Meta-Analysis of Early Adolescent Self-Regulation Interventions:

Moderation by Intervention and Outcome Type

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Data Statement

The datasets generated for this study are available from the first author.

Conflict of Interest

First author Murray has developed a self-regulation intervention for adolescents called Be CALM for which she has intellectual interest in promoting for potential financial gain and consults with Mindfully FIERCE to provide trainings to educators in this program for a fee. However, this intervention was not included in the present review. None of the other authors have any commercial or financial relationships that could be construed as a potential conflict of interest.

Abstract

Introduction: Self-regulation has been identified as a highly promising target for interventions promoting broad wellbeing across development; however, there appear to be notable limitations in efficacy for early adolescents in particular. One possible reason is that the emotion regulation needs of youth have not been intentionally targeted in many interventions for this age group. The aim of this work is to advance understanding of how different intervention approaches defined from a clear theoretical model may impact different types of outcomes and with regard to different types of measures.

Methods: We conducted a systematic literature review of four databases using PRISMA guidelines and identified 33 studies of early adolescents (aged 10-15) using five different intervention approaches that were methodologically rigorous (e.g., randomized controlled trial design with low risk of bias). Studies were conducted predominantly in North America (58%), and Western Europe (30%).

Results: A two-level mixed-effects meta-analysis indicated a small but significant overall intervention effect (Hedges g = .12). When examined by intervention type, effects were significant only for approaches focusing predominantly on emotion regulation (g = .20), which significantly improved behavioral outcomes as well as emotional outcomes. Approaches examining cognitive regulation, parent training, physical activity, and working memory did not differ significantly from zero. Across intervention types, outcomes demonstrated the largest effects for youth report of emotional distress.

Conclusion: Overall, results suggest that emotion regulation may be a critically important self-regulation mechanism during early adolescence and demonstrates value in use of applied theoretical frameworks to operationalize intervention approaches and outcomes.

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Self-regulation (SR) can be defined as the ability to manage cognition and emotions to enable goal-directed action (Murray et al., 2019). The value of supporting SR skill development is evidenced by a large cross-disciplinary literature showing that SR skills are related to a wide range of functional outcomes from mental health and social-emotional wellbeing to physical health, academic achievement, and socio-economic success (Buckner et al., 2009; Dishion & Connell, 2006; Moffitt et al., 2011; Shonkoff et al., 2012). Youth SR interventions have been recommended to reduce risk behaviors such as violence and substance use and to promote positive developmental trajectories (Evans & Kim, 2013). However, SR intervention outcomes for youth are highly variable (Pandey et al., 2018; van Genugten et al., 2017) and it is not clear if some intervention approaches are more effective than others.

Early adolescence in particular appears to be a developmental period during which there is significant variability in the effectiveness of existing interventions (Carsley et al., 2017; Murray et al., 2016). There are several factors that might reduce intervention impact at this age, including increased disinhibition and sensitivity to peer reward (Chein et al., 2011; Dahl, 2004), increased demands for self-regulation within academic and social contexts (Jacobshagen et al., 2009; Wang & Dishion, 2012), emotional intensity and instability (Hare et al., 2008; Larson et al., 2002; Silk et al., 2009). At the same time, adolescents experience dramatic neuro-developmental growth and integration of brain processes involved in self-regulation (Casey, 2015; Luciana, 2010), suggesting opportunity for intervention as well as the potential need for developmental tailoring of SR interventions.

Self-regulation interventions for adolescents have largely focused on cognitive behavioral approaches (Murray et al., 2016; van Genugten et al., 2017), although mindfulness-based

interventions that promote present-moment awareness through meditation and other practices have proliferated in the last decade (Carsley et al., 2017; Zenner et al., 2014). Given the developmental challenges to emotion regulation during adolescence, approaches that specifically target emotional processes may be well-suited for this age group and may have direct relevance for adolescent decision-making in emotionally-laden risk situations. Indeed, in a recent meta-analysis of 158 adolescent mental health interventions (primarily universal, school-based programs), emotion regulation was identified as one of only three core components with positive impact across outcomes including enhancing mental health and decreasing symptoms of anxiety and depression (Skeen et al., 2019).

Self-Regulation as a Framework for Understanding Theoretical Mechanisms of Interventions

Although the Skeen et al. (2019) review is relevant and informative, intervention science may be further advanced by application of a theoretical framework that leverages current developmental science (Shonkoff, 2018). One such framework is the Self-Regulation Promotion model (Murray et al., 2019) that links self-regulation mechanisms and processes with observable intervention skills. In this model, *Emotion Regulation Approaches* involve managing strong feelings through skills such as emotional awareness, tolerance of feelings of internal distress, and strategies for reducing dysregulation such as deep breathing. These skills may be influenced by affect-biased attention, wherein certain types of information or stimuli with motivational value are preferentially noticed and processed (Todd et al., 2012). Another potential mechanism that has been associated with decreased physiological reactivity in the context of negative stimuli is "bottom-up" regulation strategies such as breath awareness (Goldin & Gross, 2010).

Intervention Approaches

Cognitive and emotion regulation approaches are typically provided through skills-based instruction. Cognitive approaches include goal setting, perspective-taking, re-appraisal, problem-solving, decision-making, and self-monitoring, which are directly supported by "cool" executive functioning (EF) processes that include shifting and sustaining attention, working memory, cognitive flexibility, and inhibitory control (Zhou et al., 2012). EF processes provide a "top-down" influence on emotion through effortful or intentional activation (Raver et al., 2012). For example, shifting attention to specific aspects of a situation may change one's appraisal to a more positive or less threatening interpretation and thereby reduce negative emotions (Troy et al., 2018). Emotional and cognitive regulation processes interact in ways that may be difficult to distinguish; for example, emotional acceptance may reduce negative thoughts and attributions and strengthen problem-solving (Zelazo & Cunningham, 2007). However, it is this interaction that is believed to support behavior regulation and other observable changes in day-to-day functioning.

In addition to cognitive and emotion regulation skills approaches, parent training is also a well-established approach for enhancing self-regulation. Hundreds of studies support the impact of parent training on the development of behavior regulation, at least in younger children (e.g., Grolnick & Farkas, 2002; Karreman et al., 2006; Rueda et al., 2004). In the context of a caring and consistent relationship, parents assist their children in understanding, expressing, and modulating their thoughts, feelings and behaviors through repeated day-to-day interactions. More specifically, the theoretical co-regulation mechanisms are: "(a) providing emotional support; (b) modifying the environment to reduce regulatory demands; and (c) in vivo teaching and coaching of self-regulation skills, including modeling, instruction, prompts, and reinforcement" (Murray et al., 2019).

More recently, physical activity has also been identified as a promising approach for enhancing attention and behavioral control (Carson et al., 2016; Wood et al., 2020). Suggested mechanisms of action include direct effects, such as through increased oxyhemoglobin, which can enhance attention. Alternately, an indirect effect may occur through increased inhibitory control required for successful engagement in structured sports activities, although unstructured physical play has also been associated with enhanced cognitive abilities relevant to self-regulation such as goal setting and planning (Bidzan-Bluma & Lipowska, 2018).

Alignment of Outcomes with Intervention Approaches

Because contextual factors are critical for the enactment of self-regulation (Murray et al., 2019), intervention effects may be enhanced to the extent that they are aligned with the skills that have been trained (i.e., domain-specificity). For example, focusing on cognitive skills may have stronger impact on cognitive-related outcomes like attention, while interventions focused on managing emotions may have greater impact on emotional distress. Examining differences in self-regulation outcomes by intervention approach can help address this question. Two recent meta-analyses of self-regulation approaches for adolescents found limited support for moderation of outcomes by approach (Pandey et al., 2018; Van Genugten et al., 2017). However, both studies lacked a theoretical framework for defining interventions, which may confound identification of intervention mechanisms, suggesting further work is needed.

Measures and Methods Variability in Self-Regulation Intervention Research

Understanding outcome variation related to self-regulation approaches is also confounded by significant heterogeneity in measures and methods. For example, EF is often measured by laboratory-based performance tasks that are emotionally neutral and often computer-based, while emotion regulation is typically measured in more behaviorally complex ways that consider

social-emotional context (Bailey & Jones 2019). Additionally, outcomes may be influenced by the method of assessment used (e.g., task or performance based vs. youth or parent report; Nigg, 2017), which demonstrate limited convergent validity (Duckworth & Kern, 2011). Thus, understanding effects of different intervention approaches requires examination of variability in outcomes across different types of measures as well as across different outcome domains.

The Present Paper

To advance self-regulation promotion and intervention research, this work examines the efficacy of different intervention approaches in relation to different types of outcomes and measures, with a specific focus on interventions that may be most effective for early adolescents' day-to-day functioning in school and community settings. We examined the following specific research questions:

1) What is the overall effect of SR interventions with different theoretical mechanisms on outcomes for early adolescents?
2) How well does intervention approach (predominantly cognitive vs. predominantly emotional) align with outcome effects (cognitive, emotional, behavioral)?
3) To what extent do effects vary by a) five different intervention approaches, b) outcome, and c) measurement type?

Method

Search Strategy

Following guidelines for the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA; Moher et al., 2009), relevant studies were identified through systematic searches in four databases: *PubMed, PsycInfo, Scopus,* and *ERIC,* using a combination of three lists of keywords to identify interventions for early adolescents that assess

self-regulation related outcomes (e.g., general, cognitive, emotional, and stress-related). A full summary of the search strategy, including keyword lists and the electronic search strategy for *PsycInfo* is included in Supplementary Table 1.

Eligibility Criteria

Study population

Participants aged 10-15 years (or grades 5-9) were included. Samples with high-incidence psychiatric disorders with recognized self-regulation difficulties such as anxiety, depression, or ADHD, were included. Studies were excluded if the population was low-incidence and/or where theoretical change mechanisms may differ from the broader population (e.g., youth who are incarcerated, those with autism, and pediatric cancer patients).

Study design

Studies must be randomized controlled trials (RCTs) comparing an intervention with a no-treatment control group.

Study intervention

Interventions must explicitly target self-regulation or with a theoretical basis for improving self-regulation, including cognitive regulation, emotion regulation, parent training, physical activity, and working memory. Although working memory training can be considered a specific cognitive regulation approach, it was examined separately in this study given research indicating limited generalizability to functional outcomes (Melby-Lervåg et al., 2016; Shinaver et al., 2014), which we did not want to confound with other cognitive-behavioral approaches. Studies were excluded if the intervention required specialized equipment (e.g., biofeedback) or medication, given our interest in strategies that could be readily delivered within school and community settings.

Study outcomes

Outcomes were examined in three domains: *behavioral* (including adult or youth report of behaviors reflecting self-control or self-management), *emotional* (including awareness/regulation and emotional distress), and *cognitive* (including executive functioning based on adult report or performance tasks). Given our interest in identifying effects relevant to day-to-day functioning, studies had to include functional outcomes beyond laboratory measures (e.g., attention or working memory tasks). Thus, studies limited to these outcome measures were excluded while those that had laboratory measures as well as other functional measures such as behavior ratings were included. Indirect measures of SR (i.e., school readiness, general social-emotional competence, psychiatric symptoms, risk behaviors), were not sufficient for inclusion.

Study publication

Studies must be published in peer reviewed journals between 2010 and 2017.

Other exclusion criteria

Studies were excluded if they were determined to be at high risk of methodological bias based on Cochrane's Risk of Bias tool (Higgins et al., 2011). If missing data could not be obtained from authors to calculate effect sizes, the study was also excluded.

Screening Process

Our search terms resulted in 4209 articles for review after de-duplication, which were uploaded to Covidence (covidence, n.d.) to facilitate screening. One reviewer screened titles and abstracts to remove irrelevant articles with consultation from the study team, resulting in 359 papers for full text review. Two reviewers on the coding team, including the first two authors and two research assistants, assessed each article independently and had to agree for an article to be included. A third reviewer resolved any disagreements.

Data Extraction and Coding

Codes for intervention and study characteristics and outcome data were developed by the team through an iterative process. All coders were trained on example articles, with any discrepancies discussed to obtain consensus and definitive determination. Any missing or incorrect data were corrected at this step. A total of 233 effect sizes across 33 studies were extracted for analysis. See Figure 1 for the full PRISMA diagram.

Six outcome types were coded: youth-reported emotion regulation (e.g., management of anger or sadness, emotion dysregulation, coping), youth-reported emotional distress (e.g. anxiety or depression symptoms, stress, other internalizing symptoms), performance task measures of EF (e.g., WISC, Flanker, Stroop, working memory, processing speed), adult report of EF (e.g., BRIEF EF subscale, attention, meta-cognition and working memory ratings), adult report of behavior regulation (BRIEF behavior regulation subscale, externalizing behavior and impulse control), and youth report of behavior regulation (similar to adult behavior regulation measures). To look at outcomes more conceptually, we also combined outcome types into domains in alignment with the Self-Regulation Promotion model (Murray et al., 2019): *emotional outcomes* = youth report of emotion regulation and emotional distress; *cognitive outcomes* = performance tasks assessing EF, and *behavioral outcomes* = youth and adult report of behavior regulation.

Interventions were categorized by the first and second authors, who had 100% agreement. Intervention approach was categorized as follows: *Cognitive Regulation Approaches, Emotion Regulation Approaches, Parent Training, Physical Activity, and Working Memory*. *Cognitive Regulation Approaches* focused predominantly on modifying maladaptive thoughts, problem-solving, and goal setting, or were described as cognitive-behavioral interventions. *Emotion Regulation Approaches* focused predominantly on awareness and acceptance of thoughts and

feelings, distress tolerance, self-compassion, or were described as mindfulness or mind-body approaches. *Cognitive and Emotion Regulation Approaches* are most theoretically aligned with the direct self-regulation outcomes of interest in this study.

Overall reliability across sample and study characteristics was >80% based on 20% of studies being double-coded. Coded demographics included age range, sex (% male), and overall "risk" level of the sample. Risk was defined in terms of intervention tiers, with Tier 1 reflecting a general universal population (preventive interventions), Tier 2 including youth with some level of identified need or emotional/behavioral concern (targeted interventions), and Tier 3 including those with significant behavioral or mental health needs (e.g., clinical interventions). Intervention details were also collected on setting (e.g., school, outpatient clinics), who delivered the intervention, the format of the intervention (e.g., small or large group, computerized), dosage defined by number of sessions, and intervention recipient. Race/ethnicity and poverty were coded but were not reported in enough studies to support analysis.

Study Risk of Bias Assessment

Each study was evaluated using Cochrane's Risk of Bias Tool (Higgins et al., 2011) based on quality of randomization, allocation concealment, blinding (for randomization status and outcome assessments), sample attrition, and completeness of outcome data. Reviewers also considered whether outcome data were attained solely through self or parent/teacher report, if outcome measures were over-aligned with intervention (i.e., "teaching to the test"), and whether appropriate statistical methods were used. Each study was coded as high or low risk for each domain, with an overall risk determination based upon team consensus. If data needed to determine risk were not available, the domain was coded as unclear; if multiple criteria were unclear, information was requested from the study authors. If the study was determined to be

high risk overall (typically if more than one risk was identified), the study was excluded from further review.

Analytic Approach

First, we examined the average size of treatment and control groups across studies, the number of effect sizes per study, and the number of outcomes and approaches utilized in each study. Next, to reduce positive bias in studies with small sample sizes, we estimated Hedges *g* effect sizes using standard mean differences when available, or raw means and standard deviations for the intervention and comparison groups. Third, we used a contour-enhanced funnel plot to probe for publication bias due to omission of null results.

We conducted a two-level mixed-effects meta-analysis in *R* using the multivariate function (rma.mv) of the *metafor* package (Viechtbauer & Cheung, 2010). This approach accounts for effects nested within studies and can be used to examine heterogeneity of treatment effects within and across studies; it also allows estimation of the mean effect size of a population of effect sizes we believe to exist, allowing inferences beyond the studies included in the meta-analysis (Hedges & Vevea, 1998).

To address RQ1, we examined the overall effect of self-regulation interventions across all outcomes. For RQ2, we examined whether the average effect of *Cognitive Regulation* and *Emotion Regulation* varied by outcome domain (*cognitive, emotional, and behavioral*). We focus on these two approaches with this question as they reflect our theoretical model most directly. Finally, for RQ3, we examined whether the average estimated effect of self-regulation interventions varied due to a) intervention approach, b) outcome type, and c) measurement type (i.e., moderators were adult report, youth report, performance task).

Results

Study and Intervention Characteristics

The number of studies and effect sizes examined for each intervention approach and outcome type is shown in Tables 1 and 2, respectively. The *Emotion Regulation Approach* was the most common (n = 13), followed by *Cognitive Regulation Approaches* (n = 9) and *Physical Activity* (n = 7). The most frequently examined outcome type was *emotional distress* (n = 18 studies and 58 effects), with other outcomes examined in 7 to 11 studies (21 - 46 effects) each. A total of 7,269 participants contributed to effect sizes. A full summary of effect sizes, intervention approach, and outcome domains by study is available in Supplemental Table 2.

Table 3 shows descriptive characteristics of the sample. Average sample size was 112.54 (SD = 205.03) for intervention and 104.62 (SD = 192.35) for control groups. Studies included an average of 52% male participants aged 12.08 years. Approximately half of the interventions (55%) were delivered at Tier 1 (prevention), with the other half including Tier 2 targeted (30%) or Tier 3 clinical (15%) programs. Slightly more than half of the studies were conducted in the US or Canada (58%), 30% in Western Europe, 9% in Asia, and one in South America. Interventions were delivered by a wide range of agents (teacher, clinicians, researchers, computer and others), most often in a classroom or small group format. Interventions were primarily conducted in schools, with a few provided in outpatient clinics or recreation settings. The average number of intervention sessions was 28 (SD = 24.28) with post-assessments being conducted 16 weeks (SD = 11.73) after pre-test, reflecting tremendous variability in number of sessions and duration, with several studies having multiple sessions per week.

Heterogeneity and Bias

Between-study heterogeneity was substantial ($Q(232) = 767.7146$, $p < .001$). Though between-study variation was small ($\sigma^2 = .06$), it was largely attributed to true heterogeneity in

effects (I^2 = 71% [58.38, 82.05]), suggesting that random-effects models were indicated. To inform understanding of methodological bias across studies, we first utilized Cochrane's criteria. One-third of studies demonstrated low risk of bias across all six criteria. Thirty percent of studies demonstrated high risk for one criterion, most commonly lack of blinding of outcome assessment as is typical for this type of research (e.g., van Genutgen et al. 2016's findings). No studies in our sample demonstrated more than one indicator of high risk. However, data were unavailable to rate random sequence generation and allocation concealment for 57.5% and 30.3% of studies, respectively. Supplemental Table 3 shows each risk of bias domain criteria by study.

Next, we examined the degree to which the sample of studies and effects represent publication bias, utilizing a contour-enhanced funnel plot. A Kendall's tau test indicated presence of asymmetry ($\tau = 0.19$, $p < .0001$); however, inspection of the funnel plot (Figure 2) suggests that asymmetry is likely related to other sources of error rather than publication bias (e.g., measurement error).

Model Specifications

We examined whether inclusion of covariates (intervention tier or prevention/clinical focus, child sex, and average child age) would improve model fit (see Supplemental Table 4). A baseline random-effects multi-level model was compared with a conditional model including covariates. The Wald-type test of model coefficients indicated presence of a non-zero amount of heterogeneity in the model ($Q(232) = 767.72$, $p < .001$). Adding covariates to the model did not explain additional heterogeneity, ($Q_M(4) = 3.13$, $p = 0.536$). Furthermore, test statistics for the baseline versus full/conditional model suggested better model fit for the baseline model (e.g., lower AIC/BIC, larger logLikelihood value, non-significant p-value for the logLikelihood test,

and a larger Wald-type test value (Q_E)). Based on these results, a baseline model was used for all analyses.

Outlier Analysis

We used one-study removed analyses to test for influential cases in the dataset. This procedure examines the change in the average estimated effect when studies are removed one at a time, relative to the estimated effect when all studies are included. This analysis indicated that two studies in our dataset had a significant influence when removed due to positive effects on their specific outcome measures. When Koning et al. (2011) and Kendall et al. (2016) were removed, the overall effect size estimate was reduced by -0.52 and -0.75 *SD*-units, respectively. Koning et al. (2011) examined a combined parent-student alcohol prevention intervention focused on strengthening parent rule setting and student cognitive-behavioral instruction and Kendall et al. (2016) evaluated a cognitive-behavioral program delivered by highly trained clinicians to youth with anxiety. We performed sensitivity analyses to examine the extent of these studies' influence on overall findings (described next).

RQ1: Overall Impact of Interventions

Across all studies, the average intervention effect size was small but different from zero (Hedges' g = .12 [.03, .22], k = 233). Figure 3 depicts effect sizes by the five intervention approaches and Figure 4 presents effect sizes by the six types of outcomes examined. As can be seen, there was considerable heterogeneity both across and within studies.

Given concern of the influence of two studies, we performed further sensitivity analyses by estimating the models with and without these outliers. This yielded average estimated effects of g = 0.12 [0.07, 0.17] and g = 0.12 [0.07, 0.16] when Koning et al. (2011) and Kendall et al.

(2016) were removed, respectively. Given that the average estimated effects did not differ when these cases were included or not, both were included in final analyses.

RQ2: Alignment of Outcome Effects with Intervention Foci

To examine whether the effects of the two theoretical intervention approaches of interest differed as a function of alignment with the outcome, two distinct meta-analytic models were estimated: one for studies with *Emotion Regulation Approaches*, and one with *Cognitive Regulation Approaches* (exclusive of working memory programs). Due to the relatively small number of studies, outcomes were examined by domain (*emotional*, *behavioral,* and *cognitive*), and entered as a potential moderator (i.e., one moderator with three levels) for both models (see Table 4).

As seen in Figure 5, the estimated average effect of *Cognitive Regulation Approaches* did not differ by outcome (white bars), $Q_M(2) = 1.00$, $p = .605$, $k = 68$. That is, they did not produce different effects for any of the three SR outcome domains: *emotional, behavioral, or cognitive*. In fact, none of the effects were significantly different from zero. Conversely, the effects of interventions with *Emotion Regulation Approaches* were stronger for the *emotional* and *behavioral* outcome domains than for the *cognitive* domain ($Q_M(2) = 8.25$, $p = .016$, $k = 86$). That is, the estimated average effect of *Emotion Regulation Approaches* was stronger (and significantly different from zero) for *emotional* ($z = 4.55$, $p = .033$) and *behavioral* ($z = -2.86$, $p = .004$) than for *cognitive outcomes*. The effect of *Emotion Regulation Approaches* did not differ between *emotional* and *behavioral* outcomes ($z = -0.66$, $p = .508$). Of note, results of cognitive outcomes should be interpreted in light of the low precision in the estimates of cognitive effects ($k = 8$, estimated Hedge's $g = -0.03$ [-0.26, 0.21], $SE = 0.12$).

RQ3a. Variation in Effects Related to Intervention Type

SR approach was not significantly related to intervention effects (Table 5) ($Q_M(4) = 2.53$, $p = .639$) for any of the five interventions examined (*Cognitive, Emotional, Working Memory, Parent Training, Physical Activity*). Nonetheless, the average effect of *Emotion Regulation Approaches* was, albeit small, significantly different from 0 (Hedge's $g = .20$ [.05, .36]), consistent with the previous findings. In exploratory analyses, this effect size for this approach was larger for higher risk (clinical or targeted) samples (Hedge's $g = .72$, $SE = .22$, $p = .001$).

RQ3b. Variation in Effects Across Outcome Domains

Outcome types were significantly related to intervention effect size ($Q_M(5) = 18.67$, $p = .002$), suggesting that variation in intervention effects were associated with different outcome types (Table 6). Post-hoc tests of linear combinations (omnibus Wald-type test) indicated that youth-reported *behavioral outcomes* are significantly smaller than *emotional distress outcomes*, which were reliably different from zero ($Q_M(1) = 6.68$, z = -2.59, $p = .010$). Furthermore, *emotion regulation* outcomes were significantly smaller than *emotional distress* outcomes ($Q_M(1) = 13.71$, z = -3.70, $p < .001$).

RQ3c. Variation in Effects Across Measurement Type

Measurement type (self-report, adult report, performance task) did not moderate the effect of intervention on outcomes ($Q_M(2) = 3.01$, $p = .222$, $k = 233$) (Table 7). However, the average estimated effect was significantly different from zero when outcomes were measured via self-report (Hedge's $g = .16$ [.06, .26]), but not when outcomes were measured with adult report (Hedge's $g = .10$ [-.00, .21]) or performance task (Hedge's $g = .06$ [-.07, .20]).

Discussion

This study contributes to understanding SR intervention mechanisms by examining the efficacy of different intervention approaches in relation to different types of outcomes. Strengths

of this work include use of a clear theoretical model to categorize interventions, examination of method and measure variance, rigorous methodological examination of intervention effects, and absence of identifiable publication bias. Our inclusion criteria resulted in identification of a wide range of interventions delivered in different ways across a variety of settings, with SR related outcomes relevant to day-to-day functioning. Our sample included both universal or preventive interventions as well as targeted or indicated interventions for youth experiencing emotional or behavioral difficulties or highly prevalent clinical conditions such as anxiety and ADHD. Results should therefore be highly relevant to program staff in schools and communities.

Key Findings

Given the specific sample considerations described, *Emotion Regulation Approaches* were identified as the only specific approach with consistent positive effects (g = .20). Slightly larger effects were seen for outcomes in the *emotional* domain including dysregulation as well as distress (g = .24). However, significant effects (g = .20) were also seen in the *behavioral* domain based on report of parents and teachers as well as youth. This is consistent with the hypothesis that emotion regulation may be foundational to behavior change during early adolescence, and therefore may represent a critical SR intervention mechanism. Importantly, however, *Emotion Regulation Approaches* did not appear to have a significant impact on *cognitive outcomes* based on the studies included in this review, although neither did *Cognitive Regulation Approaches*. This may reflect heterogeneity in cognitive measures, or perhaps a misalignment with critical developmental change mechanisms.

Our overall estimated effect (g = .12) was slightly lower than seen in prior SR meta-analyses, although results are not directly comparable. Pandey et al. (2018) found notably larger overall average effects of g = .40, however, this was based only on performance tasks, the

majority of which were excluded from our review. Van Genugten et al. (2017) found g = .20 for internalizing behavior for preventive interventions which is comparable to our finding of g = .22 for emotional distress outcomes. In a large meta-analysis of social-emotional interventions, of which SR is included, the average effect size for social behavior and emotional distress for youth in middle school was g = .24 (Durlak et al., 2011), similar to our findings for emotion regulation interventions. Our emotion regulation effects also align well with meta-analyses of mindfulness-based interventions, where overall effects for mental health and wellbeing range from ES =.19 - .25 (Carsley et al., 2017; Zenner et al., 2014). Consistent with prior work (e.g., van Genugten et al., 2017; Wilson et al., 2003), exploratory analyses suggested that higher risk samples had larger effects for Emotion Regulation interventions, which was the only approach for which statistically significant effects were found.

Sources of Variation in Effects

As expected, there was significant heterogeneity of effects among the studies included in analysis, related in part to measurement type and, likely, measurement error. Our results suggest that youth self-report of emotion and behavior may have greater sensitivity to intervention effects (g = .15) relative to adult report of EF and behavior (g = .10) and direct performance tasks (g = .06). Although youth report may be critiqued as biased and may not immediately translate to observable change, it is also the most proximal to the intervention. That is, changes in managing thoughts and emotions would be expected to be experienced before behavioral changes reported by parents and teachers might be observed. Although task-based assessments are sometimes considered more objective, they often do not include an emotional component that is more typical of SR demands in day-to-day life and it is not clear how well they might generalize outside of lab settings (Robson et al., 2020).

When heterogeneity in outcomes was examined by outcome type, youth self-report of *emotional distress* demonstrated the largest effects (g = .22), but adult report of *behavior* also approached significance (g = .12) as did adult report of *executive functioning* (g = .11), such that with a larger sample size these effects may be reliably different than zero. These average effect sizes are nonetheless quite small and have large confidence intervals, suggesting that further work in understanding heterogeneity in effects is needed. Surprisingly, youth report of *emotion regulation* and *behavior* were not significant when effects were examined across different interventions. One potential explanation is that, as youth become more self-aware of their emotional and behavioral functioning, their perceptions of their SR success in may actually decrease, a well-established self-report bias (Aiken & West, 1990).

We also demonstrated value in combining outcomes that share a similar theoretical construct into domains (emotional, cognitive, and behavioral). This approach yielded the largest effects for interventions targeting emotion regulation on emotion-related outcomes (g = .24), as might be expected given the alignment of foci. However, the same was not true for interventions targeting cognitive regulation on cognitive outcomes (g = .08). Indeed, none of the outcome domains were significant for *Cognitive Regulation Approaches* (primarily cognitive-behavioral programs for anxiety or depression). This may reflect a lack of sensitive and reliable measures for assessing changes in thoughts and feelings. On the other hand, this could suggest that emotion regulation interventions may be more well-aligned with the developmental needs of early adolescents.

Limitations

Our results are limited by our inclusion criteria, which were determined by the objectives of this work to evaluate SR interventions that can be implemented across contexts (i.e., not solely

within a laboratory or clinic). For example, we prioritized outcomes relevant to day-to-day functioning and did not capture treatment programs that were provided to youth who were incarcerated or those with autism. And as noted, although we examined 45 effect sizes from cognitive performance tasks, our results may not reflect the full range or effectiveness of interventions that focus primarily on these types of outcomes such as attention-training or working memory programs. Finally, the significant heterogeneity in effects contributed to large and potentially unstable variance, which may have reduced the likelihood of finding significant effects.

Conclusions

Current understanding of the effects of SR interventions is complicated by inconsistent conceptualization of interventions and poorly operationalized SR outcomes. The present work represents one attempt to assess underlying SR mechanisms framed within a specific translational model. Our findings suggest that *Emotion Regulation Approaches* may be critical for obtaining meaningful change in SR during early adolescence, with largest positive impact on youth's *emotional distress* and potential for generalizing to other cognitive and behavioral outcomes. This is consistent with recommendations to match intervention strategies to developmental processes during adolescence(Dahl et al., 2018).

Clearly, more theoretically driven research in this area is needed to refine the selection and specificity of outcome measures in SR intervention research, which is likely to yield more consistent effects. In addition, future work is encouraged to examine whether change in cognitive and emotion regulation mediate changes in behavior. Another specific area for future research to examine is the additive benefit of targeting both emotion regulation and cognitive regulation within one intervention. Such approaches like mindfulness-based cognitive therapy are being

utilized in clinical settings (e.g., Piet & Hougaard, 2011); however, they have not been well-integrated into prevention programs in schools where the greatest number of youth would benefit.

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*References marked with an asterisk indicate studies included in the meta-analysis.

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Table 1. *Number of Studies and Effect Sizes by Intervention Type*

Intervention Type	Number of Studies (n = 33)	Number of Effect Sizes (k = 233)
Cognitive Regulation	9	68
Emotion Regulation	12	86
Parent Training	3	15
Physical Activity	7	25
Working Memory	3	39

Table 2. *Number of Studies and Effect Sizes by Outcome Domain/Method*

Outcome Domain	Number of Studies (n = 33)	Number of Effect Sizes (n = 233)
Behavior Regulation: Adult Report	10	35
Behavior Regulation: Youth Report	7	21
Executive Function: Adult Report	9	28
Executive Function: Performance Task	11	45
Emotion Regulation: Youth Report	11	46
Emotional Distress: Youth Report	17	58

Table 3. *Study and Intervention Descriptives*

Variable	*n*	*M* (*SD*)	Range	Count
Age	33	12.08 (1.65)	10-15.85	
Intervention Level	33			Tier 1= 18 studies Tier 2 = 10 studies Tier 3 = 5 studies
Intervention Delivery Agent	35			Teacher = 10 Researcher = 7 Clinician = 4 Computer = 4 Camp counselor = 3 Other professional = 7
Intervention Format	36			Classroom = 16 Small group = 9 Computerized = 4 Individual = 3 Parent workshop = 1 Summer camp = 1 Parent & teen workshop = 1 Small group & individual = 1
Intervention Setting	34			School = 25 Outpatient clinic = 5 Recreation = 3 Home = 1
Percent male	33	51.94 (11.13)	33.30-88	
Number of intervention sessions	33	28.36 (24.28)	3-100	
Number of weeks between assessments	33	16.21 (11.73)	2-52	
Type of Measure	47			Self-report = 20 Direct assessment = 10 Parent report = 10 Teacher report = 6 School records = 1

Note. Studies may have included more than one age group, risk level, intervention format, intervention setting, delivery agent, and intervention. As such, the number of entries summarized may exceed the number of studies included in the analysis. For studies in which multiple mean ages were reported, average was first calculated within a given study, and the result was used in the overall average. "Other providers" includes those with a certification in a specific intervention, such as yoga or mindfulness instructors.

Table 4. *Effect sizes for Outcome Domains by Intervention Type*

Outcome Type	Intervention Type							
	Emotion Regulation				Cognitive Regulation			
	Hedges' *g* [95% CI]	*SE*	*p*	*k*	Hedges' *g* [95% CI]	*SE*	*p*	*k*
Emotional	0.24 [0.07, 0.42]	0.09	.006	58	0.12 [-0.12, 0.36]	0.12	.338	42
Behavioral	0.20 [-0.01, 0.39]	0.10	.043	20	0.04 [-0.21, 0.29]	0.03	.743	19
Cognitive	-0.03 [-0.26, 0.21]	0.12	.839	8	0.08 [-0.17, 0.33]	0.13	.545	7

Table 5. *Estimated Effects by Intervention Type*

Intervention Type	*k*	Estimated Hedges' *g*	95% *CI*	*SE*	*p*-value
Cognitive Regulation	68	0.08	[-0.10, 0.27]	0.10	.387
Emotion Regulation	86	0.20	[0.05, 0.36]	0.08	.012
Parent Training	15	0.06	[-0.21, 0.32]	0.13	.673
Physical Activity	25	0.12	[-0.10, 0.34]	0.11	.296
Working Memory	39	-0.03	[-0.30, 0.24]	0.14	.819

Table 6. *Summary of Estimated Effects by Outcome Type*

Outcome Type	*k*	Estimated Hedges' *g*	95% *CI*	*SE*	*p*-value
Behavior reg: Adult report	35	0.12	[-0.01, 0.24]	0.06	.058
Behavior reg: Youth report	21	0.07[a]	[-0.05, 0.19]	0.06	.262
EF: Adult report	28	0.11	[-0.02, 0.23]	0.06	.089
EF: Performance Task	45	0.08	[-0.05, 0.21]	0.07	.233
Emotion regulation: Youth report	46	0.06[a]	[-0.07, 0.18]	0.06	.357
Emotional distress: Youth report	58	0.22[b]	[0.11, 0.33]	0.06	.0001

Note. EF = Executive functioning. Different superscripts indicate significant differences between effect sizes at $p < .05$

Table 7. *Estimated Effects by Measurement Type*

Intervention Type	*k*	Estimated Hedges' *g*	95% *CI*	*SE*	*p*-value
Self-Report	111	0.15	[0.06, 0.26]	0.05	.002
Other Report	82	0.10	[-0.00, 0.21]	0.05	.054
Direct Assessment	40	0.06	[-0.07, 0.19]	0.07	.376

Supplemental Table 1: Search keywords by list

List 1: Intervention or Strategy

- Intervention
- Interventions
- Program
- Programs
- Programme
- Curriculum
- Curricula
- Training
- Train
- Strategy
- Strategies
- Manipulation
- Manipulations
- Enhance
- Enhances
- Enhancing
- Enhancement
- Improve
- Improves
- Improving
- Improvement
- Prevent
- Prevents
- Preventing
- Prevention

List 2: Target age of sample

- Middle school
- Middle Schoolers
- Junior High
- Child
- Children
- Childhood
- Adolescent
- Adolescence
- Adolescents
- Youth

- Youths

List 3: Target of strategy or outcome assessed

- General self-regulation
    - Self Regulation
    - Self-Regulation
    - Self Regulatory
    - Self Regulate
    - Self control
    - Behavioral Inhibition
    - Behavior Inhibition
    - Inhibition Control
    - Inhibitory Control
    - Impulsivity
    - Impulsiveness
    - Sensation seeking
    - Delay AND (reward or gratification)
    - Ego depletion

- Emotion Regulation/Dysregulation
    - Emotion regulation
    - Emotional regulation
    - Mindful
    - Mindfulness
    - Emotion processing
    - Emotional processing
    - Emotion awareness
    - Emotional awareness
    - Emotional Acceptance
    - Emotion acceptance
    - Cognitive acceptance
    - Emotion suppression
    - Emotional suppression
    - Mood reactivity
    - Non judgment
    - Distress tolerance
    - Emotional dysregulation
    - Emotion dysregulation

- Cognitive Regulation/Dysregulation
    - Executive function
    - Executive Functions
    - Executive functioning
    - Cognitive flexibility
    - Cognitive control
    - Effortful control
    - Working memory
    - Attention control

    - Attentional control
    - Attention bias
    - Attentional bias
    - Attribution bias
    - Attributional bias
    - Problem solving
    - Problem solve
    - Perspective taking
    - Future orientation
    - Goal setting
    - Self-monitoring
    - Self-monitor
    - Goal engagement
    - Goal re-engagement
    - Goal disengagement
    - Cognitive Appraisal
    - Emotional Avoidance
    - Emotion avoidance
    - Cognitive avoidance
    - Reappraisal
    - Rumination
    - Denial
    - Cognitive restructuring
    - Self talk
    - Mental contrasting

- Stress Related
    - Stress reactivity
    - Stress reactive
    - Stress responsivity
    - Stress response
    - Stress responsiveness

PsycINFO Full Search Strategy

Limiters - Publication Year: 2010-2017; Publication Type: All Journals; English; Age Groups: School Age (6-12 yrs), Adolescence (13-17 yrs); Population Group: Human; Document Type: Journal Article; Exclude Dissertations

(Intervention OR Interventions OR Program OR Programs OR Programme OR Curriculum OR Curricula OR Train OR Training OR Strategy OR Strategies OR Manipulation OR Manipulations)

AND

(Enhance OR Enhances OR Enhancing OR Enhancement OR Improve OR Improves OR Improving OR Improvement OR Prevent OR Prevents OR Preventing OR Prevention)

AND
(“Middle school” OR “middle schoolers” OR Adolescence OR Adolescent OR Adolescents OR child OR childhood OR children OR “junior high” OR youth or youths)

AND

(“Self regulation” OR “self-regulation” OR “self regulatory” OR “self regulate” OR “Self control” OR “Behavioral inhibition” OR “behavior inhibition” OR “Inhibition control” OR “inhibitory control” OR Impulsivity OR impulsiveness OR “emotion acceptance” OR “emotional acceptance” OR “Sensation seeking” OR (Delay AND (reward OR gratification)) OR “Ego depletion” OR
“Emotion regulation” OR “emotional regulation” OR Mindful OR Mindfulness OR “Emotion processing” OR “emotional processing” OR “Emotion awareness” OR “emotional awareness” OR “Emotion suppression” OR “emotional suppression” OR “Mood reactivity” OR “Non judgment” OR “Distress tolerance” OR “emotion dysregulation” OR “emotional dysregulation” OR
"executive function" OR “executive functions” OR “executive functioning” OR “Cognitive flexibility” OR “Cognitive control” OR “Effortful control” OR “Working memory” OR “Attention control” OR “attentional control” OR “Attention bias” OR “attentional bias” OR “Attribution bias” OR “attributional bias” OR “Problem solving” OR “problem solve” OR “Perspective taking” OR “Future orientation” OR “Goal setting” OR “Self-monitoring” OR “self-monitor” OR “goal engagement” OR “goal re-engagement” OR “goal disengagement” OR “cognitive appraisal” OR “cognitive avoidance” OR “emotion avoidance” OR “emotional avoidance” OR Reappraisal OR Rumination OR “Cognitive restructuring” OR “Self talk” OR “Mental contrasting” OR
“Stress reactivity” OR “stress reactive” OR “Stress responsivity” OR “stress response” OR “stress responsiveness”)

NOT

MR ("literature review" or "systematic review" or "meta analysis")

NOT Preschool

Supplemental Table 2

Descriptive Characteristics of Included Studies

Study	*N*	M_{age}	Measurement Type	Intervention Type	Outcome Type	Number of Effects in Study
Afsha2014	20	10.57	Parent Report Self-Report	Cognitive Regulation	Emotional Distress Emotion Awareness/Regulation	24
Annes2016	145	10	Self-Report	Physical Activity	Emotional Distress	1
Annes2017	141	10	Self-Report	Physical Activity	Emotional Distress	1
Bouch2013	46	10.4	Self-Report	Cognitive Regulation	Emotional Distress	3
Bradl2010	98	15.3	Self-Report	Emotion Regulation	Emotion Awareness/Regulation Emotional Distress	5
Britt2014	100	11.79	Self-Report	Emotion Regulation	Behavior Regulation: Youth Report Emotion Awareness/Regulation Emotional Distress	4
Butze2017	205	12.64	Self-Report	Emotion Regulation	Behavior Regulation: Youth Report Emotion Awareness/Regulation Emotional Distress	13
Chen2016	50	12.74	Direct Assessment	Physical Activity	EF: Performance Task	2
Choi2015	47	11.2	Self-Report	Emotion Regulation	Emotion Awareness/Regulation Emotional Distress	6
deVoo2017	76	14.45	Direct Assessment Parent Report Self-Report	Cognitive Regulation	EF: Performance Task Emotional Distress Behavior Regulation: Adult Report	8
Egela2013	67	10.4	Direct Assessment Parent Report Teacher Report	Working Memory	EF: Performance Task Behavior Regulation: Adult Report EF: Adult Report	25
Franc2016	27	15.85	Self-Report	Emotion Regulation	Behavior Regulation: Youth Report Emotion Awareness/Regulation	7
Frank2017	159	12.5	Records	Emotion Regulation	Emotion Awareness/Regulation Emotional Distress	4

Study	*N*	M_{age}	Measurement Type	Intervention Type	Outcome Type	Number of Effects in Study
Ghahr2013	445	15.11	Self-Report	Emotion Regulation	Behavior Regulation: Youth Report	4
Huang2015	92	12	Direct Assessment Parent Report	Physical Activity	EF: Performance Task Behavior Regulation: Adult Report EF: Adult Report	5
Kenda2016	216	10.7	Parent Report Self-Report	Cognitive Regulation	Emotion Awareness/Regulation Emotional Distress	6
Konin2011	1477	12.7	Self-Report	Parent Training	Behavior Regulation: Youth Report	2
Lakes2013	27	12.2	Parent Report	Physical Activity	Behavior Regulation: Adult Report EF: Adult Report EF: Performance Task	8
Lochm2014	171	10.7	Teacher Report	Cognitive Regulation	Behavior Regulation: Adult Report	8
Mason2015	226	13.41	Parent Report	Parent Training	Emotion Awareness/Regulation	2
Nelwa2016	43	10.78	Direct Assessment	Working Memory	EF: Performance Task	4
Parke2014	108	10.09	Direct Assessment Teacher Report	Emotion Regulation	EF: Performance Task Behavior Regulation: Adult Report EF: Adult Report Emotional Distress	6
Pesce2016	90	14.5	Direct Assessment	Physical Activity	EF: Performance Task	2
Quach2016	112	13.18	Direct Assessment Self-Report	Emotion Regulation	EF: Performance Task Emotional Distress	6
Reite2016	77	13.64	Self-Report	Cognitive Regulation	Emotional Distress	5
Sempl2010	25	10.48	Parent Report Self-Report	Emotion Regulation	Behavior Regulation: Adult Report EF: Adult Report Emotional Distress	4
Sibing2016	300	11.5	Self-Report	Emotion Regulation	Emotion Awareness/Regulation Emotional Distress	18
Smith2016	1880	10.51	Self-Report Teacher Report	Cognitive Regulation	Behavior Regulation: Youth Report Behavior Regulation: Adult Report EF: Adult Report	6

Study	*N*	M_{age}	Measurement Type	Intervention Type	Outcome Type	Number of Effects in Study
Steeg2016	51	12.5	Direct Assessment Parent Report Teacher Report	Parent Training Working Memory	EF: Performance Task Behavior Regulation: Adult Report EF: Adult Report	21
Tarp2016	584	12.9	Direct Assessment	Physical Activity	EF: Performance Task	6
Terje2016	107	13.5	Self-Report Teacher Report	Emotion Regulation	Emotional Distress EF: Adult Report	9
Vassi2015	34	10.67	Self-Report	Cognitive Regulation	Behavior Regulation: Youth Report Emotion Awareness/Regulation	3
Young2017	23	11.65	Parent Report	Cognitive Regulation	Behavior Regulation: Adult Report EF: Adult Report	5

Note: EF = Executive Functioning

Supplemental Table 3. Risk of Bias by Study

Study Reference	Quality of Randomization	Allocation Concealment	Blinding: Randomization Status	Blinding: Outcome Assessments	Sample Attrition	Completeness of Outcome Data	Overall Risk Level
Afshari et al., 2014	Unclear	Low	Low	Low	Low	Low	Low
Annesi et al., 2016	Low	Low	Low	Low	Low	Low	Low
Annesi et al., 2017	Low	Low	Low	Low	Low	Low	Low
Bouchard et al., 2013	Unclear	Unclear	Low	High	Low	Low	Low
Bradley et al., 2010	Unclear	High	Low	Low	Low	Low	Low
Britton et al., 2014	Low	Low	Low	Low	Low	Low	Low
Butzer et al., 2017	Unclear	Low	Low	High	Low	Low	Low
Chen et al., 2016	Low	Low	Low	Low	Low	Low	Low
Choi & Lee, 2015	Low	Low	Low	Low	Low	Low	Low
De Voogd et al., 2014	Low	Low	Low	Low	Low	Low	Low
Egeland et al., 2013	Low	Low	Low	Low	Low	Low	Low
Franco et al., 2016	Unclear	Unclear	Low	Low	Low	Low	Low
Frank et al., 2017	Unclear	Unclear	Low	Low	Low	Low	Low
Ghahremani et al., 2013	Unclear	Unclear	Low	Low	High	Low	Low
Huang et al., 2015	Low	Low	Low	Low	High	Low	Low
Kendall et al., 2016	Unclear	Unclear	Low	Low	Low	Unclear	Low
Koning et al., 2010	Low	Low	Low	High	Low	Low	Low
Lakes et al., 2013	Low	Low	Low	Low	Low	Low	Low
Lochman et al., 2014	Unclear	Unclear	Low	Low	Low	Low	Low
Mason et al., 2015	Unclear	Low	Low	Low	Low	Low	Low
Nelwan et al., 2016	Unclear	Low	Low	Low	Low	Low	Low
Parker et al., 2014	Unclear	Unclear	Low	Low	Low	Low	Low
Pesce et al., 2016	Unclear	Unclear	Low	Low	Low	Low	Low
Quach et al., 2016	Unclear	Unclear	Low	Low	Low	Low	Low
Reiter & Wilz, 2016	Unclear	Low	Low	Low	Low	Low	Low
Semple et al., 2010	Unclear	Low	High	Low	Low	Unclear	Low
Sibinga et al., 2016	Unclear	Low	Low	High	Low	Low	Low
Smith et al., 2016	Low	Low	Low	High	Low	Low	Low
Steeger et al., 2016	Low	Low	Low	Low	Low	Low	Low
Tarp et al., 2016	Low	Low	Low	Low	Low	Low	Low
Terjestam et al., 2016	Unclear	Unclear	Low	High	Low	Low	Low
Vassilopoulos et al., 2015	Low	Low	Low	Low	Unclear	Low	Low

Young et al., 2017	Unclear	Low	Low	Low	Low	Low	Low

Supplemental Table 4: *Test Fit Statistics for Baseline versus Full Model*

	df	AIC	BIC	AICc	logLik	LRT	*p*-value	Q_E
Baseline Model	2	293.23	300.13	293.28	-144.61	3.46	.484	767.72
Full Model	6	297.77	318.47	198.14	-142.88			758.53

FIGURE CAPTIONS

Figure 1. PRISMA flow diagram

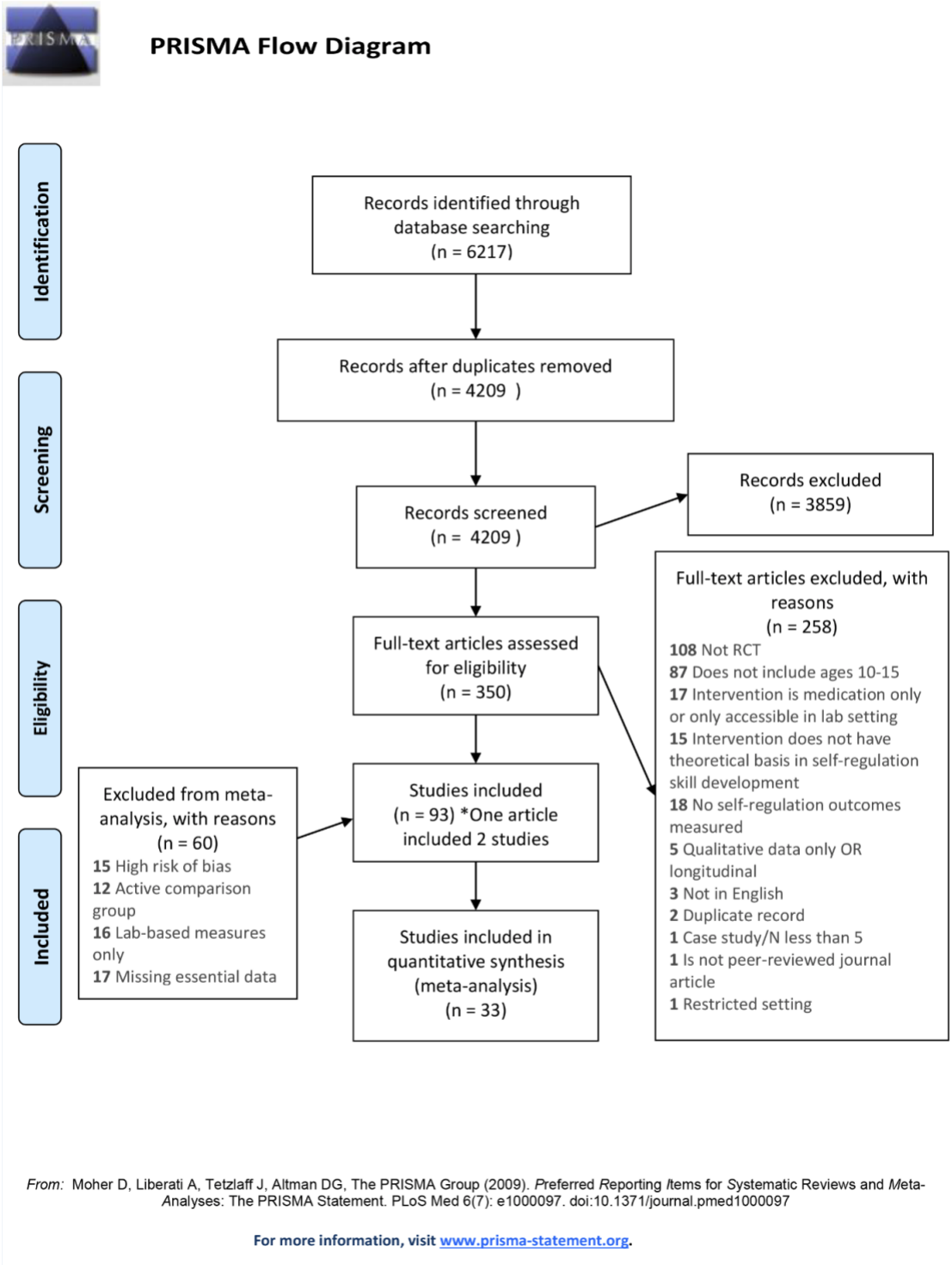
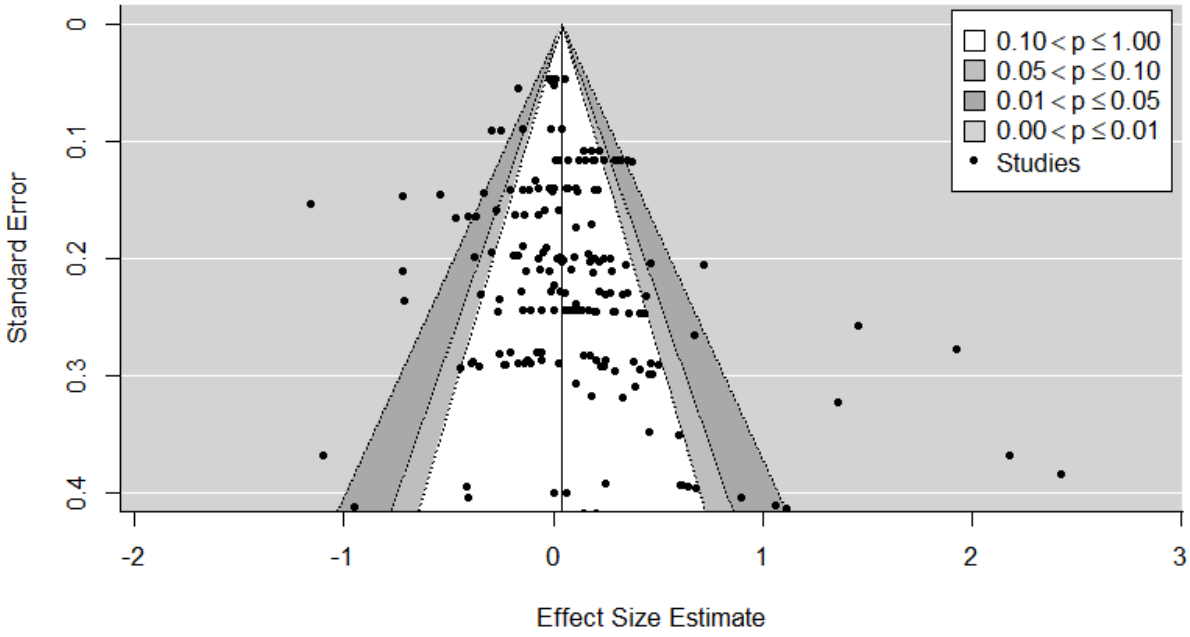
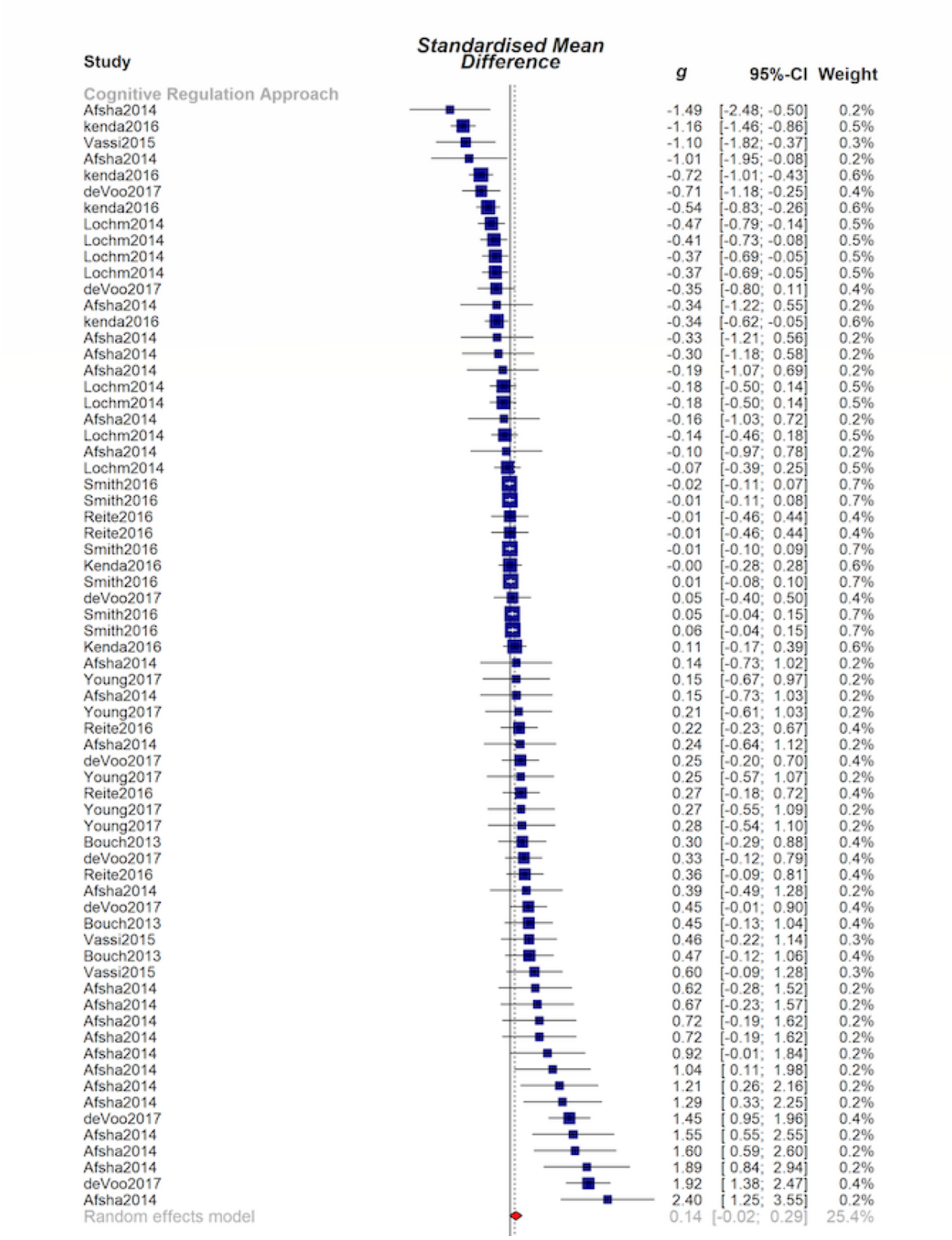


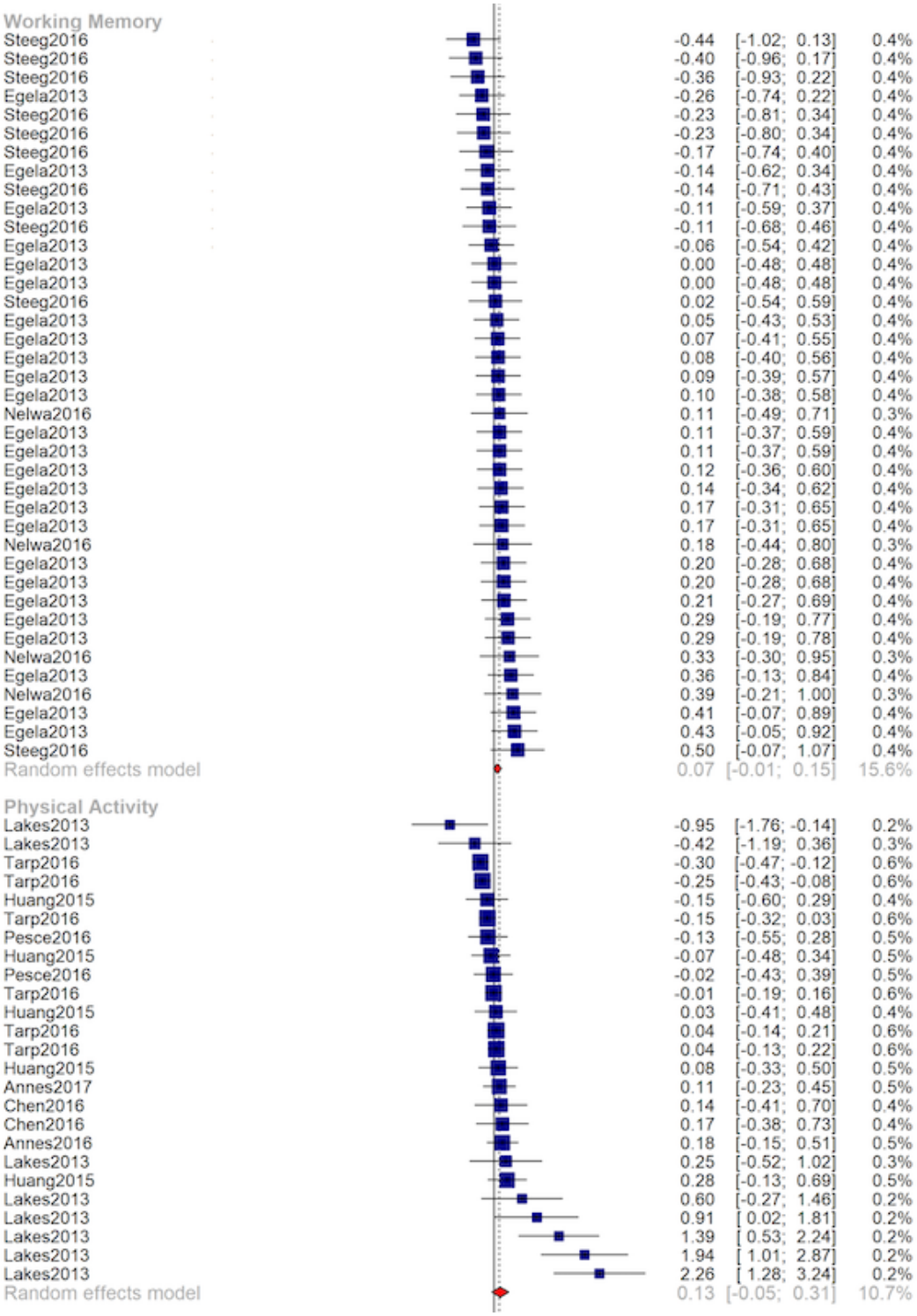
Figure 2. Funnel Plot of all Intervention Effects



Contour-enhanced funnel plot depicting estimated effect sizes against the degree of standard error. Shaded areas represent conventional regions of significance. The vertical line at the center of the funnel indicates the univariate estimated effect size across all effect sizes.

Figure 3. Forest Plot of Effect Sizes by Intervention Approach




Working Memory
Steeg2016 -0.44 [-1.02; 0.13] 0.4%
Steeg2016 -0.40 [-0.96; 0.17] 0.4%
Steeg2016 -0.36 [-0.93; 0.22] 0.4%
Egela2013 -0.26 [-0.74; 0.22] 0.4%
Steeg2016 -0.23 [-0.81; 0.34] 0.4%
Steeg2016 -0.23 [-0.80; 0.34] 0.4%
Steeg2016 -0.17 [-0.74; 0.40] 0.4%
Egela2013 -0.14 [-0.62; 0.34] 0.4%
Steeg2016 -0.14 [-0.71; 0.43] 0.4%
Egela2013 -0.11 [-0.59; 0.37] 0.4%
Steeg2016 -0.11 [-0.68; 0.46] 0.4%
Egela2013 -0.06 [-0.54; 0.42] 0.4%
Egela2013 0.00 [-0.48; 0.48] 0.4%
Egela2013 0.00 [-0.48; 0.48] 0.4%
Steeg2016 0.02 [-0.54; 0.59] 0.4%
Egela2013 0.05 [-0.43; 0.53] 0.4%
Egela2013 0.07 [-0.41; 0.55] 0.4%
Egela2013 0.08 [-0.40; 0.56] 0.4%
Egela2013 0.09 [-0.39; 0.57] 0.4%
Egela2013 0.10 [-0.38; 0.58] 0.4%
Nelwa2016 0.11 [-0.49; 0.71] 0.3%
Egela2013 0.11 [-0.37; 0.59] 0.4%
Egela2013 0.11 [-0.37; 0.59] 0.4%
Egela2013 0.12 [-0.36; 0.60] 0.4%
Egela2013 0.14 [-0.34; 0.62] 0.4%
Egela2013 0.17 [-0.31; 0.65] 0.4%
Egela2013 0.17 [-0.31; 0.65] 0.4%
Nelwa2016 0.18 [-0.44; 0.80] 0.3%
Egela2013 0.20 [-0.28; 0.68] 0.4%
Egela2013 0.20 [-0.28; 0.68] 0.4%
Egela2013 0.21 [-0.27; 0.69] 0.4%
Egela2013 0.29 [-0.19; 0.77] 0.4%
Egela2013 0.29 [-0.19; 0.78] 0.4%
Nelwa2016 0.33 [-0.30; 0.95] 0.3%
Egela2013 0.36 [-0.13; 0.84] 0.4%
Nelwa2016 0.39 [-0.21; 1.00] 0.3%
Egela2013 0.41 [-0.07; 0.89] 0.4%
Egela2013 0.43 [-0.05; 0.92] 0.4%
Steeg2016 0.50 [-0.07; 1.07] 0.4%
Random effects model 0.07 [-0.01; 0.15] 15.6%
Physical Activity
Lakes2013 -0.95 [-1.76; -0.14] 0.2%
Lakes2013 -0.42 [-1.19; 0.36] 0.3%
Tarp2016 -0.30 [-0.47; -0.12] 0.6%
Tarp2016 -0.25 [-0.43; -0.08] 0.6%
Huang2015 -0.15 [-0.60; 0.29] 0.4%
Tarp2016 -0.15 [-0.32; 0.03] 0.6%
Pesce2016 -0.13 [-0.55; 0.28] 0.5%
Huang2015 -0.07 [-0.48; 0.34] 0.5%
Pesce2016 -0.02 [-0.43; 0.39] 0.5%
Tarp2016 -0.01 [-0.19; 0.16] 0.6%
Huang2015 0.03 [-0.41; 0.48] 0.4%
Tarp2016 0.04 [-0.14; 0.21] 0.6%
Tarp2016 0.04 [-0.13; 0.22] 0.6%
Huang2015 0.08 [-0.33; 0.50] 0.5%
Annes2017 0.11 [-0.23; 0.45] 0.5%
Chen2016 0.14 [-0.41; 0.70] 0.4%
Chen2016 0.17 [-0.38; 0.73] 0.4%
Annes2016 0.18 [-0.15; 0.51] 0.5%
Lakes2013 0.25 [-0.52; 1.02] 0.3%
Huang2015 0.28 [-0.13; 0.69] 0.5%
Lakes2013 0.60 [-0.27; 1.46] 0.2%
Lakes2013 0.91 [0.02; 1.81] 0.2%
Lakes2013 1.39 [0.53; 2.24] 0.2%
Lakes2013 1.94 [1.01; 2.87] 0.2%
Lakes2013 2.26 [1.28; 3.24] 0.2%
Random effects model 0.13 [-0.05; 0.31] 10.7%

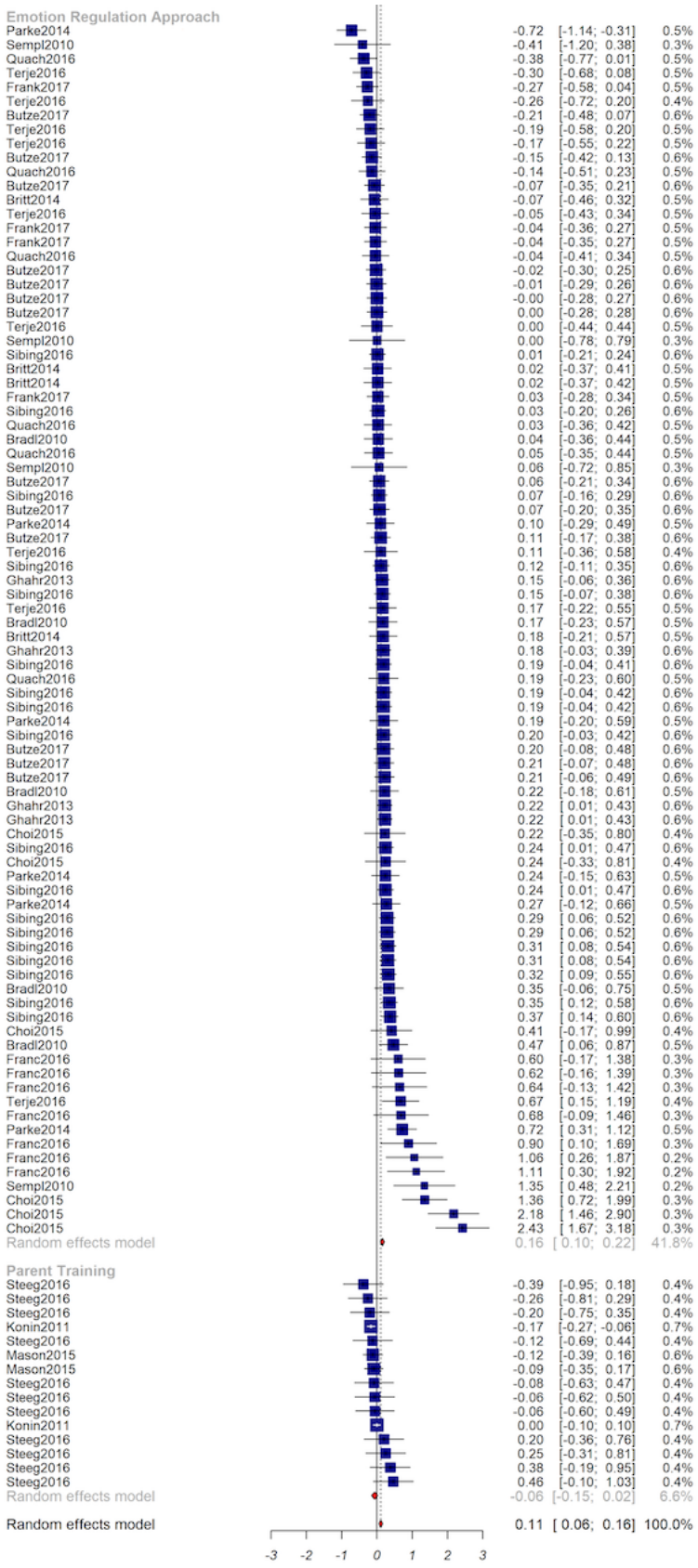
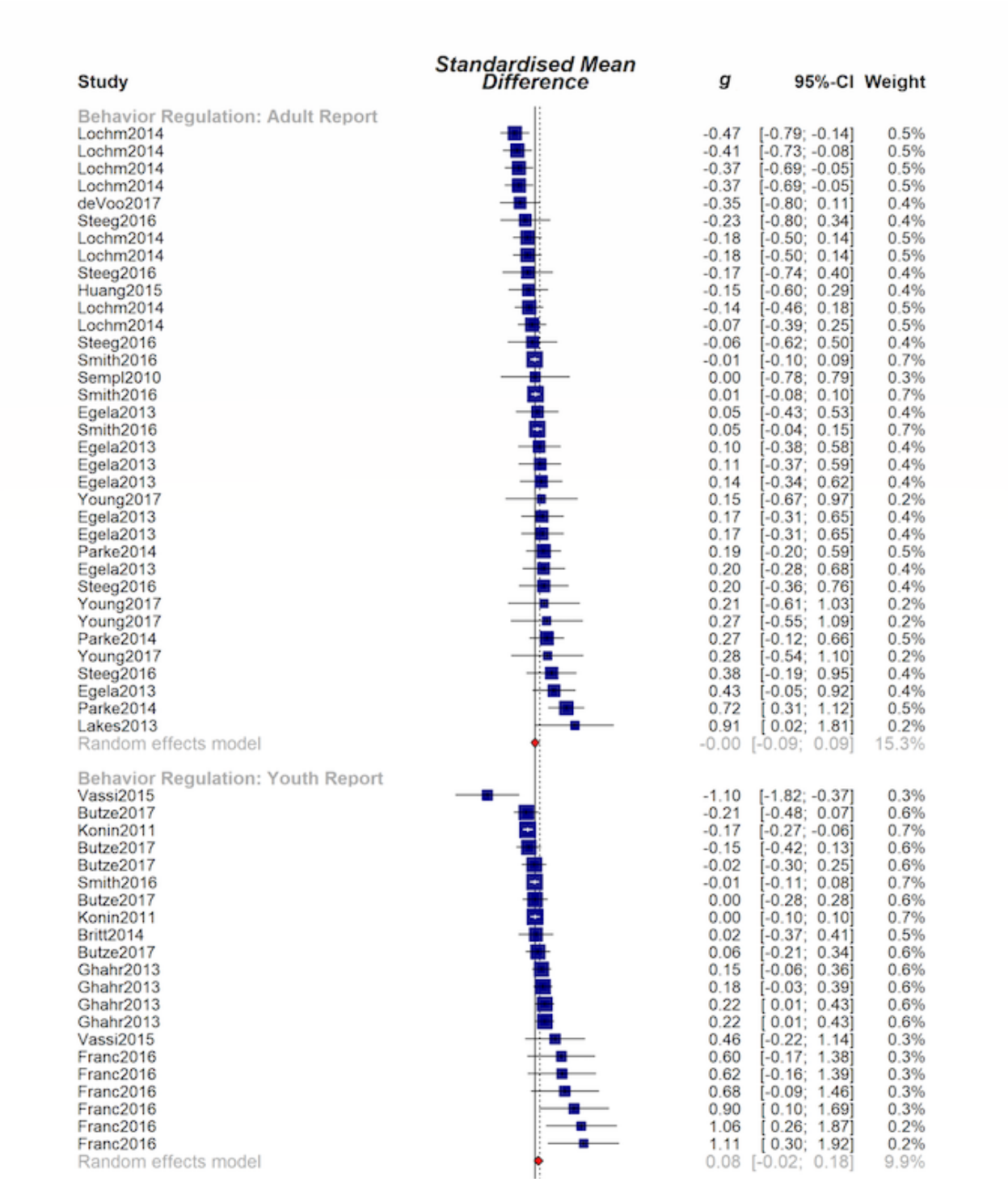
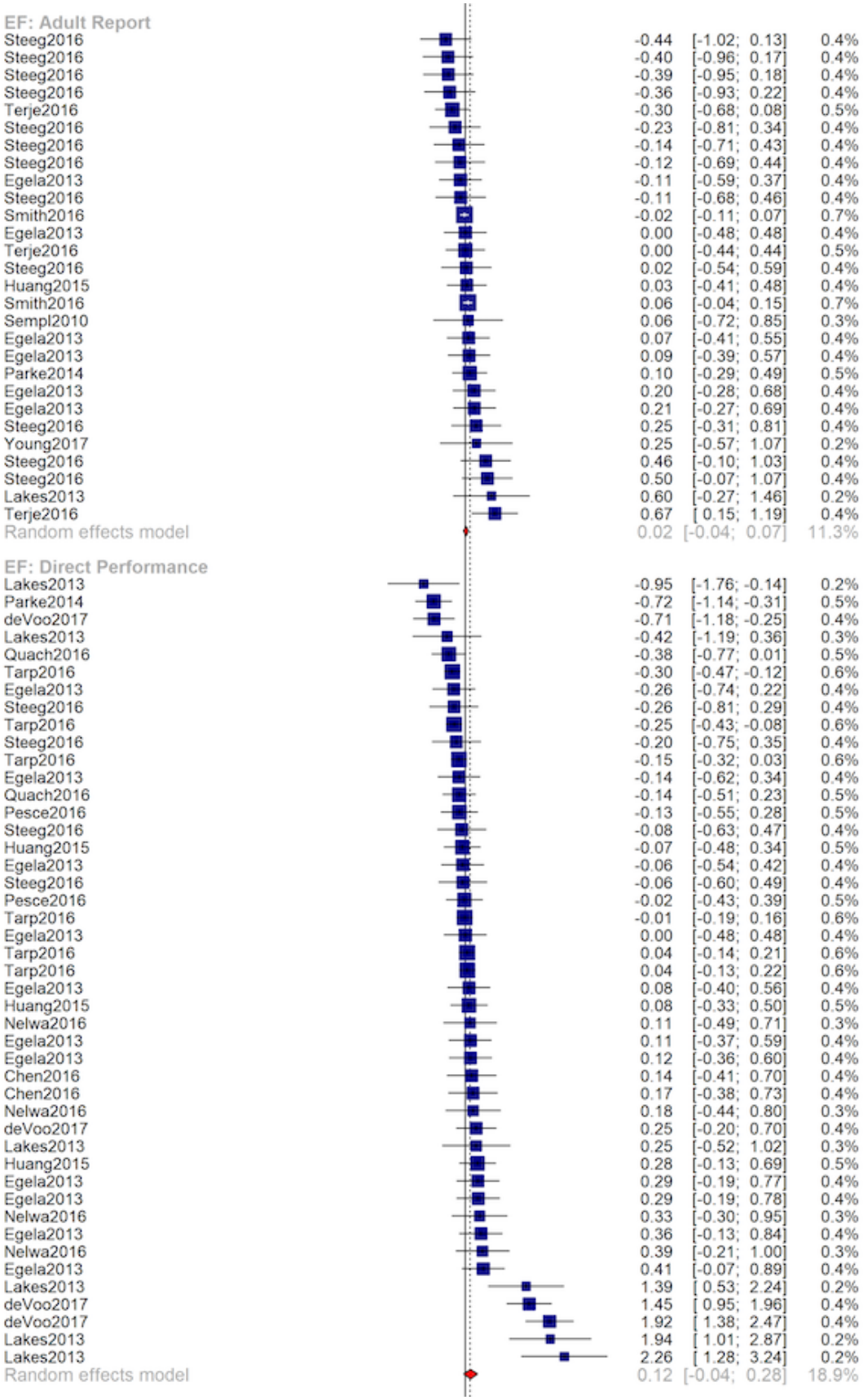

Emotion Regulation Approach
Parke2014 -0.72 [-1.14; -0.31] 0.5%
Sempl2010 -0.41 [-1.20; 0.38] 0.3%
Quach2016 -0.38 [-0.77; 0.01] 0.5%
Terje2016 -0.30 [-0.68; 0.08] 0.5%
Frank2017 -0.27 [-0.58; 0.04] 0.5%
Terje2016 -0.26 [-0.72; 0.20] 0.4%
Butze2017 -0.21 [-0.48; 0.07] 0.6%
Terje2016 -0.19 [-0.58; 0.20] 0.5%
Terje2016 -0.17 [-0.55; 0.22] 0.5%
Butze2017 -0.15 [-0.42; 0.13] 0.6%
Quach2016 -0.14 [-0.51; 0.23] 0.5%
Butze2017 -0.07 [-0.35; 0.21] 0.6%
Britt2014 -0.07 [-0.46; 0.32] 0.5%
Terje2016 -0.05 [-0.43; 0.34] 0.5%
Frank2017 -0.04 [-0.36; 0.27] 0.5%
Frank2017 -0.04 [-0.35; 0.27] 0.5%
Quach2016 -0.04 [-0.41; 0.34] 0.5%
Butze2017 -0.02 [-0.30; 0.25] 0.6%
Butze2017 -0.01 [-0.29; 0.26] 0.6%
Butze2017 -0.00 [-0.28; 0.27] 0.6%
Butze2017 0.00 [-0.28; 0.28] 0.6%
Terje2016 0.00 [-0.44; 0.44] 0.5%
Sempl2010 0.00 [-0.78; 0.79] 0.3%
Sibing2016 0.01 [-0.21; 0.24] 0.6%
Britt2014 0.02 [-0.37; 0.41] 0.5%
Britt2014 0.02 [-0.37; 0.42] 0.5%
Frank2017 0.03 [-0.28; 0.34] 0.5%
Sibing2016 0.03 [-0.20; 0.26] 0.6%
Quach2016 0.03 [-0.36; 0.42] 0.5%
Bradl2010 0.04 [-0.36; 0.44] 0.5%
Quach2016 0.05 [-0.35; 0.44] 0.5%
Sempl2010 0.06 [-0.72; 0.85] 0.3%
Butze2017 0.06 [-0.21; 0.34] 0.6%
Sibing2016 0.07 [-0.16; 0.29] 0.6%
Butze2017 0.07 [-0.20; 0.35] 0.6%
Parke2014 0.10 [-0.29; 0.49] 0.5%
Butze2017 0.11 [-0.17; 0.38] 0.6%
Terje2016 0.11 [-0.36; 0.58] 0.4%
Sibing2016 0.12 [-0.11; 0.35] 0.6%
Ghahr2013 0.15 [-0.06; 0.36] 0.6%
Sibing2016 0.15 [-0.07; 0.38] 0.6%
Terje2016 0.17 [-0.22; 0.55] 0.5%
Bradl2010 0.17 [-0.23; 0.57] 0.5%
Britt2014 0.18 [-0.21; 0.57] 0.5%
Ghahr2013 0.18 [-0.03; 0.39] 0.6%
Sibing2016 0.19 [-0.04; 0.41] 0.6%
Quach2016 0.19 [-0.23; 0.60] 0.5%
Sibing2016 0.19 [-0.04; 0.42] 0.6%
Sibing2016 0.19 [-0.04; 0.42] 0.6%
Parke2014 0.19 [-0.20; 0.59] 0.5%
Sibing2016 0.20 [-0.03; 0.42] 0.6%
Butze2017 0.20 [-0.08; 0.48] 0.6%
Butze2017 0.21 [-0.07; 0.48] 0.6%
Butze2017 0.21 [-0.06; 0.49] 0.6%
Bradl2010 0.22 [-0.18; 0.61] 0.5%
Ghahr2013 0.22 [0.01; 0.43] 0.6%
Ghahr2013 0.22 [0.01; 0.43] 0.6%
Choi2015 0.22 [-0.35; 0.80] 0.4%
Sibing2016 0.24 [0.01; 0.47] 0.6%
Choi2015 0.24 [-0.33; 0.81] 0.4%
Parke2014 0.24 [-0.15; 0.63] 0.5%
Sibing2016 0.24 [0.01; 0.47] 0.6%
Parke2014 0.27 [-0.12; 0.66] 0.5%
Sibing2016 0.29 [0.06; 0.52] 0.6%
Sibing2016 0.29 [0.06; 0.52] 0.6%
Sibing2016 0.31 [0.08; 0.54] 0.6%
Sibing2016 0.31 [0.08; 0.54] 0.6%
Sibing2016 0.32 [0.09; 0.55] 0.6%
Bradl2010 0.35 [-0.06; 0.75] 0.5%
Sibing2016 0.35 [0.12; 0.58] 0.6%
Sibing2016 0.37 [0.14; 0.60] 0.6%
Choi2015 0.41 [-0.17; 0.99] 0.4%
Bradl2010 0.47 [0.06; 0.87] 0.5%
Franc2016 0.60 [-0.17; 1.38] 0.3%
Franc2016 0.62 [-0.16; 1.39] 0.3%
Franc2016 0.64 [-0.13; 1.42] 0.3%
Terje2016 0.67 [0.15; 1.19] 0.4%
Franc2016 0.68 [-0.09; 1.46] 0.3%
Parke2014 0.72 [0.31; 1.12] 0.5%
Franc2016 0.90 [0.10; 1.69] 0.3%
Franc2016 1.06 [0.26; 1.87] 0.2%
Franc2016 1.11 [0.30; 1.92] 0.2%
Sempl2010 1.35 [0.48; 2.21] 0.2%
Choi2015 1.36 [0.72; 1.99] 0.3%
Choi2015 2.18 [1.46; 2.90] 0.3%
Choi2015 2.43 [1.67; 3.18] 0.3%
Random effects model 0.16 [0.10; 0.22] 41.8%
Parent Training
Steeg2016 -0.39 [-0.95; 0.18] 0.4%
Steeg2016 -0.26 [-0.81; 0.29] 0.4%
Steeg2016 -0.20 [-0.75; 0.35] 0.4%
Konin2011 -0.17 [-0.27; -0.06] 0.7%
Steeg2016 -0.12 [-0.69; 0.44] 0.4%
Mason2015 -0.12 [-0.39; 0.16] 0.6%
Mason2015 -0.09 [-0.35; 0.17] 0.6%
Steeg2016 -0.08 [-0.63; 0.47] 0.4%
Steeg2016 -0.06 [-0.62; 0.50] 0.4%
Steeg2016 -0.06 [-0.60; 0.49] 0.4%
Konin2011 0.00 [-0.10; 0.10] 0.7%
Steeg2016 0.20 [-0.36; 0.76] 0.4%
Steeg2016 0.25 [-0.31; 0.81] 0.4%
Steeg2016 0.38 [-0.19; 0.95] 0.4%
Steeg2016 0.46 [-0.10; 1.03] 0.4%
Random effects model -0.06 [-0.15; 0.02] 6.6%
Random effects model 0.11 [0.06; 0.16] 100.0%
-3 -2 -1 0 1 2 3

Figure 4. Forest Plot of Effect Sizes by Outcome Type




EF: Adult Report
Steeg2016 -0.44 [-1.02; 0.13] 0.4%
Steeg2016 -0.40 [-0.96; 0.17] 0.4%
Steeg2016 -0.39 [-0.95; 0.18] 0.4%
Steeg2016 -0.36 [-0.93; 0.22] 0.4%
Terje2016 -0.30 [-0.68; 0.08] 0.5%
Steeg2016 -0.23 [-0.81; 0.34] 0.4%
Steeg2016 -0.14 [-0.71; 0.43] 0.4%
Steeg2016 -0.12 [-0.69; 0.44] 0.4%
Egela2013 -0.11 [-0.59; 0.37] 0.4%
Steeg2016 -0.11 [-0.68; 0.46] 0.4%
Smith2016 -0.02 [-0.11; 0.07] 0.7%
Egela2013 0.00 [-0.48; 0.48] 0.4%
Terje2016 0.00 [-0.44; 0.44] 0.5%
Steeg2016 0.02 [-0.54; 0.59] 0.4%
Huang2015 0.03 [-0.41; 0.48] 0.4%
Smith2016 0.06 [-0.04; 0.15] 0.7%
Sempl2010 0.06 [-0.72; 0.85] 0.3%
Egela2013 0.07 [-0.41; 0.55] 0.4%
Egela2013 0.09 [-0.39; 0.57] 0.4%
Parke2014 0.10 [-0.29; 0.49] 0.5%
Egela2013 0.20 [-0.28; 0.68] 0.4%
Egela2013 0.21 [-0.27; 0.69] 0.4%
Steeg2016 0.25 [-0.31; 0.81] 0.4%
Young2017 0.25 [-0.57; 1.07] 0.2%
Steeg2016 0.46 [-0.10; 1.03] 0.4%
Steeg2016 0.50 [-0.07; 1.07] 0.4%
Lakes2013 0.60 [-0.27; 1.46] 0.2%
Terje2016 0.67 [0.15; 1.19] 0.4%
Random effects model 0.02 [-0.04; 0.07] 11.3%
EF: Direct Performance
Lakes2013 -0.95 [-1.76; -0.14] 0.2%
Parke2014 -0.72 [-1.14; -0.31] 0.5%
deVoo2017 -0.71 [-1.18; -0.25] 0.4%
Lakes2013 -0.42 [-1.19; 0.36] 0.3%
Quach2016 -0.38 [-0.77; 0.01] 0.5%
Tarp2016 -0.30 [-0.47; -0.12] 0.6%
Egela2013 -0.26 [-0.74; 0.22] 0.4%
Steeg2016 -0.26 [-0.81; 0.29] 0.4%
Tarp2016 -0.25 [-0.43; -0.08] 0.6%
Steeg2016 -0.20 [-0.75; 0.35] 0.4%
Tarp2016 -0.15 [-0.32; 0.03] 0.6%
Egela2013 -0.14 [-0.62; 0.34] 0.4%
Quach2016 -0.14 [-0.51; 0.23] 0.5%
Pesce2016 -0.13 [-0.55; 0.28] 0.5%
Steeg2016 -0.08 [-0.63; 0.47] 0.4%
Huang2015 -0.07 [-0.48; 0.34] 0.5%
Egela2013 -0.06 [-0.54; 0.42] 0.4%
Steeg2016 -0.06 [-0.60; 0.49] 0.4%
Pesce2016 -0.02 [-0.43; 0.39] 0.5%
Tarp2016 -0.01 [-0.19; 0.16] 0.6%
Egela2013 0.00 [-0.48; 0.48] 0.4%
Tarp2016 0.04 [-0.14; 0.21] 0.6%
Tarp2016 0.04 [-0.13; 0.22] 0.6%
Egela2013 0.08 [-0.40; 0.56] 0.4%
Huang2015 0.08 [-0.33; 0.50] 0.5%
Nelwa2016 0.11 [-0.49; 0.71] 0.3%
Egela2013 0.11 [-0.37; 0.59] 0.4%
Egela2013 0.12 [-0.36; 0.60] 0.4%
Chen2016 0.14 [-0.41; 0.70] 0.4%
Chen2016 0.17 [-0.38; 0.73] 0.4%
Nelwa2016 0.18 [-0.44; 0.80] 0.3%
deVoo2017 0.25 [-0.20; 0.70] 0.4%
Lakes2013 0.25 [-0.52; 1.02] 0.3%
Huang2015 0.28 [-0.13; 0.69] 0.5%
Egela2013 0.29 [-0.19; 0.77] 0.4%
Egela2013 0.29 [-0.19; 0.78] 0.4%
Nelwa2016 0.33 [-0.30; 0.95] 0.3%
Egela2013 0.36 [-0.13; 0.84] 0.4%
Nelwa2016 0.39 [-0.21; 1.00] 0.3%
Egela2013 0.41 [-0.07; 0.89] 0.4%
Lakes2013 1.39 [0.53; 2.24] 0.2%
deVoo2017 1.45 [0.95; 1.96] 0.4%
deVoo2017 1.92 [1.38; 2.47] 0.4%
Lakes2013 1.94 [1.01; 2.87] 0.2%
Lakes2013 2.26 [1.28; 3.24] 0.2%
Random effects model 0.12 [-0.04; 0.28] 18.9%

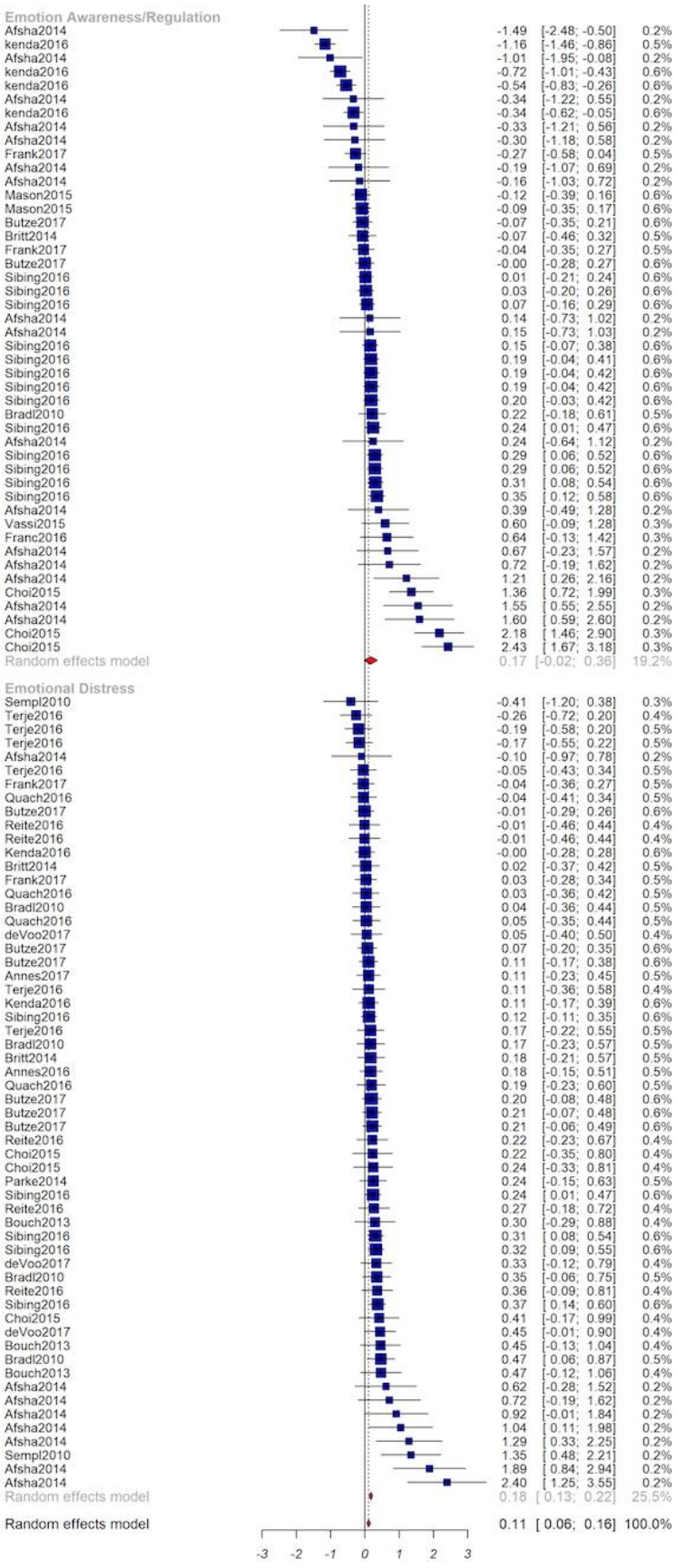

Emotion Awareness/Regulation
Afsha2014 -1.49 [-2.48; -0.50] 0.2%
kenda2016 -1.16 [-1.46; -0.86] 0.5%
Afsha2014 -1.01 [-1.95; -0.08] 0.2%
kenda2016 -0.72 [-1.01; -0.43] 0.6%
kenda2016 -0.54 [-0.83; -0.26] 0.6%
Afsha2014 -0.34 [-1.22; 0.55] 0.2%
kenda2016 -0.34 [-0.62; -0.05] 0.6%
Afsha2014 -0.33 [-1.21; 0.56] 0.2%
Afsha2014 -0.30 [-1.18; 0.58] 0.2%
Frank2017 -0.27 [-0.58; 0.04] 0.5%
Afsha2014 -0.19 [-1.07; 0.69] 0.2%
Afsha2014 -0.16 [-1.03; 0.72] 0.2%
Mason2015 -0.12 [-0.39; 0.16] 0.6%
Mason2015 -0.09 [-0.35; 0.17] 0.6%
Butze2017 -0.07 [-0.35; 0.21] 0.6%
Britt2014 -0.07 [-0.46; 0.32] 0.5%
Frank2017 -0.04 [-0.35; 0.27] 0.5%
Butze2017 -0.00 [-0.28; 0.27] 0.6%
Sibing2016 0.01 [-0.21; 0.24] 0.6%
Sibing2016 0.03 [-0.20; 0.26] 0.6%
Sibing2016 0.07 [-0.16; 0.29] 0.6%
Afsha2014 0.14 [-0.73; 1.02] 0.2%
Afsha2014 0.15 [-0.73; 1.03] 0.2%
Sibing2016 0.15 [-0.07; 0.38] 0.6%
Sibing2016 0.19 [-0.04; 0.41] 0.6%
Sibing2016 0.19 [-0.04; 0.42] 0.6%
Sibing2016 0.19 [-0.04; 0.42] 0.6%
Sibing2016 0.20 [-0.03; 0.42] 0.6%
Bradl2010 0.22 [-0.18; 0.61] 0.5%
Sibing2016 0.24 [0.01; 0.47] 0.6%
Afsha2014 0.24 [-0.64; 1.12] 0.2%
Sibing2016 0.29 [0.06; 0.52] 0.6%
Sibing2016 0.29 [0.06; 0.52] 0.6%
Sibing2016 0.31 [0.08; 0.54] 0.6%
Sibing2016 0.35 [0.12; 0.58] 0.6%
Afsha2014 0.39 [-0.49; 1.28] 0.2%
Vassi2015 0.60 [-0.09; 1.28] 0.3%
Franc2016 0.64 [-0.13; 1.42] 0.3%
Afsha2014 0.67 [-0.23; 1.57] 0.2%
Afsha2014 0.72 [-0.19; 1.62] 0.2%
Afsha2014 1.21 [0.26; 2.16] 0.2%
Choi2015 1.36 [0.72; 1.99] 0.3%
Afsha2014 1.55 [0.55; 2.55] 0.2%
Afsha2014 1.60 [0.59; 2.60] 0.2%
Choi2015 2.18 [1.46; 2.90] 0.3%
Choi2015 2.43 [1.67; 3.18] 0.3%
Random effects model 0.17 [-0.02; 0.36] 19.2%
Emotional Distress
Sempl2010 -0.41 [-1.20; 0.38] 0.3%
Terje2016 -0.26 [-0.72; 0.20] 0.4%
Terje2016 -0.19 [-0.58; 0.20] 0.5%
Terje2016 -0.17 [-0.55; 0.22] 0.5%
Afsha2014 -0.10 [-0.97; 0.78] 0.2%
Terje2016 -0.05 [-0.43; 0.34] 0.5%
Frank2017 -0.04 [-0.36; 0.27] 0.5%
Quach2016 -0.04 [-0.41; 0.34] 0.5%
Butze2017 -0.01 [-0.29; 0.26] 0.6%
Reite2016 -0.01 [-0.46; 0.44] 0.4%
Reite2016 -0.01 [-0.46; 0.44] 0.4%
Kenda2016 -0.00 [-0.28; 0.28] 0.6%
Britt2014 0.02 [-0.37; 0.42] 0.5%
Frank2017 0.03 [-0.28; 0.34] 0.5%
Quach2016 0.03 [-0.36; 0.42] 0.5%
Bradl2010 0.04 [-0.36; 0.44] 0.5%
Quach2016 0.05 [-0.35; 0.44] 0.5%
deVoo2017 0.05 [-0.40; 0.50] 0.4%
Butze2017 0.07 [-0.20; 0.35] 0.6%
Butze2017 0.11 [-0.17; 0.38] 0.6%
Annes2017 0.11 [-0.23; 0.45] 0.5%
Terje2016 0.11 [-0.36; 0.58] 0.4%
Kenda2016 0.11 [-0.17; 0.39] 0.6%
Sibing2016 0.12 [-0.11; 0.35] 0.6%
Terje2016 0.17 [-0.22; 0.55] 0.5%
Bradl2010 0.17 [-0.23; 0.57] 0.5%
Britt2014 0.18 [-0.21; 0.57] 0.5%
Annes2016 0.18 [-0.15; 0.51] 0.5%
Quach2016 0.19 [-0.23; 0.60] 0.5%
Butze2017 0.20 [-0.08; 0.48] 0.6%
Butze2017 0.21 [-0.07; 0.48] 0.6%
Butze2017 0.21 [-0.06; 0.49] 0.6%
Reite2016 0.22 [-0.23; 0.67] 0.4%
Choi2015 0.22 [-0.35; 0.80] 0.4%
Choi2015 0.24 [-0.33; 0.81] 0.4%
Parke2014 0.24 [-0.15; 0.63] 0.5%
Sibing2016 0.24 [0.01; 0.47] 0.6%
Reite2016 0.27 [-0.18; 0.72] 0.4%
Bouch2013 0.30 [-0.29; 0.88] 0.4%
Sibing2016 0.31 [0.08; 0.54] 0.6%
Sibing2016 0.32 [0.09; 0.55] 0.6%
deVoo2017 0.33 [-0.12; 0.79] 0.4%
Bradl2010 0.35 [-0.06; 0.75] 0.5%
Reite2016 0.36 [-0.09; 0.81] 0.4%
Sibing2016 0.37 [0.14; 0.60] 0.6%
Choi2015 0.41 [-0.17; 0.99] 0.4%
deVoo2017 0.45 [-0.01; 0.90] 0.4%
Bouch2013 0.45 [-0.13; 1.04] 0.4%
Bradl2010 0.47 [0.06; 0.87] 0.5%
Bouch2013 0.47 [-0.12; 1.06] 0.4%
Afsha2014 0.62 [-0.28; 1.52] 0.2%
Afsha2014 0.72 [-0.19; 1.62] 0.2%
Afsha2014 0.92 [-0.01; 1.84] 0.2%
Afsha2014 1.04 [0.11; 1.98] 0.2%
Afsha2014 1.29 [0.33; 2.25] 0.2%
Sempl2010 1.35 [0.48; 2.21] 0.2%
Afsha2014 1.89 [0.84; 2.94] 0.2%
Afsha2014 2.40 [1.25; 3.55] 0.2%
Random effects model 0.18 [0.13; 0.22] 25.5%
Random effects model 0.11 [0.06; 0.16] 100.0%
-3 -2 -1 0 1 2 3

Figure 5. Effect of Intervention Format by Outcome Type