the true effect task difficulty may have in mere presence situations.

Practical application

With the observed trend, it may be possible to implement social facilitation effects in certain contexts,

e.g., physical-education classes or condition training, while preventing social inhibition effects during tasks requiring coordination under precision pressure until they are well-learned. Technical skills with high degrees of cognitive load should be performed alone in the beginning of learning. To gather more conclusive evidence for the relationship between coordination and the *capacity hypothesis*, measures of both speed and accuracy requirements in the same experiment or even same motor task are necessary. First examples of explicitly testing the hypotheses by Strauss (2002) were recently set in a rat population (Sekiguchi & Hata, 2019b) as well as a human population (Kaczmarek et al., 2022): performance in the plank task was facilitated in the presence of spectators, but speed-stacking was inhibited.

Additionally, it may be interesting to study the effects of virtual audiences in the future (Liu & Pu, 2020). Dashiell (1930) already argued that physical presence is not necessary for social facilitation or inhibition, as long as the subject has the impression that someone is working on the task simultaneously (see e.g., Feltz et al., 2011). This may hold important implications for virtual teams and electronic performance monitoring to reduce social inhibition effects during learning (Claypoole & Szalma, 2019; Davidson & Henderson, 2000). Nonetheless, individual differences and responses to social situations should be considered (Uziel, 2007).

Future research

Our findings advocate an integrated framework of activation- and attention-oriented social facilitation theories. To empirically confirm this hypothesis, future research should target the operationalization of activation and attention processes, e.g., by using condition- and coordination-based exercises rather than simple and complex tasks, ideally within the same experiment. Important requisites for these studies are the precise operationalization of condition- and coordination-based motor tasks, the application of modern quality criteria (see NHLBI, 2020), and social facilitation specific considerations like controlling for competition effects, the impact of the experimenter's presence, and providing a definition of task difficulty (task difficulty/complexity, skill level or learning).

Once these processes are understood in their purest form, additional concepts like gender effects (see Heinrich et al., 2021), virtual audiences (e.g., Claypoole & Szalma, 2019) or motivational states can be integrated (already suggested by Blascovich et al, 1999; Paulus,

1983). E.g., in the *Theory of Challenge and Threat States in Athletes*, Jones et al. (2009) and Meijen et al. (2020) have expanded the framework of Blascovich et al. (1999) to include emotional/motivational consequences of primary and secondary appraisal, which affect the potential to meet situational demands and explain potential controversial effects of social presence.

Conclusion

To summarize, this systematic review and meta-analysis align previous findings (Bond & Titus, 1983; Landers & McCullagh, 1976; Strauss, 2002): tasks that predominantly rely on energetic processes are facilitated by the active or passive presence of others, as are tasks performed under time pressure or balancing tasks, whereas tasks that require accuracy are either inhibited or remain unaffected, with no obvious pattern, supporting the hypothesis by Strauss (2002). Since we cover 100 years of research, the methodological quality of the included studies is somewhat limited with respect to current requirements and standards of our inclusion criteria. Therefore, the meta-analysis might be biased towards more recent evidence, hence, the systematic review and meta-analysis should only be considered together. In the previous paragraphs, we have highlighted the quality criteria specific for clean social facilitation conditions during motor task performances and provided suggestions for future research. Most importantly, all information required by quality assessment tools should be reported, the influence of the experimenter as an additional evaluative spectator should be eliminated, and key statistical information should be provided (key statistical information: sample sizes, means and standard deviations per condition, correlations between related samples). Specific to sports and motor tasks, direct comparisons of the effect of spectators or co-actors on condition- and coordination-based tasks is warranted to establish conclusively how activation or attention processes determine the direction of the effect. The distinction of simple/well-learned and complex tasks seems less appropriate in the motor learning and sports context. Despite a decline in this area of research, many questions remain unanswered, see already Aiello and Douthitt (2001).

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Supplement 1. Search strategy per database.

Database	Date	Search strategy	Limited to
Scopus	2019-12-06	TITLE-ABS-KEY ("social facilitation" OR coaction OR co-action OR "mere presence" OR audience) AND ("motor task" OR athletic OR sport OR physical OR exercise OR movement)	
PsycINFO	2019-12-06	TX ("social facilitation" OR coaction OR co-action OR "mere presence" OR audience) AND ("motor task" OR athletic OR sport OR physical OR exercise OR movement))	
Web of Science	2019-12-06	("social facilitation" OR coaction OR co-action OR "mere presence" OR audience) AND ("motor task" OR athletic OR sport OR physical OR exercise OR movement) (all fields)	
Academic Search Premier	2019-12-06	TX ("social facilitation" OR coaction OR co-action OR "mere presence" OR audience) AND ("motor task" OR athletic OR sport OR physical OR exercise OR movement)	
ProQuest Dissertations	2022-02-08	noft(("social facilitation" OR coaction OR co-action OR "mere presence" OR audience) AND ("motor task" OR athletic OR sport OR physical OR exercise OR movement))	Date until 2019-12-06
OvidSP	2022-02-08	("social facilitation" OR coaction OR co-action OR "mere presence" OR audience) AND ("motor task" OR athletic OR sport OR physical OR exercise OR movement)	1860-2019, no related terms

Supplement 2. Quality assessment.

Quality Assessment of Controlled Intervention Studies (NHLBI, 2020)

1. Was the method of randomization adequate (i.e., use of randomly generated assignment)?
2. Were study participants and providers blinded to treatment group assignment?
3. Were the people assessing the outcomes blinded to the participants' group assignments?
4. Were the groups similar at baseline on important characteristics that could affect outcomes (e.g., demographics, baseline performance)?
5. Did the authors conduct a manipulation check?
6. Were outcomes assessed using valid and reliable measures, implemented consistently across all study participants? (valid & reliable as indicated by the authors)
7. Did the authors report that the sample size was sufficiently large to be able to detect a difference in the main outcome between groups with at least 80% power?
8. Were outcomes reported or subgroups analyzed prespecified (i.e., identified before analyses were conducted)? (Interpreted as only analyzing the proposed hypothesis, no further analyses)

Reference	<i>N</i> _{alone}	<i>N</i> _{SF}	1	2	3	4	5	6	7	8	Rating
Abel (1938) – Exp. 1	74	rm		✓	–	✓			–	–	*
Abel (1938) – Exp. 2	74	rm			–	✓			–	–	*
Abrams et al. (1981)	20	60	✓	✓	–	✓	✓	✓	–	✓	***
Beckmann & Strang (1992)	80	rm		–	–				–	✓	*
Bell & Yee (1989)	33	rm	–	✓	–	✓		–	–	✓	*
Ben-Ezra et al. (1986)	13	rm	✓		–			✓	–	✓	*
Bird (1973)	15	30	✓		–				–	✓	*
Bowman & Dunn (1982)	30	rm	✓		–			✓	–	✓	*
Burwitz & Newell (1972)	36	72	✓		–				–	✓	*
Butki (1994)	15	45	✓		–	✓			–	✓	*
Carment (1970)	10	10	✓	✓	–				–	✓	*
Carment & Latchford (1970)			✓	✓	–				–	✓	*
Chevrette (1968)			✓		–			✓	–	✓	*
Corston & Colman (1996)	24	48	✓	✓	–		✓		–	✓	**
Cox (1966) – Exp. 1	20*	40*	✓		–	✓			–	✓	*
Cox (1966) – Exp. 2	20*	60*	✓		–	✓			–	✓	*
Cox (1966) – Exp. 3	20*	40*	✓		–	✓			–	✓	*
Cox (1968) – Exp. 1	20*	40*	✓		–	✓			–	✓	*
Cox (1968) – Exp. 2	20*	60*	✓		–	✓			–	✓	*
Cox (1968) – Exp. 3	20*	40*	✓		–	✓			–	✓	*
Crabbe (1973)	30	30			–			✓	–	–	*
D. M. Landers (1975)	45	90	✓		–		–		–	✓	*
D. M. Landers & Landers (1973)	20	20	✓		–		–		–	✓	*
Dube & Tatz (1991)	16	rm	✓	✓	–	✓		–	–	✓	**
E. G. Murray et al. (2016)	20	40	✓		–	✓	✓		–	✓	**
El Baden (1984)	104	208	✓		–			✓	✓	✓	**
F. G. Miller et al. (1979)	5	20	✓		–				–	✓	*

Reference	<i>N</i> _{alone}	<i>N</i> _{SF}	1	2	3	4	5	6	7	8	Rating
Feltz et al. (2011)	49	132	✓		–	✓	✓	✓	–	✓	**
Forgas et al. (1980)	40	rm	✓		–	✓	–		–	✓	*
Fouts (1980)	48	rm			–				–	✓	*
Gates (1924)	25	37			–		✓		–	–	*
Geisler & Leith (1997)	20	20	✓		–		✓	✓	–	✓	**
Graydon & Murphy (1995)	20	rm			–				–	✓	*
Griffith et al. (1989)	32	rm	✓	✓	–	✓	✓		–	✓	**
Guerin (1986)	39	rm			–				–	✓	*
Haas & Roberts (1975)	45	rm	✓	✓	–	✓			–	✓	**
Hall & Bunker (1979)	32	rm	✓		–	✓			–	✓	*
Hollifield (1982)	20	20	✓	–	–	✓			–	✓	*
Hutchinson & Cotton (1973)	144	rm			–	✓	✓		–	✓	*
Innes & Gordon (1985)	20	40	✓		–		✓		–	–	*
J. F. Murray (1983)	42	42	✓		–	✓	✓		–	✓	**
Johnson (1974)	24	24	✓	✓	–	✓			–	✓	**
Kamal (1980)	80	rm	✓		–	✓	✓		–	✓	**
Kenyon & Loy (1966)			✓	–	–	✓		✓	–	✓	**
Kieffer (1977)			✓		–	✓	✓		–	✓	**
Kozar (1973)	50	100	✓		–		✓		–	✓	*
Krendl et al. (2012)	38	36	✓	✓	✓	✓	✓	✓	–	✓	***
Landers, Brawley, & Hale (1977)	36	72	✓	✓	–	✓	✓	✓	–	✓	***
Lau et al. (2019)	35	35	✓		–				–	✓	*
Livingston et al. (1974)			✓		–	✓		✓	–	✓	**
Lombardo & Catalano (1975)	12	12		–	–		✓		–	✓	*
Lombardo & Catalano (1978)	30	31		✓	–				–	✓	*
MacCracken & Stadulis (1985)	99	rm	✓		–	✓			–	✓	*
Markus (1978)	15	30	✓	✓	–		✓		–	✓	**
Martens (1969a)	48	48	✓		–	✓	✓	✓	–	✓	**
Martens (1969b)	48	48	✓		–	✓	✓		–	✓	**
Martens (1969c)	24	24			–	✓	✓	✓	–	✓	**
Martens & Landers (1969a)	60	120			–	✓	✓		–	✓	*
Martens & Landers (1972)	24	108	✓		–			✓	–	✓	*
Maxwell et al. (2008)	28	rm	✓		–	✓	✓	✓	–	✓	**
McCullagh & Landers (1976)	16	80	✓	–	–		–	✓	–	✓	*
Miyamoto (1979)	15	15	✓	✓	–				–	✓	*
Navarro et al. (2013)	10	rm			–	✓			–	✓	*
Paulus & Cornelius (1974)			✓		–	✓		✓	–	✓	**
Paulus et al. (1972) – Exp. 1	24	rm	✓	✓	–				–	✓	*
Paulus et al. (1972) – Exp. 2	21	rm		✓	–				–	✓	*
Pessin & Husband (1933)	30	60			–				–	–	*

Reference	<i>N</i> _{alone}	<i>N</i> _{SF}	1	2	3	4	5	6	7	8	Rating
Piche & Sachs (1982)	24	24		–	–		–		–	✓	*
Q. L. Miller (1989)	24	24	✓		–				–	✓	*
Rajecki et al. (1977)	10	50	✓	✓	–		–		–	✓	*
Sasfy & Okun (1974)	24	72	✓	✓	–		✓	✓	–	✓	**
Sawyer & Noel (2000)	32	rm	✓		–	✓			–	✓	*
Selan (1986)	30	30			–				–	✓	*
Shaver & Liebling (1976) – Exp. 1	30	rm		✓	–				–	✓	*
Shaver & Liebling (1976) – Exp. 2	16	48		✓	–				–	✓	*
Sheridan et al. (2019)	12	rm		✓	–	✓	✓	✓	–	✓	**
Simensky (1991)	40	40	✓	✓	–	✓	✓	✓	–	✓	***
Singer (1965)	32	rm			–	✓			–	✓	*
Singer (1970)	40	40	✓		–				–	✓	*
Strube et al. (1981) – Exp. 1	40	80	✓		–		–		–	✓	*
Strube et al. (1981) – Exp. 2			✓		–		✓		–	✓	*
Thielemier & Church (2014)	17	rm			–				–	✓	*
Travis (1925)	22	rm			–				–	–	*
Wankel (1972)			✓	✓	–		✓	✓	–	✓	**
Wankel (1975)	48	48	✓	✓	–				–	✓	*
Wankel (1977)	20	40	✓	✓	–		✓		–	✓	**
Weinstein et al. (1987)	14	rm			–				–	✓	*
Welch (2005)	27	rm	✓		–				–	✓	*
White (1991)	36	36	✓	✓	–				–	✓	*
Worringham & Messick (1983)	12	24	✓	✓	–	–			–	✓	*

Note: ✓ = criterion fulfilled; – = criterion not fulfilled; empty = no information provided; rm = repeated measures. *N*_{SF} denotes all subjects in all included social-facilitation conditions (up to 5, cf. Rajecki et al., 1977; McCullagh & Landers, 1976). Cox (1966, 1969): *N*s not explicitly stated, derived from design.

Supplement 3. Social facilitation manipulation in coordination-based tasks.

Reference	Sample	Age [y]	Design	Audience condition	Motor task
Abel (1938) <i>Series 1</i> ^{USA} <i>Series 2</i> ^{USA}	<i>N</i> =74 girls, sub-normal intelligence level (0% male)	15-16	within	1: alone? 2: in pairs	paper-pencil maze
Manstead (1981) ^{Great Britain}	<i>N</i> =80 students (50% male)	19-24	between	1: alone 2: audience present 3: evaluation 4: mirror	Glockenspiel pattern
Bird (1973) ^{USA}	<i>N</i> =90 undergraduate students (0% male)	18-23	between	1: alone? 2: audience (2) present 3: co-actor present	A: steadiness tester-hole type B: Minnesota Rate of Manipulation turning test
Burwitz & Newell (1972) ^{USA}	<i>N</i> =108 undergraduate students (100% male)	<i>M</i> =19	between	1: alone* 2: coaction in dyads 3: coaction in tetrads	Roll-up game
Butki (1994) ^{USA}	<i>N</i> =60 persons (60% male)	19-25	between	1: alone? 2: early audience 3: middle audience 4: late audience	Pursuit rotor tracking
Carment & Latchford (1970) ^{Canada}	<i>N</i> =96 students (IP) (50% male)	nr	between	1.1: alone, no coaction 1.2: alone, coaction 2.1: observer, no coaction 2.2: observer, coaction	Panel-mounted self-centering toggle switches: move a lever back and forth with thumb & two fingers clasped around it
Carment (1970) ^{Canada}	<i>N</i> =80 students (IP) (50% male)	nr	between	1: alone? 2: co-actor	Gerbrands-Lindsey conditioning panel, providing ball bearings to place in tubes
Corston & Coleman (1996) ^{Great Britain}	<i>N</i> =72 undergraduate students (50% male)	16-52	between	1: alone 2: audience, same sex 3: audience, opposite sex	computer-based tracking task
Cox (1966) ^{Canada} <i>Experiment 1</i>	<i>N</i> =60 children (100% male)	nr	between	1: alone* 2: teacher present 3: mother present	Marble dropping (Stevenson & Fahel, 1961)
<i>Experiment 2</i>	<i>N</i> =80 children (100% male)	nr	between	<i>same as Experiment 1</i> 4: boy present	Marble dropping (Stevenson & Fahel, 1961)

Reference	Sample	Age [y]	Design	Audience condition	Motor task
<i>Experiment 3</i>	<i>N</i> =60 children (100% male)	nr	between	1: alone* 2: teacher present 3: unknown female present	Marble dropping (Stevenson & Fahel, 1961)
Cox (1968) ^{Canada} <i>Experiment 1</i>	<i>N</i> =60 children (100% male)	nr	between	1: alone* 2: teacher present 3: father present	Marble dropping (Stevenson & Fahel, 1961)
<i>Experiment 2</i>	<i>N</i> =80 children (100% male)	nr	between	<i>same as Experiment 1</i> 4: classmate present	Marble dropping (Stevenson & Fahel, 1961)
<i>Experiment 3</i>	<i>N</i> =60 children (100% male)	nr	between	1: alone* 2: teacher present 3: unknown male present	Marble dropping (Stevenson & Fahel, 1961)
Crabbe (1973) ^{USA, unpublished}	<i>N</i> =240 children (nr)	nr	between	1: alone 2: experimenter as audience	Stabilometer balancing task
Fouts (1980) ^{Canada}	<i>N</i> =48 (50% male)	10-11	within	1: alone? 2: audience present	pressing buttons in a sequence
Gates (1924) ^{USA} <i>First condition</i>	<i>N</i> =62 college students (0% male)	nr	between	1: alone* 2: small audience (4-6)	Coordination (Three Hole) Test
<i>Second condition</i>	<i>N</i> =62 college students (0% male)	nr	between	1: alone* 2: large audience (27-37)	
Griffith et al. (1989) ^{Australia}	<i>N</i> =64 right-handed under- graduates (nr)	nr	between	1: alone* 2: co-actor	Happy Man Maze Game (computer): simple & difficult maze conditions
Guerin (1986) ^{USA}	<i>N</i> =39 undergraduate students (nr)	nr	between	1: alone 2: a mirror to distract 3: confederate (no evaluation)	Pursuit rotor tracking (30 rpm)
Haas & Roberts (1975) ^{USA} <i>learning</i> <i>performing</i>	<i>N</i> =45 right-handed undergraduate students (0% male)	nr	within	1: alone? 2: blindfolded audience 3: evaluative audience	computer-based tracking task
Hall & Bunker (1979) ^{USA}	<i>N</i> =128 students (IP & PE) (nr)	nr	between	1: alone 2: co-actor present	Roll-up game (Rotter, 1966)
Hollifield (1982) ^{USA}	<i>N</i> =80 children (100% male)	<i>M</i> =9.5	between	1: alone 2: evaluative audience	Pursuit rotor tracking (no information on speed)

Reference	Sample	Age [y]	Design	Audience condition	Motor task
Hutchinson & Cotton (1973) ^{USA}	N=144 freshmen (PE) (0% male)	nr	within	1: alone* 2: unknown male audience 3: unknown female audience	ball-throwing skill (variation of (McCraw, 1955), multiple conditions
Innes & Gordon (1985) ^{Australia}	N=60 students (0% male)	nr	between	1: alone? 2: mirror 3: audience (1) present	wire loop game (Biedny, 1969)
Johnson (1974) ^{USA, unpublished}	N=72 students (0% male)	M=19.4	between	1: alone* 2: observing audience 3: evaluating audience	Stabilometer balancing task
Kenyon & Loy (1966) ^{USA} <i>Task 1</i> <i>Task 2</i>	N=47 undergraduates (100% male)	nr	between	1: alone* 2: small audience 3: prestigious audience 4: female audience	Manual dexterity: insert 60 blocks into holes as quickly as possible Manual dexterity: turn 60 blocks, then insert into holes as quickly as possible
Kieffer (1977) ^{USA}	N=181 boys (grade 6) (100% male)	nr	between	1: alone 2: audience (1) present	Pursuit rotor tracking (no information on speed – two different conditions)
Kozar (1973) ^{USA}	N=150 students (PE) (100% male)	nr	between	1: alone 2: supportive audience 3: non-supportive audience	Stabilometer balancing task
Landers & Landers (1973) ^{USA}	N=100 grade 5 & 6 students (0% male)	10-12	between	1: alone* 2: model audience	free standing balance ladder (Bachman, 1961)
Donna Landers (1975) ^{USA}	N=180 middle school students (0% male)	11-13	between	1: alone* 2: experimenter present 3: model audience 4: unfamiliar audience	free standing balance ladder (Bachman, 1961)
Landers et al. (1977) ^{USA, unpublished}	N=134 (nr)	nr	between	1: alone 2: observer present 3: co-actor present	Maze task (Hunt & Hillery, 1973)
Lau et al. (2019) ^{Germany}	N=70 students (36% male)	23.34	within	1: alone* 2: observer present	Nintendo Wii Balanceboard: “bullet maze”
Livingston et al. (1974) ^{USA}	N=189 subjects (0% male)	15-16	between	1: alone* 2: heterogeneous co-actor 3: homogeneous co-actor	free standing balance ladder (Bachman, 1961)

Reference	Sample	Age [y]	Design	Audience condition	Motor task
Lombardo & Catalano (1975) ^{USA}	N=72 students (IP) (42% male)	17-22	between	1: alone? 2: normal audience 3: expert audience	Pursuit rotor tracking (60 rpm)
Lombardo & Catalano (1978) ^{USA}	N=61 students (IP)	17-22	between	1: alone* 2: audience present	Pursuit rotor tracking (60 rpm)
MacCracken & Stadulis (1985) ^{USA}	N=120 young children (nr)	M=6	within	1: alone* 2: coaction (2) situation 3: audience (5) present	Balancing tasks: beam walking & line walking
Markus (1978) ^{USA}	N=45 undergraduate students (IP) (100% male)	nr	between	1: alone 2: attentive audience 3: incidental audience	dressings into familiar and unfamiliar clothing
Martens (1969a) ^{USA}	N=96 undergraduate students (100% male)	nr	between	1.1: learning alone 1.2: learning with audience (10) 2.1: performing alone 2.2: performing with audience	coincident timer
Martens (1969b) ^{USA}	N=48 undergraduate students (nr)	nr	between	1: learning alone 2: learning with audience (10)	coincident timer
Martens (1969c) ^{USA}	N=96 undergraduate students (100% male)	18-24	between	1: learning alone* 2: learning with audience (10)	coincident timer
Martens & Landers (1972) ^{USA}	N=132 undergraduate students (PE) (100% male)	nr	between	1: alone 2: coaction in dyads 3: coaction in triads 4: coaction in tetrads	Roll-up game
Maxwell et al. (2008) ^{Great Britain}	N=28 students (57% male)	21-37 (M=24.78)	within	1: alone 2: evaluating passenger	driving simulation
McCullagh & Landers (1976) ^{USA}	N=96 right-handed undergraduates (PE) (100% male)	nr	between	1: alone* 2: audience (1) present ... 6: audience (5) present	Ball-rolling game (cf. (Harney & Parker, 1972), & press buttons in sequence as quickly as possible
F. Miller et al. (1979) ^{USA}	N=50 undergraduate students (0% male)	nr	between	1: alone 2: mere-presence audience 3: evaluating audience	Pursuit rotor tracking (simple: 30 rpm & difficult: 60 rpm)
Q.L. Miller (1989) ^{USA}	N=48 subjects (51% male)	M=20.5	between	1: alone 2: audience present	fine motor manual dexterity skill

Reference	Sample	Age [y]	Design	Audience condition	Motor task
Miyamoto (1979) ^{Japan}	N=60 students (0% male)	nr	between	1: alone* 2: audience present	Maze task: simple & complex maze conditions
J. F. Murray (1983) ^{USA}	N=84 males & females (nr)	nr	between	1: alone 2: audience present	Stabilometer balancing task (cf. Murray, 1982)
Pessin & Husband (1933) ^{USA}	N=90 students: experimental psychology (nr)	nr	between	1: blindfolded alone* 2: blindfolded, 2 spectators 3: not blindfl., 2 spectators	Maze task (Warden, 1924)
Rajecki et al. (1977) ^{USA}	N=60 students (IP) (0% male)	nr	between	1: alone 2: audience; 3: blind audience 4: mannikin; 5: blind mannikin; 6: mirror	Automatic tally maze
Sasfy & Okun (1974) ^{USA}	N=96 students (IP) (100% male)	nr	between	1: alone 2: expert audience 3: non-expert audience	Roll-up game
Sawyer & Noel (2000) ^{USA}	N=64 high school students (52% male)	15-18	between	1: alone* 2: audience present	Pursuit rotor tracking
Shaver & Liebling (1976) <i>Experiment 1</i> ^{USA}	N=30 undergraduate students (IP) (100% male)	nr	between	1: alone 2: observed whilst instructions 3: observed after instructions	Maze task (Hunt & Hillery, 1973)
<i>Experiment 2</i> ^{USA}	N=64 undergraduate students (IP) (100% male)	nr	between	1: low fear – alone 2: high fear – alone 3: high fear – calm observer 4: worried observer	Maze task (Hunt & Hillery, 1973)
Simensky (1991) ^{USA, unpublished}	N=80 students (100% male)	nr	between	1: alone? 2: audience present	free standing balance ladder (Bachman, 1961)
Singer (1965) ^{USA}	n=15 athletes & n=16 non-athletes/PE majors (nr)	nr	within	1: alone 2: audience present	Stabilometer balancing task, adap. from (Bachman, 1961)
Singer (1970) ^{USA}	N=40 (under-) graduate students (PE; 80% male)	nr	within	1: alone* 2: audience present	mirror-tracing task
Travis (1925) ^{USA}	n=20 freshmen, n=1 sophomore, n=1 junior (91% male)	nr	within	1: alone* 2: audience present	Pursuit rotor tracking (Koerth, 1922)

Reference	Sample	Age [y]	Design	Audience condition	Motor task
Wankel (1972) ^{Canada}	N=160 right-handed students (grade 7 & 8; 100% male)	nr	between	1.1: alone* 1.2: co-actor present 2.1: alone 2.2: audience present	Press buttons in sequence as quickly as possible
Wankel (1975) ^{Canada}	N=36 boys from grade 7 & 8 (100% male)	nr	between	1: alone* 2: audience present	Stabilometer balancing task (Singer, 1968; Wankel, 1969)
Wankel (1977) ^{Canada}	N=60 subjects (0% male)	nr	between	1: alone 2: 2 observers 3: 5-6 observers	Pursuit rotor tracking (60 rpm)
White (1991) ^{USA}	N=108 college-age subjects (nr)	nr	between	1: non-competitive situation? 2: competitive situation 3: cooperative situation	Pursuit rotor tracking (60 rpm)

PE=physical education; IP=introductory psychology course; nr=not reported;

*=experimenter present in alone condition, ?=no information on presence of experimenter

Supplement 4. Social-facilitation manipulation in condition-based tasks.

Reference	Sample	Age [y]	Design	Audience condition	Motor task
Ben-Ezra et al. (1986) ^{USA}	N=13 visually impaired men (100% male)	18-34	within	1: alone? 2: co-actor present	60m sprint dash
Beckmann & Strang (1992) ^{GER}	N=80 students (100% male)	Mdn=23	within	1: alone* 2: professor and staff member	Leg press, maximal weight
Bowman & Dunn (1982) ^{USA}	N=30 educable mentally retarded children (67% male)	M=10.42	between	1: alone* 2: audience present	1: sit-ups for 60s 2: Shuttle Run Test 3: standing broad jump
Chevrette (1968) ^{USA}	N=59 children (59% male)	nr	within	1: alone* 2: same-sex audience 3: opposite-sex audience 4: mixed-sex audience	1: vertical hang from the horizontal bar 2: grip strength (dynamometer) 3: Shuttle Run Test
El Baden (1984) ^{USA, unpublished}	N=312 undergraduate PE students (50% male)	18-29	between	1: alone? 2: passive audience 3: 3 co-actors present	1: 12min run-and-walk test 2: sit-ups for 60s 3: sit and reach

Reference	Sample	Age [y]	Design	Audience condition	Motor task
Feltz et al. (2011) ^{USA}	<i>N</i> =181 college students (IP & kinesiology) (48% male)	<i>M</i> =20.10 (<i>SD</i> =1.75)	between	1: alone* 2: coactive 3: additive 4: conjunctive	five isometric exercises: front plank, side plank (left), one leg plank (left), side plank (right), one leg plank (right)
Kamal (1980) ^{Canada, unpublished}	<i>N</i> =80 athletes (100% male)	nr	within	1: alone? 2: non-competitive co-actor 3: competitive co-actor	swimming 2x25m laps
Kenyon & Loy (1966) ^{USA} <i>Task 3</i> <i>Task 4</i>	<i>N</i> =47 undergraduates (100% male)	nr	between	1: alone* 2: small audience 3: prestigious audience 4: female audience	Max wrist strength (dynamometer) ½ max wrist strength (dynamometer, hold for as long as possible)
Martens & Landers (1969) ^{USA}	<i>n</i> =60 young boys, <i>n</i> =60 older boys & <i>n</i> =60 college men (100% male)	<i>m</i> =7.92 <i>m</i> =13.67 <i>m</i> =19.17	between	1: alone* 2: coaction in dyads 3: coaction in quadrats	horizontal leg extension
E. Murray et al. (2016) ^{Australia}	<i>N</i> =60 students (IP) (0% male)	<i>M</i> =20.20 (<i>SD</i> =2.73)	between	1: no virtual reality? 2: alone in virtual reality 3: virtual companion	Virtual reality rowing
Piché & Sachs (1982) ^{Canada}	<i>N</i> =24 students (100% male)	nr	between	1: alone* 2: unfamiliar co-actor 3: familiar co-actor	exert pressure on a 6ft pole
Selan (1986) ^{USA, unpublished}	<i>N</i> =193 students (100% male)	nr	within	1: alone 2: equally skilled audience 3: superior skilled audience	Box/weightlifting
Sheridan et al. (2019) ^{Great Britain}	<i>N</i> =12 recreational athletes (100% male)	<i>M</i> =21.3 (<i>SD</i> =0.8)	within	1: spotter hidden* 2: spotter openly present	bench press performance at 60% of subject's 1RM
Strube et al. (1981) <i>Experiment 1</i> ^{USA}	<i>N</i> =120 joggers (indoor track) (50% male)	19-30	unclear	1: alone 2: inattentive audience (1) 3: attentive audience (2)	running (17.98m stretch)
<i>Experiment 2</i> ^{USA}	<i>N</i> =36 joggers (indoor track) (50% male)	19-30	unclear	1: alone 2: inattentive audience (1) 3: attentive audience (2)	running (17.98m stretch)
Thielemier & Church (2014) ^{USA, unpublished}	<i>N</i> =17 athletes (100% male)	<i>M</i> =21.3	within	1: alone 2: audience	running (12 minutes on treadmill)

Reference	Sample	Age [y]	Design	Audience condition	Motor task
Weinstein et al. (1987) ^{USA}	N=14 baseball pitchers (100% male)	M=20.36	within	1: experimenter hidden 2: experimenter visible	Baseball throw (fastballs)
Worringham & Messick (1983) ^{USA}	N=36 joggers (50% male)	nr	between	1: alone 2: attentive audience 3: inattentive audience	running (45 yards)

PE=physical education; IP=introductory psychology course; nr=not reported;

*=experimenter present in alone condition, ?=no information on presence of experimenter

Supplement 5. Social-facilitation manipulation in mixed motor tasks.

Reference	Sample	Age [y]	Audience condition	Motor task
Bell & Yee (1989) ^{USA}	N=33 karate students (76% male)	13-38 (M=23.85)	within 1: alone* 2: audience present	Karate kicks
Dube & Tatz (1991) ^{USA}	N=32 tennis campers (66% male)	9-14	within 1: alone* 2: audience present	Tennis match of low- and high-skilled campers, evaluated on good and bad shots by referee
Forgas et al. (1980) ^{Australia}	N=40 squash players (100% male)	nr	within 1: alone 2: male (2) audience 3: female (2) audience	Squash match
Geisler & Leith (1997) ^{Great Britain}	N=40 soccer players (100% male)	19-34 (M=23.8, SD=3.5)	between 1: alone 2: audience (5) present	Penalty kicks
Graydon & Murphy (1995) ^{USA}	N=20 students (PE) (100% male)	18-22	within 1: alone* 2: audience present	table tennis forehand serves (diagonally into marked grid)
Krendl et al. (2012) ^{USA}	N=74 white (under- graduate students (100% male)	18-30	between 1: alone* 2: observation condition	Basketball free throws
Navarro et al. (2013) ^{Netherlands}	N=10 university footballers (100% male)	M=19.1 (SD=1.9)	within 1: goalkeeper absent? 2: goalkeeper 3: knowledgeable goalkeeper	Penalty kicks

Reference	Sample	Age [y]	Audience condition	Motor task
Paulus et al. (1972)				
<i>Experiment 1</i> ^{USA}	N=25 students (introductory gymnastics) (100% male)	nr	between 1: alone 2: audience (17) present	floor exercise routine (forward & backward rolls, Swedish fall, 3 leg circles, headstand, dive roll)
<i>Experiment 2</i> ^{USA}	N=21 students (introductory gymnastics) (100% male)	nr	between 1: alone 2: audience (17) present	floor exercise routine (forward & backward rolls, Swedish fall, 3 leg circles, headstand, dive roll)
Paulus & Cornelius (1974) ^{USA}	N=45 students (gymnastics) (100% male)	nr	between 1: alone? 2: no warning of 17 spectators 3: warning of 17 spectators	pommel horse routine
Welch (2005) ^{USA, unpublished}	N=27 children (0% male)	18-22	within 1: alone* 2: observer present	Basketball free throws

PE=physical education; IP=introductory psychology course; nr=not reported;

*=experimenter present in alone condition, ?=no information on presence of experimenter

Supplement 6. Reason for exclusion when applying the inclusion criteria.

1. Anderson-Hanley et al. (2011): participants were asked to cycle against and outpace a competitive on-screen rider. Since social facilitation has been distinguished from rivalry (Allport, 1920; Burnham, 1910; Dashiell, 1935), this study was excluded.
2. Bird (1975): The subjects performed an accuracy task either in the presence of a same-sex or an opposite-sex audience. However, there was no alone-condition from which to derive a social facilitation effect.
3. Corbett et al. (2012): This study compared time-trial performance run alone to a simulated head-to-head competition. Since social facilitation has been distinguished from rivalry (Allport, 1920; Burnham, 1910; Dashiell, 1935), this study was excluded.
4. Douglas (1983): Douglas (1983) investigated mentally retarded adolescents which were deemed incomparable to the present sample and research question.
5. Edwards et al. (2018): This study compared the performance during exhausting exercises with external verbal encouragement to a condition where the encouraging female sat passively 5m away. This latter condition can either be considered the alone condition (with experimenter present) or the social facilitation condition, however, in both cases, no social facilitation can be estimated.
6. Fantoni et al. (2016): Similar to Bird (1975), did not provide information on an alone condition. Hence, no claim about social facilitation could be made to contribute to this systematic review.
7. Geukes et al. (2012): The aim of this study was to test the influence of pressure on an accuracy performance. Therefore, a high-pressure situation with an audience of 1500-2000 spectators was created. However, additionally, a reward of up to €150 for the most accurate shooter was announced, which confounds potential social effects. Accordingly, the study was excluded.
8. Hrycaiko & Hrycaiko (1980): In a study employing the ball roll-up task either in the presence of an audience or alone, only palmar sweating and heart rate were measured, but no performance comparison was provided.
9. Lasky (1986): Subjects performed basketball layups and foul shots either in the presence of male or female athletes or non-athletes, but never alone, which made it impossible to estimate a social facilitation effect.
10. Law et al. (2003): Table-tennis shot performance was assessed under three audience conditions: observation-only, supportive, and adversarial. In no condition was performance without an audience assessed, which made it impossible to estimate a social facilitation effect.
11. Martens and Landers (1969): Known for their work in the field of social facilitation, Martens and Landers in this study gave specific competitive information as comparison to other participants (cf. p. 3). To avoid rivalry confounding effects, the study was not included in the systematic review.
12. Mesagno et al. (2011): Similar to Geukes et al. (2012), this study provided monetary incentive in a high-pressure situation otherwise characterized as social presence condition. Hence, it was not further considered.
13. Ortín Montero et al. (2018): assessed the influence of someone else present (among others) on several objective and subjective performance evaluations (heart rate, perceived exhaustion, mood), but not on running performance.
14. Poteet and Weinberg (1980): Although reporting a social facilitation effect, Poteet and Weinberg used a competition vs no-competition experimental design on a flexed-arm hang against a confederate. To avoid effects confounded by rivalry, the study was not included in the systematic review.
15. Slevin (1971): The audience in this study, six male peer spectators, was essentially an active one, encouraging the participant throughout the task.
16. Snyder et al. (2012): The experimenter asked participants specifically to compete against different types of competitors (virtual or live). According to Dashiell (1930) or Allport (1920), any effect here would not be considered to have been caused by social facilitation.

17. Triplett (1898): It is noteworthy that Triplett's original study, although being credited as the first experiment to measure social facilitation, fails to be included. This is due to the competitive situation in employed in the pacing partner in the experiment.
18. Walsh and Gill (2008): Subjects stood on one leg either in an inspector or a spectator condition. Neither allowed a comparison of alone vs audience comparison and hence, the study was waved.
19. Weinberg et al. (1982): manipulated both audience conditions and instructed success or failure, and afterwards assessed the subjects' attribution of their performance on a Pursuit Rotor Task, without providing information on the actual task performance. Hence, the study could not be considered for further analysis.
20. Wellner et al. (2010): In an extensive virtual-reality environment, rowers experienced audiences interspersed with silent nature-view episodes. Research expresses explicitly that social facilitation differs from social support by the involvement of the audience. In that regard, the study by Wellner et al. (2010) does not meet the requirements.
21. Whitt (1982): 96 subjects performed 20 trials on a Pursuit rotor task, in the presence of evaluative/non-evaluative expert/non-expert spectators, however, no alone condition was used to infer a social facilitation effect.
22. Whittemore (1924): rivalry between co-workers was induced through instructions and labeled social facilitation, however, in the spirit of Allport (1920) and Dashiell (1930), it was excluded from this systematic review.

To summarize, a total of 22 articles was deemed ineligible for the present analysis. An important characteristic of social facilitation is the absence of social comparison, i.e. the mere presence of others (Allport, 1920, 1924; Dashiell, 1930). Although mentioning or describing social facilitation processes, $N=9$ studies tested the theory in a competitive setting, e.g. using rewards/punishment and direct comparison to an opponent, thereby diluting the social facilitation effect (Anderson-Hanley et al., 2011; Corbett et al., 2012; Geukes et al., 2012; Martens & Landers, 1969; Mesagno et al., 2011; Poteet & Weinberg, 1980; Snyder et al., 2012; Triplett, 1898; Whittemore, 1924). Especially noteworthy is the mention of Triplett here, who, although being credited as the first scientist to empirically estimate social facilitation, employed a competitive situation in his experiment.

A social facilitation effect can only be gauged when a social facilitation condition without encouraging behavior is compared to a condition of performing alone (either in between-subjects or within-subjects fashion). $N=8$ studies failed to conduct or report the latter, hence, their results were not compatible with the goal of this research (Bird, 1975; Edwards et al., 2018; Fantoni et al., 2016; Lasky, 1986; Law et al., 2003; Slevin, 1971; Walsh & Gill, 2008; Wellner et al., 2010; Whitt, 1982). Similarly, studies ($N=3$) that failed to report the effect the presence of an audience or co-worker had on the actual performance were excluded (Hrycaiko & Hrycaiko, 1980; Ortín Montero et al., 2018; Weinberg et al., 1982).

Supplement 7. Moderator analyses.

	<i>k</i>	<i>d</i>	<i>SE</i>	95% CI	
<i>Experimenter presence</i>					$Q(44) = 317.72, p < .001, \sigma^2_{\text{level } 2} = 0.27, \sigma^2_{\text{level } 3} = 0.20$
alone	10	0.33	0.26	[-0.18; 0.84]	$F(2, 44) = 0.78, p = .464$
with experimenter	27	0.15	0.29	[-0.99; 1.30]	
<i>Task difficulty</i>					$Q(44) = 295.22, p < .001, \sigma^2_{\text{level } 2} = 0.20, \sigma^2_{\text{level } 3} = 0.20$
simple	21	0.42	0.25	[-0.47; 1.31]	$F(2, 44) = 4.79, p = .013$
complex	13	-0.23	0.20	[-0.64; 0.19]	
<i>Task familiarity</i>					$Q(44) = 361.18, p < .001, \sigma^2_{\text{level } 2} = 0.26, \sigma^2_{\text{level } 3} = 0.23$
familiar	29	0.36	0.15	[0.01; 0.72]	$F(2, 44) = 0.67, p = .517$
unfamiliar	5	-0.09	0.38	[-1.26; 1.07]	
<i>Role of others</i>					$Q(45) = 316.32, p < .001, \sigma^2_{\text{level } 2} = 0.21, \sigma^2_{\text{level } 3} = 0.22$
audience	40	0.17	0.12	[-0.10; 0.44]	$F(2, 45) = 5.08, p = .029$
co-actor	7	0.80	0.30	[-0.03; 1.63]	
<i>Evaluation potential</i>					$Q(42) = 295.47, p < .001, \sigma^2_{\text{level } 2} = 0.21, \sigma^2_{\text{level } 3} = 0.21$
observing	17	0.12	0.34	[-1.08; 1.32]	$F(4, 42) = 1.91, p = .126$
non-evaluative	3	0.75	0.53	[-0.94; 2.45]	
evaluating	15	0.14	0.35	[-1.18; 1.45]	
<i>Publication status</i>					$Q(45) = 327.81, p < .001, \sigma^2_{\text{level } 2} = 0.26, \sigma^2_{\text{level } 3} = 0.21$
published	37	0.23	0.33	[-0.93; 1.38]	$F(1, 45) = 1.01, p = .368$
not published	10	0.51	0.27	[-0.03; 1.05]	