Reasoned versus reactive prediction of behaviour: A meta-analysis of the prototype willingness model

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Abstract

The prototype willingness model (PWM) was designed to extend expectancy-value models of health behaviour by also including a heuristic, or social reactive pathway, to better explain health-risk behaviours in adolescents and young adults. The pathway includes *prototype*; i.e., images of a typical person who engages in a behaviour; and *willingness* to engage in behaviour. The current study describes a meta-analysis of predictive research using the PWM, and explores the role of the heuristic pathway and intentions in predicting behaviour. Eighty-one studies met inclusion criteria. Overall, the PWM was supported and explained 20.5% of the variance in behaviour. Willingness explained 4.9% of the variance in behaviour over and above intention, although intention tended to be more strongly related to behaviour than was willingness. The strength of the PWM relationships tended to vary according to the behaviour being tested, with alcohol consumption being the behaviour best explained. Age was also an important moderator, and, as expected, PWM behaviour was best accounted for within adolescent samples. Results were heterogeneous even after moderators were taken into consideration. This meta-analysis provides support for the PWM and may be used to inform future interventions that can be tailored for at-risk populations.

Key Words: prototype willingness model; meta-analysis; health behaviour; health models

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Rationale

Many illnesses and diseases are at least partly attributable to the performance or non-performance of health-risk or health-enhancing behaviours (World Health Organization: WHO, 2009). Investigating reasons for engaging or not engaging in these behaviours is a major area of interest for health psychologists, and many theoretical models have been proposed to explain such behaviours. Models often concentrate on social-cognitive aspects of behaviour, as these aspects tend to be malleable (Conner & Norman, 1996), and indeed such expectancy-value models dominate the literature (Gerrard, Gibbons, Houlihan, Stock, & Pomery, 2008). These models assume that health-related behaviour is planned, by a process of weighing up the costs and benefits of behavioural outcomes.

Expectancy-value models such as the Theory of Planned Behaviour (TPB), and its precursor the Theory of Reasoned Action (TRA) place intention as the most proximal determinant of volitional behaviour (Ajzen, 1991). The TPB and TRA have been used to predict a range of behaviours; however, these models tend to predict intention better than behaviour (Armitage & Conner, 2001), and the relatively weak relationship between intention and behaviour indicates that individuals do not always act as they intend (Sheeran, 2002).

A number of dual-process models have also received attention in the literature; for example, Fuzzy Trace Theory (Rivers, Reyna, & Mills, 2008), Cognitive Experiential Self Theory (Epstein, 1985), and within health psychology, the Prototype-Willingness Model (PWM; Gerrard et al., 2008). These models accept the importance of planned determinants of behaviour such as intentions, but also include unplanned, intuitive or heuristic elements to account for variations in behaviour that extend beyond the focus on rational factors encompassed by most social-cognitive models.

The PWM was developed by Gibbons, Gerrard and colleagues (Gibbons, Gerrard, Blanton, & Russell, 1998; Gibbons, Gerrard, & McCoy, 1995) to explain risk elements of behavioural decisions in adolescents. The PWM includes both a reasoned pathway, determined by intentions, and a social reactive pathway, determined by willingness to engage in the behaviour (Gibbons, Gerrard, & Lane, 2003; see Supplementary File 1). The reasoned pathway of the PWM is very similar to the TRA: attitudes and subjective norms predict intention to engage in that behaviour, and intention subsequently predicts actual behaviour. The social reactive pathway includes prototypes and willingness. Prototypes are images of the type of person who engages in the target behaviour, and are shaped by perceptions of favourability and similarity of the prototype to the individual. Gibbons, Gerrard, Lando, and McGovern (1991) found that individuals who were trying to quit smoking would consider the image of a typical smoker more negatively, and would also consider themselves less similar to this image than smokers who were not trying to quit. According to the model, these prototype images then influence how willing the individual is to engage in that particular behaviour when the opportunity arises. Gibbons et al. (1998) argued that willingness differs from intentions, as individuals may not intend to engage in a risky behaviour, but may still do so if the opportunity is available. Willingness therefore represents a reactive determinant of behaviour, unlike intentions, which tend to be planned.

The PWM has been used to predict a range of health-risk behaviours in adolescents, such as smoking and alcohol use (Andrews, Hampson, & Barckley, 2008), and unsafe sex (Gibbons et al., 1998), as well as health-promoting behaviours such as exercising and breakfast eating (Rivis, Sheeran, & Armitage, 2006). Two reviews have been conducted by Gibbons, Gerrard and their colleagues. Firstly, Gerrard et al. (2008) reviewed dual-process theories within psychology (including the PWM) and concluded that these models could help to better explain the decision-making of adolescents compared to single-process motivational models. This review was, however, primarily an explanation of dual-process models, and did not provide a systematic review or meta-analytic analysis of the literature.

Gibbons, Houlihan, and Gerrard (2009) subsequently provided an overview of both expectancy-value theories of health behaviour and the PWM. It was found that including both dual-process and expectancy-value elements in health behaviour models was a more effective way of predicting health behaviour than considering these elements alone. Again, however, the review of PWM studies was not systematic, included only studies published up to 2008, and focussed more on the predictive utility of willingness and intention, rather than prototypes. A systematic examination of PWM research is therefore needed in order to clarify the relative contributions of the reasoned and heuristic pathways to determining health behaviour engagement.

Objectives

The current meta-analysis has two main aims:

1. To meta-analytically evaluate the associations between key PWM constructs. It was expected that prototypes would be positively associated with willingness to engage in behaviour, and that willingness would be associated with actual behavioural engagement. Given that no relationship between prototypes and intention was specified in the PWM, it

was also expected that prototypes would not be directly associated with intention or behaviour.

2. To explore whether the strength of PWM construct relationships is moderated by context factors (type of behaviour), sample factors (age and gender of the sample) and study factors (length of follow-up, presence of an intervention, or reporting data that overlaps with the data of other studies).

While the PWM overlaps somewhat with the TRA/TPB, the constructs of attitudes and subjective norm were not investigated in the current meta-analysis for a number of reasons. Firstly, there are a number of TPB meta-analyses that have investigated the relationship between these constructs and their ability to predict intentions (McEachan, Conner, Taylor, & Lawton, 2011), and therefore this was deemed to be redundant. Secondly, many of the studies reviewed did not report on these variables, and instead focused on the heuristic pathway. Finally, the main question of interest was to determine what the PWM model *added* to reasoned models such as the TRA/TPB, and therefore this review focused on the heuristic pathway, and its role in the prediction of behaviour.

Method

Information Sources and Search Strategy

Studies were identified by searching electronic databases. The search was applied to Medline, PubMed, PsycINFO, Web of Science, Cinahl, Scopus, and Science Direct databases. The search period was from 1990 up to and including January 2014. The search terms used were Prototype* AND Willing*. Key authors in the field were contacted for any recent publications that may have been missed. A total of 4813 articles were identified.

Inclusion and Exclusion Criteria

The following inclusion and exclusion criteria were used:

1. Studies needed to explicitly test the PWM (including making reference to the PWM and/or Gerrard and Gibbons);
2. While papers did not need to provide a full test of the model (i.e., measure all components), in order to compute the relevant correlations, it was necessary that at least two of the following constructs were measured: prototype, willingness, intention, and behaviour. Whilst prototype measures could include prototype similarity, prototype favourability and/or overall prototype (usually a combination of prototype similarity and prototype favourability), where more than one prototype measure was included, at least one other non-prototype construct needed to be included. Studies were required to report bivariate correlations between these constructs; i.e., at least one of the prototype-willingness, willingness-behaviour, willingness-intention, prototype-intention or prototype-behaviour correlations;
3. Studies needed to employ a cross-sectional or prospective design; where interventions were reported, the study needed to include a cross-sectional measure of key variables so that relationships between these variables were not influenced by the intervention;
4. Studies needed to focus on health behaviour (health-risk and/or health-promoting), even when a measure of actual behaviour was not present;
5. Studies needed to be reported in the English language;
6. Studies needed to be published between 1990 and January 2014, inclusive.

Studies were included regardless of the nature of behaviour measurement (i.e., self-report or objective behaviour), type of sample (i.e., all ages and clinical and non-clinical samples were included) and publication status (i.e., unpublished dissertation theses were included).

Studies that reported on identical or overlapping datasets were included; for example, when data from a sub-sample of participants was used, when data was used from different time-points in a longitudinal study, or where the sample was identical but either the studies had a different focus or used different measures. The rationale for including studies that may report identical datasets was that it was often difficult to identify whether the sample was identical or overlapping, and thus these decisions would be arbitrarily based on clarity of reporting rather than reflecting the actual data. The exception to this was when the results of a thesis were clearly reported in a publication, utilising identical data. In this case, the thesis was excluded and the article was included. Dissertation theses were otherwise included to reduce the chance of publication bias (i.e., that published studies may be more likely to include significant results than unpublished studies), as has been recommended in the literature (McAuley, Pham, Tugwell, & Moher, 2000). Conference presentations and secondary sources such as reviews were also excluded.

Information Extracted

Pearson's correlations for prototype-willingness (including prototype favourability-willingness and prototype similarity-willingness), willingness-behaviour, prototype-behaviour, intention-behaviour, intention-willingness, and prototype-intention relationships, as well as number of participants reported for these relationships were extracted from the relevant studies. For each study that reported some form of prototype, these were used to compute an overall prototype construct, either by combining prototype similarity and favourability, or directly from the results. In addition, where possible, separate prototype favourability and prototype similarity indexes were extracted for further analysis. Although health-protective behaviour studies may not include a measure of willingness, and therefore may not include relationships between all the constructs as specified in the PWM, such studies frequently included prototype-behaviour or prototype-intention relationships, and thus were included based on this information. These relationships were also included to determine whether they added to the relationship theoretically specified in the PWM.

Where studies reported results for more than one behaviour, these were analysed separately. Further, where more than one measure of a key variable was used (e.g., prototype similarity, prototype favourability), these were also pooled to create a weighted average correlation for that variable. In addition where behaviour was measured at more than one time point, correlations at these time points were pooled to create a weighted average behaviour correlation. For studies reporting interventions, only cross-sectional data was used.

The following moderators were extracted:

Behaviour type: Based on consensus between the authors, behaviours were grouped into the following categories: sexual behaviour, sun protection, vaccination, alcohol use, smoking cigarettes, substance use, performance-enhancing substance use, risky driving, and unhealthy eating.

The sexual behaviour category included contraception use, unprotected sex, and casual sex behaviours, as these were frequently confounded in the measurement of PWM constructs and behaviour. For example, frequency of casual sex and frequency of contraception use (reverse coded) were often combined into a single risky sex measure. In addition, there was variation in measures of target behaviours across constructs. For example, willingness was often framed in terms of risk, such as willingness to engage in unsafe sex; whilst intention was often framed in terms of health-promoting behaviour, such as intention to use contraception. Likewise, behaviour and prototype measures were framed both in terms of health-risk behaviour and health-promoting behaviour. A combined sexual behaviour moderator was therefore used. Where target behaviours were not consistent, absolute values of the correlations were used to ensure that the relationship was coded in the correct direction. For example, negative correlations between willingness to engage in unsafe sex and intention to use contraception were re-coded as positive.

Studies were assigned to the alcohol use (encompassing general alcohol use, binge-drinking, and excessive alcohol use) and cigarette smoking categories when this was the only behaviour under investigation. Because many studies measured substance use without providing data for each included substance separately (e.g., alcohol, cigarettes, and marijuana combined), a substance use category was also included and reflected studies that measured a combination of substances, as well as studies that measured illicit drugs only. Performance enhancing substances included athletic enhancing substances and non-prescription stimulants for enhancing cognitive capacity. Risky driving included studies that measured driving under the influence of alcohol and other drugs, as well as speeding. Unhealthy eating included unhealthy snacking and composite unhealthy diet measures.

Age of sample: Average age was used as a continuous moderator. Although this is not an accurate indicator of sample age range, it can provide some indication of whether variation in sample age was influential in PWM relationships. In addition, samples were classified according to whether they were pre-adolescent (under 13 years), adolescent (13-18 years) or adult (18+ years). Where the sample contained both pre-adolescent and adolescent categories, the sample was classified as adolescent, as many of these samples used longitudinal follow-ups and sample age was taken at the first assessment. Whilst both age measures have limitations, inclusion of both may help to overcome some of the limitations of each whilst still obtaining meaningful results.

Gender: Proportions of females in the sample was used to determine whether gender was influential in PWM relationships. In addition, where studies reported separate correlations for males and females, these were also included in a categorical variable that classified samples as female, male, or of mixed gender.

Length of follow-up: Whether the study was cross-sectional or included prospective measures was used as a dichotomous moderator variable. A continuous variable was also created based on the length of time between data collection for measures of willingness and measures of behaviour. If studies reported correlations for more than one follow-up time, these correlations were pooled, and the length of follow-up was also averaged. As only single time point data was used from intervention studies even if they had longer follow-ups, these studies were classified as cross-sectional.

Presence of an intervention: Although only cross-sectional data was used from intervention studies, whether or not a study reported an intervention was used as a moderator, as there may have been differences in how intervention studies are conducted that led to differences in the PWM relationships.

Overlapping datasets: As many of the studies reported samples and data that overlapped with at least one other study included in the meta-analysis, these studies were coded according to whether or not they contained overlapping data.

Risk of Bias

In order to reduce the risk of bias, the following measures were taken. An effort was made to include unpublished studies, as including only published studies risks inflation of effects due to significant results potentially being more likely to be published (Fanelli, 2010). Furthermore, when required statistics were not reported in published papers, the authors were contacted in order to avoid potential inflation[1]. In addition, by focusing on Pearson's product correlations rather than other analytic forms (such as regression), it is likely that these results were not the primary focus of the paper, and therefore may have been included regardless of whether they were significant or not. Fail-safe N was used to assess the likelihood that, had studies had been missed, that a null result would have been obtained, to further assess the risk of bias (Rosenthal, 1979).

Summary Measures and Synthesis of Results

Meta-analytical correlation statistics were obtained using the *Metafor* meta-analysis package for R (Viechtbauer, 2010), using a random effects model. Within these calculations, Fisher's Z transformed correlations were used to minimise bias (Silver & Dunlap, 1987). Forest plots were used to illustrate the relative strength of the effect for each study included in the analyses, and funnel plots were generated in order to provide further information about the likelihood of publication bias. Categorical and continuous moderator analyses were also conducted using the *Metafor* package for R. Where a significant categorical moderator was identified for three or more model relationships, the studies were split according to the moderator and correlations were meta-analysed separately for these groups.

Meta-analytic path analysis conducted in AMOS 19.0 was performed using the pooled correlation matrix in order to provide an overall estimate of the variance in behaviour accounted for by PWM variables. Three models were created; 1) only the reasoned pathway (i.e., intention-behaviour), 2) including the social reactive pathway (i.e., addition of prototype-willingness, willingness-intention, and willingness-behaviour), and 3) including additional relationships (i.e., prototype-intention and prototype-behaviour). This stepped modelling enabled investigation of the relative contribution of the socially reactive pathway, as well as testing relationships that were reported in the literature but are not explicitly part of the PWM. See Figure 1 for a pictorial representation of these models. For the purposes of the analyses, the harmonic mean N was used to specify sample size. The percentage variance explained was reported (R^2) and the relative contribution of each variable to the final equation was reported by way of beta weights (β). The 95% confidence interval for each beta weight was also reported. Significance levels have not been reported, as they are not meaningful due to the high numbers of participants included in the analyses.

FIGURE 1 NEAR HERE

Results

Study Selection

Following removal of duplicate articles, 4244 manuscripts were identified. A title search and abstract search were used to eliminate studies that were clearly not related to health behaviour and health models. A full text search was then conducted on 223 manuscripts, removing studies that did not meet the selection criteria. Additional reasons for excluding studies at the full text search level included investigating non-health behaviours such as recycling (Ohtomo & Hirose, 2007), organ donation (Hyde & White, 2009; Hyde & White, 2010), or help-seeking decisions (Hammer & Vogel, 2013); investigating the outcome of behaviour (e.g., BMI) rather than the behaviour itself (Hampson, Andrews, Peterson, & Duncan, 2007); or dissertation theses where the findings had since been published in an article (Lane, 2005; Litt, 2011). Studies that measured PWM constructs were excluded if the necessary information was not reported in the paper and the primary author/s no longer had access to the data (Blanton, Gibbons, Gerrard, Conger, & Smith, 1997; Blanton et al., 2001), were not able to provide the information in the required timeframe (Spijkerman, van den Eijnden, Vitale, & Engels, 2004), were not able to be contacted (Pomery, Gibbons, Reis-Bergan, & Gerrard, 2009; Wills et al., 2007), or were deceased (Ge et al., 2006). In addition, intervention studies that did not report cross-sectional PWM data were also excluded (e.g. Brody et al., 2004).

Eighty-one articles were retained (see Supplementary File 2 for a flow diagram of study selection, and Supplementary File 3 for a full list of references included). A selection of approximately ten percent of titles and ten percent of abstracts was screened by a second author for the purposes of ensuring reliability. Inter-rater reliability using Cohen's (1960) kappa was good for titles (k= 0.59) and excellent for abstracts (k=0.86). Furthermore, 93% and 94% of disagreements on titles and abstracts respectively were due to conservative inclusions on the part of the primary researcher. Abstract discrepancies were resolved with discussion between authors. Full text articles retrieved were included based on consensus between authors.

Study Characteristics

A total of 81 articles reporting 90 studies were included, although 36 of these studies reported data that overlapped with at least one other study. Sample sizes ranged from 50 to 6522, with the average age at baseline ranging from 9 to 46.3 years. Twenty-one interventions were included. Of the rest, the majority of studies were prospective (k=46), with follow-up ranging from 5 days to 11 years, and the remainder of studies were cross-sectional (k=24). Six dissertation theses were included. For further details of the study characteristics, see the Supplementary File 4. Behaviours included alcohol (k=29), smoking (k=15), substance use (k=14), performance enhancing substance use (k=3), sexual behaviour (k=22), sun protection (k=4), exercise (k=2), risky driving (k=5), flu vaccination (k=1), unhealthy eating (k=3), and multiple health behaviours (k=1), with some studies reporting separate data for more than one behaviour.

Overall Model Results

The mean correlations as a general test of the model are presented in Table 1, which includes the meta-analysed Fisher corrected (Z) correlations. In accordance with the PWM, prototype was a stronger predictor of willingness (r=0.34) than intention (r=0.25). When prototype was separated into prototype similarity and prototype favourability, prototype favourability was a stronger predictor of willingness (r=0.31) than intention (r=0.23); however, prototype similarity was the stronger predictor of intention (r=0.47) than willingness (r=0.41).

INSERT TABLE 1 HERE

In addition, a series of path analytic models were computed. In the first model, paths were drawn from intention to behaviour (see Figure 1, Panel 1). The hypothesised paths from overall prototype to willingness, from willingness to intention, and from willingness to behaviour were added in the second model (see Figure 1, Panel 2). In the third model, pathways from prototype to intention and from prototype to behaviour were added.

Results from these path analyses for the overall model are reported in Table 2. Intention accounted for 15.6% of variance in behaviour; the addition of willingness in Model 2 accounted for a further 4.9% of the variance in behaviour; and the addition of prototype in Model 3 accounted for a further 1.2% of the variance in behaviour (Final R^2=.217). In the final model, intention and willingness were the main predictors of behaviour (β =.263 and β =.235 respectively). Prototype was not a strong direct predictor of behaviour (β =.096), after accounting for intention and willingness. Willingness was the main predictor of intention, and accounted for 21.6% of the variance (β =.465). Prototype was not a strong predictor of intention, accounting for 0.5% of the variance (β =.100), but accounted for 10.5% of the variance in willingness (β =.325).

INSERT TABLE 2 HERE

It is important to note that there was significant heterogeneity across all correlations (I^2= 83.77-97.60%; H^2= 6.16-41.68). Therefore, exploring potential study and methodological covariates was warranted, and a series of moderator analyses were conducted for this purpose.

Behaviour Type as a Moderator

Type of behaviour was a significant moderator for the prototype-intention ($QM_{(df=7)}$=18.94, p=.01), prototype similarity-intention ($QM_{(df=5)}$=65.43, p<.001), prototype favourability-intention ($QM_{(df=5)}$=16.59, p=.01), prototype similarity-willingness ($QM_{(df=5)}$=16.22, p=.01), prototype-behaviour ($QM_{(df=8)}$=19.44, p=.01), and willingness-intention ($QM_{(df=7)}$=30.40, p<.001) relationships. Other relationships were not significantly moderated by behaviour ($QM_{(df=4-9)}$=0.69-11.76, p=.08-.95). Separate analyses were conducted by behaviour type to further explore these differences, as displayed in Table 3. Significant differences between groups were determined using confidence intervals. Only behaviour types that were measured with more than five studies were included in these analyses; i.e., alcohol use, cigarette use, substance use and sexual behaviours. Prototype similarity and prototype favourability measures were not used in these analyses due to a smaller number of studies reporting these constructs separately.

INSERT TABLE 3 HERE

A series of path analytic models were also conducted separately for each behaviour type, as with the overall data. These results are displayed in Table 4. For alcohol use, intention accounted for 41.3% of variance in behaviour. The addition of willingness accounted for a further 1.4% of the variance in behaviour, and the addition of prototype accounted for a further 1.1% of the variance in behaviour (Final R^2=.436). In the final model, intention was the main predictor of behaviour (β =.537). Willingness (β =.069) and prototype (β =.145) were not strong direct predictors of behaviour, after accounting for intention. Willingness alone was a strong predictor of intention, accounting for 56.4% of the variance, and the addition of prototype did not improve the variance explained (β =.054). Prototype accounted for 19.3% of the variance in willingness (β =.325) in the final model.

For cigarette use, intention accounted for 24.1% of variance in behaviour. The addition of willingness accounted for a further 3.1% of the variance in behaviour, and the addition of prototype accounted for a further 0.1% of the variance in behaviour (Final R^2=.273). In the final model, intention and willingness were the main predictors of behaviour (β =.323, β =.227 respectively). Prototype was not a strong predictor of behaviour (β =.050) after accounting for intention and willingness. Willingness was initially a strong predictor of intention, explaining 48.3% of the variance (β =.695), which was not improved by the addition of prototype to predict intention (β =.002). Prototype accounted for 6.9% of the variance in willingness (β =.262) in the final model.

For substance use, intention accounted for 8.3% of variance in behaviour. The addition of willingness accounted for a further 20.2% of the variance in behaviour; and the addition of prototype accounted for a further 0.5% of the variance in behaviour (Final R^2=.207). In the final model, intention and willingness were the main predictors of behaviour (β =.225, β =.360 respectively). Prototype was not a strong predictor of behaviour (β =-.008) after accounting for intention and willingness. Willingness initially explained 3.9% of the variance in intention, and the addition of prototype accounted for a further 6.9% of the variance. In the final model, prototype was the main predictor of intention (β =.289), and willingness was not a strong predictor of intention (β =.087). Prototype accounted for 11.2% of the variance in willingness in the final model (β =.335).

For sexual behaviour, intention accounted for 16.9% of variance in behaviour. The addition of willingness accounted for a further 5.2% of the variance in behaviour, and the addition of prototype accounted for a further 0.5% of the variance in behaviour (Final R^2=.226). In the final model, intention and willingness were the main predictors of behaviour (β =.343, β =.226 respectively). Prototype was not a strong predictor of behaviour (β =.058) after accounting for intention and willingness. Willingness initially explained 7.1% of the variance in intention, and the addition of prototype accounted for a further 0.3% of the variance. In the final model, willingness was the main predictor of intention (β =.249), and prototype was not a strong predictor (β =.061). Prototype accounted for 7.9% of the variance in willingness in the final model (β =.281).

INSERT TABLE 4 HERE

Age of Sample as a Moderator

Average age as a continuous variable significantly moderated the prototype-behaviour ($QM_{(df=1)}$=6.15, p=.01) and intention-behaviour relationships, ($QM_{(df=1)}$=6.30, p=.01) such that the relationships were stronger amongst older samples. Average age did not moderate other relationships ($QM_{(df=1)}$=0.004-3.24, p=.07-.95). In addition, whether the sample was pre-adolescent, adolescent, or adult significantly moderated the prototype similarity-behaviour ($QM_{(df=2)}$=9.27, p=.009), prototype favourability-willingness ($QM_{(df=2)}$=8.67, p=.01), prototype-willingness ($QM_{(df=2)}$=11.97, p=.003), and willingness-behaviour ($QM_{(df=2)}$=8.75, p=.01) relationships. Age category was not a significant moderator of the other relationships ($QM_{(df=2)}$= 0.28-4.97, p=.08-.87). Given the number of relationships for which age category was a moderator, sub-group analyses were conducted for each of the three age categories, and significant differences between groups were determined using confidence intervals. These results are displayed in Table 5.

INSERT TABLE 5 HERE

A series of path analytic models were also conducted to explore the PWM separately for each age group, as with the overall sample. These results are displayed in Table 6. For pre-adolescents, intention accounted for 6.8% of variance in behaviour. The addition of willingness accounted for a further 0.2% of the variance in behaviour, and the addition of prototype accounted for a further 0.9% of the variance in behaviour (Final R^2=.079). In the final model, intention was the main predictor of behaviour (β =.203 respectively). Willingness (β =.092) and Prototype (β =.062) were not strong predictors of behaviour after accounting for intention. Willingness initially explained 24.9% of the variance in intention, and the addition of prototype accounted for a further 0.6% of the variance. In the final model, willingness was the main predictor of intention (β =.472), and prototype was not a strong predictor (β =.062). Prototype accounted for 3.5% of the variance in willingness in the final model (β =.188).

For adolescents, intention accounted for 25.2% of variance in behaviour. The addition of willingness accounted for a further 7.4% of the variance in behaviour, and the addition of prototype accounted for a further 0.7% of the variance in behaviour (Final R^2=.333). In the final model, intention and willingness were the main predictors of behaviour (β =.337, β =.287 respectively). Prototype was not a strong predictor of behaviour (β =.082) after accounting for intention and willingness. Willingness initially explained 50.3% of the variance in intention, and the addition of prototype reduced the variance explained. In the final model, willingness was the main predictor of intention (β =.478), and prototype was not a strong predictor (β =.058). Prototype accounted for 15.9% of the variance in willingness in the final model (β =.399).

For adults, intention accounted for 25.4% of variance in behaviour. The addition of willingness accounted for a further 3.1% of the variance in behaviour, and the addition of prototype accounted for a further 1.6% of the variance in behaviour (Final R^2=.301). In the final model, intention and willingness were the main predictors of behaviour (β =.356, β =.212 respectively). Prototype was not a strong predictor of behaviour (β =.099) after accounting for intention and willingness. Willingness initially explained 56.5% of the variance in intention, and the addition of prototype accounted for a further 11.6% of the variance. In the final model, willingness was the main predictor of intention (β =.519), and prototype was not as strong a strong predictor (β =.116). Prototype accounted for 11.8% of the variance in willingness in the final model (β =.343).

INSERT TABLE 6 HERE

Other Sample and Methodological Moderators

Gender of sample

Proportion of females in each study was not a significant moderator of any of the relationships tested ($QM_{(df=1)}$=0.02-1.15, p=.28-.89). Gender category (male, female, or combined) was also not a significant moderator for any of the relationships tested ($QM_{(df=2)}$=0.04-5.40, p=.07-.98). Separate analyses by gender were therefore not conducted.

Length of follow-up

Presence or absence of follow-up and length of follow-up moderators were only explored for behaviour relationships, as studies that used follow-ups were most likely to measure prototype, willingness, and intention together, and then behaviour at a later time-point (although this did not apply to cross-sectional studies which measured all constructs simultaneously). Whether or not the study was cross-sectional was a significant moderator of the intention-behaviour relationship ($QM_{(df=1)}$=4.49, *p*=.03), such that this relationship was stronger for prospective studies (*r*=.54, se=.05, 95% CI: .43-.64, *k*=26) compared to cross-sectional studies (*r*=.32, se=.07, 95% CI: .18-.46, *k*=9). There was no significant difference in the willingness-behaviour or prototype-behaviour relationships according to whether the study was prospective or cross-sectional ($QM_{(df=1)}$=0.03-2.03, *p*=.15-.87). Average length of follow-up in days was not a significant moderator for any of the PWM-behaviour relationships ($QM_{(df=1)}$=0.004 -1.65, *p*=.19-.95).

Presence of an intervention

Presence of an intervention was a significant moderator for the prototype similarity-willingness relationship ($QM_{(df=1)}$=4.21, *p*=.04). The relationship was stronger in studies conducted without an intervention (*r*=.49, se=.07, 95%CI: .35-.63, *k*=8) than those where an intervention was present (*r*=.27, se=.06, 95%CI: .16-.38, *k*=6). The presence of an intervention was not a significant moderator of any of the other PWM relationships ($QM_{(df=1)}$=0.07-3.27, *p*=.07-.78).

Overlapping data and samples

Whether or not the study reported on data from a larger project that overlapped with other studies included in the meta-analysis was not a significant moderator of any of the tested relationships ($QM_{(df=1)}$=0.01-2.17, *p*=0.14-.94). Forest plots and funnel plots of 1) all studies and 2) without overlapping studies were created in order to further explore the potential influence of including overlapping data (see Supplementary File 5 and 6). These plots were consistent with the moderator analyses and there were no major differences with or without overlapping studies.

Discussion

The aim of this meta-analysis was to explore the relationships between the heuristic PWM variables of prototypes and willingness, in addition to intention and behaviour, and to determine whether contextual, sample, and study factors influenced the strength of these relationships. The heuristic pathway was supported, as willingness generally added to the prediction of behaviour, and prototype was generally a strong predictor of willingness. As shown in Tables 2, 4, and 6 the addition of willingness to the prediction of behaviour significantly attenuated the intention-behaviour relationship within the overall dataset, within studies of alcohol and cigarette use, and within studies that included adolescent and adult samples. In addition, pathways not specified by the PWM (i.e., from overall prototype to intention and behaviour) received minimal support. Thirdly, there was evidence of differences in the model relationships depending on behaviour type and age. In particular, whilst willingness did not meaningfully add to the prediction of alcohol use above intentions for alcohol use, willingness accounted for a large proportion of variance for cigarette use. In addition, the model explained greater variance in behaviour for adolescents and adults than for pre-adolescents. These results reinforce the utility of the PWM in predicting health behaviour. Intention was generally a stronger predictor of behaviour than was willingness, and prototype *similarity* was strongly associated with willingness, intention and behaviour; which were both interesting findings that warrant further exploration.

Overall, the analyses indicated that the PWM (willingness and intention) explained 20.5% of the variance in behaviour. Intention alone explained 15.6% of the variance in behaviour, which is consistent with previous research; for example, intention was found to explain between 13.8% and 15.3% (R^2) of the variance in risk behaviours within a TPB meta-analysis (McEachan et al., 2011). Willingness improved the prediction of behaviour over and above intention, explaining an additional 4.9% of variance, supporting the argument that willingness is a meaningful construct with which to further explain health behaviour beyond traditional TRA/TPB constructs (Head & Noar, 2013).

The relationship between prototype and willingness was stronger than the prototype-intention relationship, which is also consistent with the PWM in which the latter pathway is not specified. Prototype *similarity*, however, had the strongest relationship with both willingness and intention, and contrary to predictions, it was more strongly associated with intention than willingness. Previous studies investigating organ donation willingness have also found prototype similarity to be a stronger predictor of willingness than prototype favourability (Hyde & White, 2009), adding further support for the importance of this construct.

The results of this meta-analysis are generally consistent with previous reviews, which have found that the addition of a social reactive or heuristic pathway can further improve the explanation of behaviour above reasoned models such as the TPB (Gerrard et al., 2008; Gibbons et al., 2009). Given the strength of the pathways from prototype similarity to intention and behaviour, this construct may play an important role in predicting and explaining intention and behaviour, perhaps above the role of prototype favourability. This finding may reflect social and peer influences on behaviour that have been found in the literature (Jaccard, Blanton, & Dodge, 2005; Maxwell, 2002). Although there were insufficient studies to investigate the prototype similarity associations for separate behaviours or age categories, this would be interesting to explore in the future.

Behaviour as a Moderator

Significant heterogeneity in results was found for all model relationships, and therefore several moderator variables were explored. Using behaviour as a moderator helped to reduce the unaccounted for variance in most variable relationships, although a significant amount of residual heterogeneity remained. When explored separately, the largest proportion of variance was accounted for in alcohol consumption. Interestingly, for substance use, willingness was a stronger predictor of behaviour than intention, whereas for alcohol use, cigarette use, and sexual behaviours, intention was stronger than willingness. These findings suggest that substance use may be a more socially reactive behaviour than other behaviours, although the overlap between substance use (encompassing all substances including alcohol and cigarettes when measured as part of a composite behaviour) and the separate categories of alcohol and cigarette use (when measured as the sole behaviour) limits the conclusions that can be drawn from this finding, and therefore the results must be interpreted with caution.

Age as a Moderator

Another important moderator of the PWM relationships was age – that is, whether the sample was pre-adolescent, adolescent, or adult. The PWM was originally designed as a model to explain adolescent risk-taking behaviour, and consistent with predictions, willingness and intention together accounted for the greatest proportion of variance in behaviour for adolescents (R^2= .33), although the proportion of variance explained for adults was close (R^2=.29). These findings suggest that the model may also be of value when applied to adult samples.

Gerrard et al. (2008) have proposed that whilst risk-taking behaviour begins as being governed by social reactions, with time and experience, the intention-behaviour pathway strengthens and takes precedence over the willingness-behaviour relationship. Whilst this tendency has been supported in the literature (Pomery et al., 2009), this was only partially supported in the current meta-analysis. Although the PWM as a whole better accounted for behaviour in adolescents than adults, willingness alone was a stronger predictor for adults, suggesting that social reactions continue to be important in health behaviour decisions as individuals age. It may therefore be useful to continue applying the PWM within adult populations, as interventions that incorporate willingness in addition to intentions may be as successful for this age group as for adolescents.

In contrast, for pre-adolescents, willingness added less to the model and was much weaker than intention in predicting behaviour, compared to adolescents and adults. Only 7.6% of the variance in behaviour was accounted for in pre-adolescents, suggesting that the PWM may be of limited value within this age group. However, it is worth noting that it may be generally harder to account for differences in behaviour in pre-adolescents, rather than being specific limitation of the PWM. Increases in risk-taking behaviour have been observed to correspond to the onset of puberty, which has been associated with the development of certain cortical changes that occur during this time (Steinberg, 2008). Prior to this time, it may be that individuals are less willing to engage in risk behaviours. In addition, as it has been found that intentions develop with behavioural experience (Gerrard et al., 2008; Pomery et al., 2009), it is likely that few pre-adolescents would have developed intentions to smoke, take drugs, consume alcohol, or engage in risky sex that would correspond to actual behavioural engagement. Thus, the predictive ability of intentions may be small within this age group, at least for some behaviours. Other factors may also be important within this age group; for example, parental factors such as parental health cognitions and behaviour, parenting style, and socio-economic status have been found to be related to pre-adolescent behaviour (Cleveland, Gibbons, Gerrard, Pomery, & Brody, 2005; Gerrard, Gibbons, Stock, Lune, & Cleveland, 2005).

Other Moderators Investigated

Other study and methodological variables were included in an attempt to explain the variability across studies and thus reduce heterogeneity. Gender of the sample did not significantly moderate any of the PWM relationships, although as most studies tested a mixed gender sample further behaviour-specific research that reports gender results separately would be useful.

Other methodological variables that were investigated included whether or not the study reported an intervention, whether the study was cross-sectional or prospective, the average length of the follow-up, and whether or not the sample was independent from the samples reported in other studies. The presence of an intervention influenced the prototype similarity-willingness relationship, such that the relationship was stronger for studies not reporting an intervention. In addition, of the relationships with behaviour, presence of a follow-up influenced the intention-behaviour relationship, such that prospective studies found stronger relationships. This is surprising because cross-sectional measures of constructs can be biased (Maxwell & Cole, 2007; Noar & Head, 2014), and meta-analytic research has generally found stronger intention-behaviour relationships over shorter periods of time (McEachan et al., 2011). Indeed, cross-sectional research may also overestimate the association of these constructs with behaviour, as other factors that may influence the strength of the association over time (such as the translation of intentions into behaviour over longer periods), do not come into play. In addition, measuring constructs only at a single time point does not show whether *changes* in constructs are related to behaviour change, which is a criticism of much of the research in this field, and extends beyond the PWM (Sniehotta, Presseau, & Araújo-Soares, 2014). Whilst prospective studies also have limitations and, unlike experimental research, cannot definitively conclude whether changes in the constructs are responsible for behaviour change, they can at least provide some indication on whether the relationships between these constructs are reliably tracking behaviour over time. The current findings suggest that PWM constructs continue to predict behaviour over longer time periods. Whether or not the study reported on overlapping data did not, however, influence any of the PWM relationships, and, in general, it appears that these methodological factors have a limited influence on the PWM relationships.

Strengths and Weaknesses

It is worth noting that the full PWM was not tested. Attitudes and subjective norms, which are proposed to influence both intention and willingness, were not investigated, as these constructs have been more thoroughly investigated within the TRA/TPB literature, and many PWM studies do not measure these constructs. The extent to which the model accounts for intention and willingness was therefore not able to be determined. Nonetheless, the relative contribution of the reasoned and heuristic pathways to health behaviour engagement was able to be determined, and other pathways within the model were explored.

Despite investigating several moderators, significant heterogeneity remained between studies indicating that there are likely to be other factors that influence the strength of the PWM relationships that were not explored within this meta-analysis. It is also likely that part of the residual heterogeneity is due to other moderators included within the meta-analysis but not tested simultaneously (e.g., exploring the effect of behaviour within age category) due to an insufficient number of studies, which has been a difficulty in other meta-analyses (e.g., McEachan et al., 2011). It is likely that, at different age groups, different behaviours may be more relevant and better predicted by the PWM than for other age groups. For example the nature of drug and substance use may change over time (Arnett, 2005; Schulenberg & Maggs, 2002), and therefore the determinants of behaviour are likely to change too. Nonetheless, that several moderators from the diverse categories of contextual, sample, and study characteristics were tested in the current study represents a strength. Important moderators such as age and behaviour type were identified, which may help to determine under which circumstances the PWM is most likely to be effective in explaining health behaviour.

There were several health behaviours that could not be compared due to small numbers of studies, and therefore conclusions that can be drawn from these behaviours are limited. In addition, it was not possible to investigate specific sub-classes of behaviours within the behavioural categories, which may have confounded the results. Nonetheless, the application of PWM to a wide range of behaviours and findings in support of the model appears promising, and further research should continue to build upon these studies to create a sound base of research across health behaviours areas such as diet, physical activity, sun protection and risky driving.

Approximately half the studies included reported data from a sample that partially or fully overlapped with the sample of another study. This is problematic as it is likely to have inflated the sample size and therefore reduced the error, which may have led to an inflation of significant effects, and must therefore be taken into consideration when reviewing the current findings. Despite this, the relationships between constructs did not significantly differ between these studies and studies that reported independent samples, as was also found when comparing funnel and forest plots, which suggests that the strength of the effects is unlikely to have been grossly affected by including these studies. Furthermore, often these studies took a different focus or reported different PWM associations, and therefore including them provided opportunity for more comprehensive analyses and results.

It is important to note that constructs were not always measured consistently within a study; for example, health-protective behaviour studies that included willingness items tended to measure willingness to engage in health-risk behaviours, whereas health-risk behaviour studies that included intention measures often measured intention to engage in health-protective behaviours. These inconsistencies may have reduced the strength of associations between variables, and where possible, future studies should try to match construct items in terms of direction for increased reliability. In addition, that measures of health-risk and health-protective behaviours were often combined or confounded made it impractical to conduct separate analyses on these classes of behaviours. However, it is worth noting that if classed according to whether behaviour *action* is risky or healthy, the majority of studies included investigated health risk behaviours. It is stipulated in the PWM that the nature of the behaviour is likely to influence the strength of the relationships, with health-risk behaviour being more strongly predicted by willingness, whilst health-protective behaviours are expected to be more strongly predicted by intention. Reviews have supported this distinction (Rivis et al., 2006), although, to date, the influence of health-risk versus health-promoting status within a single behaviour class (e.g., condom use and unsafe sex; healthy eating and unhealthy eating) has only been explored at the single study level, and it remains difficult to distinguish the methodological effects of question framing (e.g., proportion of unprotected sexual encounters compared to proportion of protected sexual encounters) and social desirability (Tversky & Kahneman, 1981) from true differences in health-risk versus health-promoting behaviours. More research is therefore needed to elucidate the differences in explaining health-risk and health-protective behaviours using models such as the PWM.

The large number of PWM studies that have been published in the literature enabled examination of effects that are likely to be robust, which is a strength of this field of research and of this meta-analysis. By including dissertation theses and by contacting authors for publications that may have been missed or where necessary data was not presented in the article, the risk of obtaining biased results that favour positive effects was reduced, and is also reflected in the large fail-safe N reported for each correlation.

Conclusions

This was the first study to meta-analytically explore the PWM. Overall, support for the PWM was demonstrated, and in particular including willingness as a predictor of behaviour, in addition to intention, appears warranted. The strength of the relationships between prototype similarity and other constructs was surprising, as within the PWM its only direct pathway is to willingness. Research conducted in this area should therefore continue to include both prototype favourability and similarity measures separately, as it appears that these two constructs differentially impact willingness, intentions, and behaviour. Age of the sample and type of behaviour investigated moderated several construct relationships, which may be of particular utility when conducting further research and designing theory-driven interventions that are informed by the literature. Several PWM experiments and interventions have been conducted already in the literature (e.g., Blanton et al., 1997; Brody et al., 2004; Teunissen et al., 2012; Thornton, Gibbons, & Gerrard, 2002); and a meta-analysis of PWM interventions would also be useful for informing future intervention development.

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Notes

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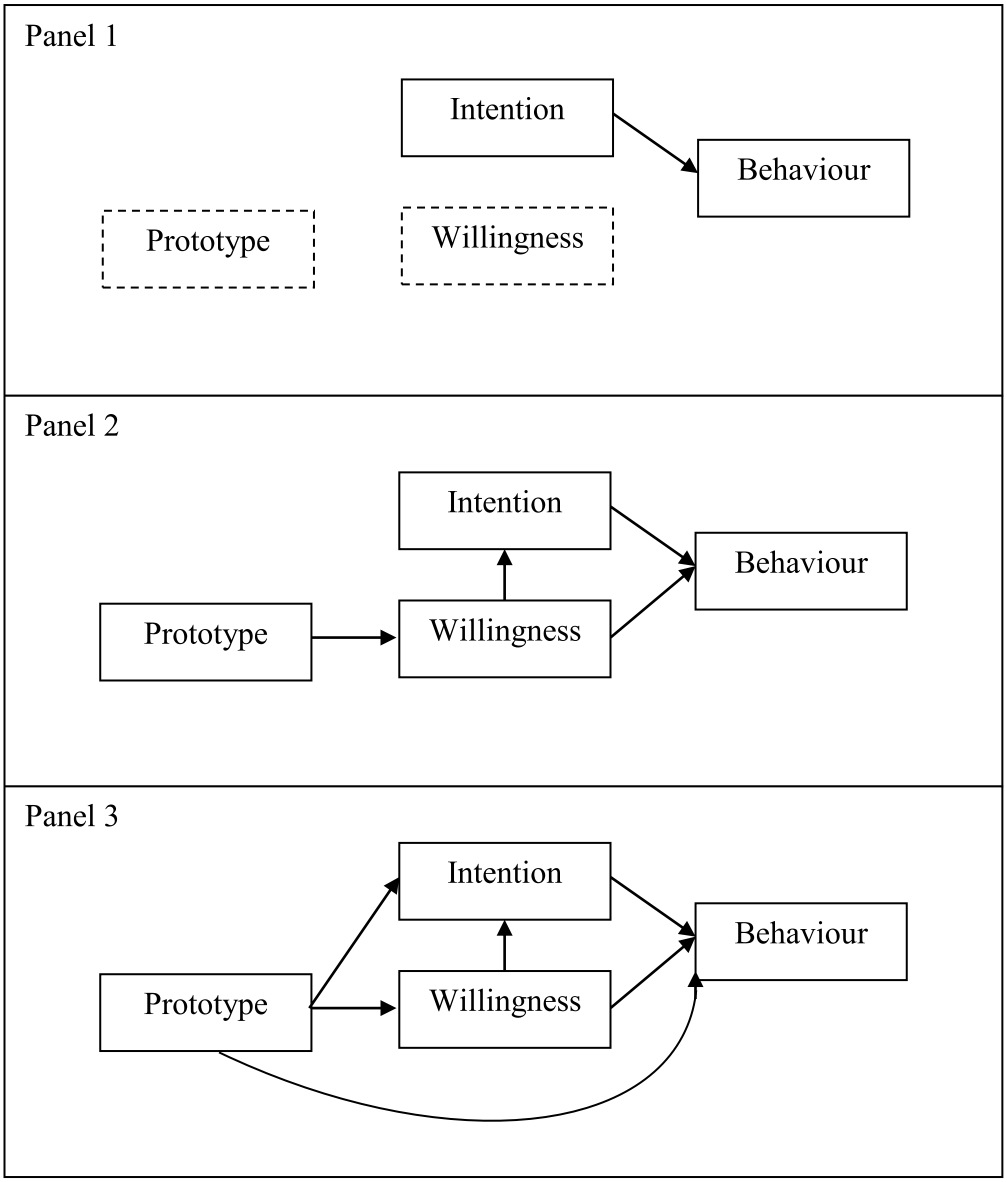


Figure 1. Prototype Willingness Model Pathways, Tested with Path Analysis Modelling.

Notes. Panel 1= partial test of the reasoned pathway (excluding attitudes and subjective norms); Panel 2= addition of the social reactive pathway; Panel 3= including additional relationships not specified within the model.

Table 1. ***General Prototype Willingness Model Correlations***

	Willingness	Intention	Behaviour
Prototype	.343 [.30, .39] *k*=51, FSN=47471	.255 [.20, .31] *k*=40, FSN=11957	.255 [.20, .31] *k*=51, FSN=25775
Proto Similarity	.406 [.30, .51] *k*=14, FSN= 1899	.466 [.31, .62] *k*=12, FSN=3740	.408 [.32, .50] *k*=12, FSN=2381
Proto Favourability	.313 [.24, .38] *k*=17, FSN=2559	.227 [.13, .32] *k*=15, FSN=1815	.286 [.20, .37] *k*=12, FSN=1238
Willingness		.535 [.43, .64] *k*=44, FSN= 62821	.438 [.38, .50] *k*=57, FSN=92075
Intention			.481 [.39, .57] *k*=35, FSN= 32963

Notes. Reported: correlations [95% Confidence Interval], number of studies (k), fail-safe N (FSN). Fail-safe N is an estimate of the number of missed studies necessary to obtain a null result, and is used as an indicator of bias with higher numbers suggesting lower risk of bias. Correlations ≥ 0.1, 0.3 and 0.5 can be interpreted as small, medium, and large effect sizes, respectively, according to Cohen's (1992) guidelines.

Table 2. ***Path Analysis of the Prototype Willingness Model: Reasoned, Heuristic, and Additional Pathways***

	Model 1	Model 2	Model 3
Total R^2 (behaviour)	.156	.205	.217
Total R^2 (intention)		.216	.221
Total R^2 (willingness)		.107	.103
Intention → behaviour	.394 [0.34; 0.45]	.254 [0.19; 0.32]	.263 [0.20; 0.33]
Willingness → behaviour		.274 [0.21; 0.33]	.235 [0.17; 0.30]
Willingness → intention		.465 [0.41; 0.52]	.429 [0.37; 0.49]
Prototype → willingness		.328 [0.27; 0.39]	.321[0.26; 0.38]
Prototype → intention			.100 [0.04; 0.16]
Prototype → behaviour			.096 [0.04; 0.15]

Notes. Values are standardised Beta regression coefficients [95% confidence intervals], except where indicated as R^2 (proportion of variance explained). Fit statistics are reported in supplementary file 7.

Model 1= reasoned pathway (intention to behaviour); Model 2= addition of the social reactive pathway (prototype to willingness, willingness to intention, intention to behaviour); Model 3= addition of relationships not specified within the model (prototype to intention, prototype to behaviour).

Table 3. ***Average Prototype Willingness Model Correlations, by Behaviour Type***

		r	Se	Z	CI-	CI+	k	N	FSN	Diffs
P-W	A. Alcohol	.440	0.05	9.05	.34	. 53	15	12324	8711	D
	B. Cigs	.262	0.08	3.32	.11	.42	5	5841	430	
	C. Subs	.335	0.06	5.77	.22	.45	5	3627	746	
	D. Sex	.281	0.03	10.64	.23	.33	17	5638	2339	A
P-I	A. Alcohol	.373	0.06	6.30	.26	.49	9	2111	830	D
	B. Cigs	.184	0.06	3.06	.07	.30	8	5604	350	
	C. Subs	.318	0.03	11.32	.26	.37	3	1274	131	D
	D. Sex	.131	0.03	4.17	.07	.19	14	3493	239	A, C
P-B	A. Alcohol	.376	0.05	7.48	.28	.47	20	13425	8789	C, D
	B. Cigs	.169	0.08	2.23	.02	.32	5	3916	83	
	C. Subs	.184	0.03	5.37	.12	.25	8	4953	447	A
	D. Sex	.166	0.03	6.41	.12	.22	10	3994	374	A
W-B	A. Alcohol	.535	0.05	9.76	.43	. 64	18	13148	17549	
	B. Cigs	.465	0.10	4.82	.28	.65	9	3622	2153	
	C. Subs	.398	0.07	5.60	.26	.54	10	4867	1899	

	D. Sex	.334	0.06	5.60	.22	.45	10	3436	1290	
I-B	A. Alcohol	.643	0.10	6.45	.45	.84	9	2214	2804	
	B. Cigs	.491	0.12	4.24	.26	.72	7	2690	1397	
	C. Subs	.289	0.12	2.46	.06	.52	3	2125	192	
	D. Sex	.411	0.11	3.90	.20	.62	6	1773	699	
W-I	A. Alcohol	.749	0.12	6.445	.52	.98	12	2609	6423	C, D
	B. Cigs	.695	0.10	6.90	.50	.89	6	4131	3171	C, D
	C. Subs	.184	0.03	5.37	.12	.25	8	4953	447	A, B
	D. Sex	.266	0.06	4.65	.15	.38	16	4119	1480	A, B

Note. P=prototype, W=willingness, I=intention, B=behaviour, Cigs=cigarette use, Subs=substance use, FSN= fail-safe N, Diffs= significant differences between confidence intervals

Table 4. ***Path Analysis of the Prototype Willingness Model by Behaviour***

Behaviour Type		Model 1	Model 2	Model 3
Alcohol	Total R^2 (behaviour)	.413	.425	.436
	Total R^2 (intention)		.564	.564
	Total R^2 (willingness)		.204	.193
	Intention → behaviour	.643 [0.6; 0.69]	.535 [0.45; 0.59]	.537 [0.47; 0.61]
	Willingness → behaviour		.147 [0.07; 0.21]	.069 [0.09; 0.20]
	Willingness → intention		.751 [0.71; 0.79]	.725 [0.68; 0.77]
	Prototype → willingness		.452 [0.41; 0.52]	.440 [0.39; 0.49]
	Prototype → intention			.054 [0.01; 0.10]
	Prototype → behaviour			.145 [0.00; 0.14]
Cigarette	Total R^2 (behaviour)	.241	.272	.273
	Total R^2 (intention)		.483	.483
	Total R^2 (willingness)		.069	.069
	Intention → behaviour	.491 [0.44; 0.55]	.324 [0.25; 0.40]	.323 [0.25; 0.40]
	Willingness → behaviour		.241 [0.17; 0.32]	.227 [0.15; 0.30]
	Willingness → intention		.695 [0.65; 0.74]	.695 [0.65; 0.74]

	Prototype → willingness		.263 [0.20; 0.32]	.262 [0.20; 0.32]
	Prototype → intention			.002 [-0.05; 0.05]
	Prototype → behaviour			.050 [0.00; 0.10]
Substance Use	Total R^2 (behaviour)	.083	.202	.207
	Total R^2 (intention)		.039	.108
	Total R^2 (willingness)		.129	.112
	Intention → behaviour	.289 [0.23; 0.35]	.211 [0.16; 0.29]	.225 [0.17; 0.28]
	Willingness → behaviour		.357 [0.30; 0.41]	.360 [0.30; 0.42]
	Willingness → intention		.198 [0.12; 0.24]	.087 [0.02; 0.15]
	Prototype → willingness		.359 [0.32; 0.45]	.335 [0.28; 0.39]
	Prototype → intention			.289 [0.23; 0.35]
	Prototype → behaviour			-.008 [-0.07; 0.05]
Sex	Total R^2 (behaviour)	.169	.221	.226
	Total R^2 (intention)		.071	.074
	Total R^2 (willingness)		.080	.079
	Intention → behaviour	.411 [0.35; 0.47]	.341 [0.28; 0.40]	.343 [0.29; 0.40]
	Willingness → behaviour		.245 [0.19; 0.30]	.226 [0.17; 0.28]

Willingness → intention	.267 [0.21; 0.32]	.249 [0.19; 0.31]
Prototype → willingness	.283 [0.22; 0.35]	.281 [0.22; 0.34]
Prototype → intention		.061 [0.00; 0.12]
Prototype → behaviour		.058 [0.00; 0.11]

Notes. Values are standardised Beta regression coefficients [95% confidence intervals], except where indicated as R^2 (proportion of variance explained). Fit statistics are reported in supplementary file 7.

Model 1= reasoned pathway (intention to behaviour); Model 2= addition of the social reactive pathway (prototype to willingness, willingness to intention, intention to behaviour); Model 3= addition of relationships not specified within the model (prototype to intention, prototype to behaviour).

Table 5. ***Average Prototype Willingness Model Correlations, by Age Category***

		r	Se	Z	CI-	CI+	k	N	FSN	diffs
P-W	A. Pre-adoles.	0.188	0.03	5.85	0.12	0.25	7	6078	479	B
	B. Adolescent	0.399	0.04	10.60	0.33	0.47	20	17661	15208	A
	C. Adult	0.343	0.03	11.77	0.29	0.40	24	6027	5241	
P-I	A. Pre-adoles.	0.198	0.04	5.35	0.13	0.27	10	5844	873	
	B. Adolescent	0.250	0.06	4.13	0.13	0.37	13	4165	612	
	C. Adult	0.294	0.05	6.20	0.20	0.39	17	5850	2991	
P-B	A. Pre-adoles.	0.119	0.03	3.83	0.06	0. 18	7	4665	167	B
	B. Adolescent	0.281	0.04	6.42	0.20	0.37	25	18632	9034	A
	C. Adult	0.276	0.04	7.70	0.21	0. 35	19	5784	2695	A
W-B	A. Pre-adoles.	0.204	0.067	3.11	0.08	0.33	6	3919	359	B, C
	B. Adolescent	0.489	0.05	9.97	0.39	0.59	25	17310	28710	
	C. Adult	0.445	0.04	11.52	0.37	0.52	26	7480	13183	
I-B	A. Pre-adoles.	0.261	0.09	2.85	0.08	0.44	4	2115	221	
	B. Adolescent	0.524	0.10	5.28	0.33	0.72	11	3801	3401	
	C. Adult	0.504	0.05	9.21	0.40	0.61	20	6639	11698	

W-I	A. Pre-adoles.	0.493	0.10	4.99	0.30	0.69	4	3903	1455
	B. Adolescent	0.501	0.12	4.03	0.26	0.75	14	4556	5676
	C. Adult	0.559	0.06	9.01	0.44	0.68	26	6725	18773

Note. P=prototype, W=willingness, I=intention, B=behaviour, Pre-adoles.= pre-adolescent less than 13 years, Adolescent= 13-17 years, Adult= 18+ years, FSN= fail-safe N, Diffs= significant differences between confidence intervals

Table 6. ***Path Analysis of the Prototype Willingness Model by Age Group***

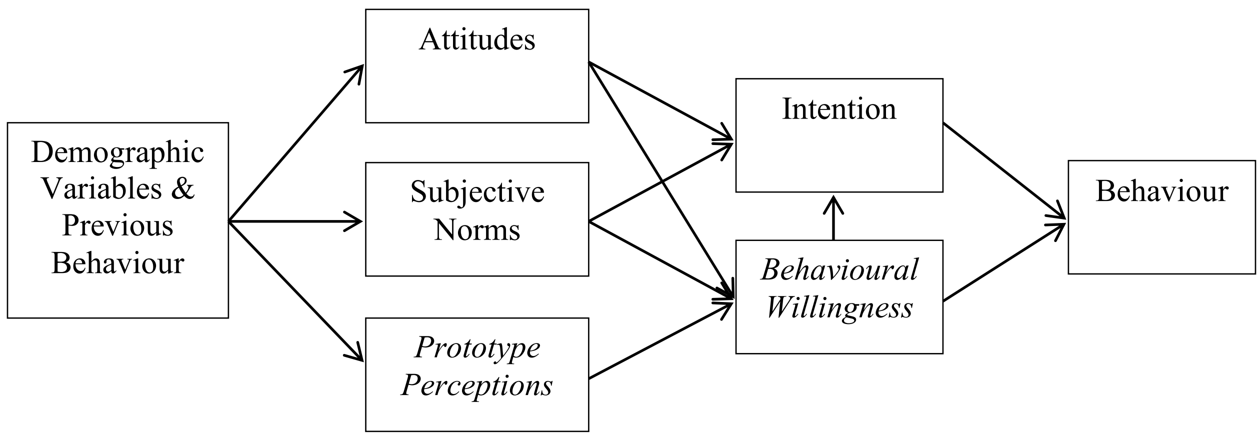
Behaviour Type		Model 1	Model 2	Model 3
Pre-adolescent	Total R^2 (behaviour)	.068	.070	.079
	Total R^2 (intention)		.249	.255
	Total R^2 (willingness)		.037	.035
	Intention → behaviour	.261 [0.2; 0.32]	.193 [0.12; 0.26]	.203 [0.13; 0.27]
	Willingness → behaviour		.109 [0.04; 0.18]	.092 [0.02; 0.16]
	Willingness → intention		.499 [0.44; 0.55]	.472 [0.42; 0.53]
	Prototype → willingness		.191 [0.13; 0.26]	.188 [0.06; 0.18]
	Prototype → intention			.109 [0.05; 0.16]
	Prototype → behaviour			.062 [0.00; 0.12]
Adolescent	Total R^2 (behaviour)	.252	.326	.333
	Total R^2 (intention)		.253	.254
	Total R^2 (willingness)		.162	.159
	Intention → behaviour	.502 [0.45; 0.55]	.334 [0.27; 0.39]	.337 [0.28; 0.40]
	Willingness → behaviour		.325 [0.26; 0.38]	.287 [0.22; 0.35]
	Willingness → intention		.503 [0.45; 0.55]	.478 [0.42; 0.54]

	Prototype → willingness		.403 [0.35; 0.47]	.399 [0.34; 0.46]
	Prototype → intention			.058 [0.00; 0.12]
	Prototype → behaviour			.082 [0.03; 0.14]
Adult	Total R^2 (behaviour)	.254	.285	.301
	Total R^2 (intention)		.320	.324
	Total R^2 (willingness)		.124	.118
	Intention → behaviour	.504 [0.45; 0.56]	.343 [0.28; 0.41]	.356 [0.29; 0.42]
	Willingness → behaviour		.259 [0.19; 0.32]	.212 [0.15; 0.28]
	Willingness → intention		.565 [0.51; 0.61]	.519 [0.46; 0.57]
	Prototype → willingness		.352 [0.30; 0.42]	.343 [0.28; 0.40]
	Prototype → intention			.116 [0.06; 0.17]
	Prototype → behaviour			.099 [0.04; 0.15]

Notes. Values are standardised Beta regression coefficients [95% confidence intervals], except where indicated as R^2 (proportion of variance explained). Fit statistics are reported in supplementary file 7. Pre-adolescent= up to 13 years; Adolescent= 13-17 years; Adult= 18 or more years Model 1= reasoned pathway (intention to behaviour); Model 2= addition of the social reactive pathway (prototype to willingness, willingness to intention, intention to behaviour); Model 3= addition of relationships not specified within the model (prototype to intention, prototype to behaviour).

SUPPLEMENTARY FILE 1

The Prototype Willingness Model

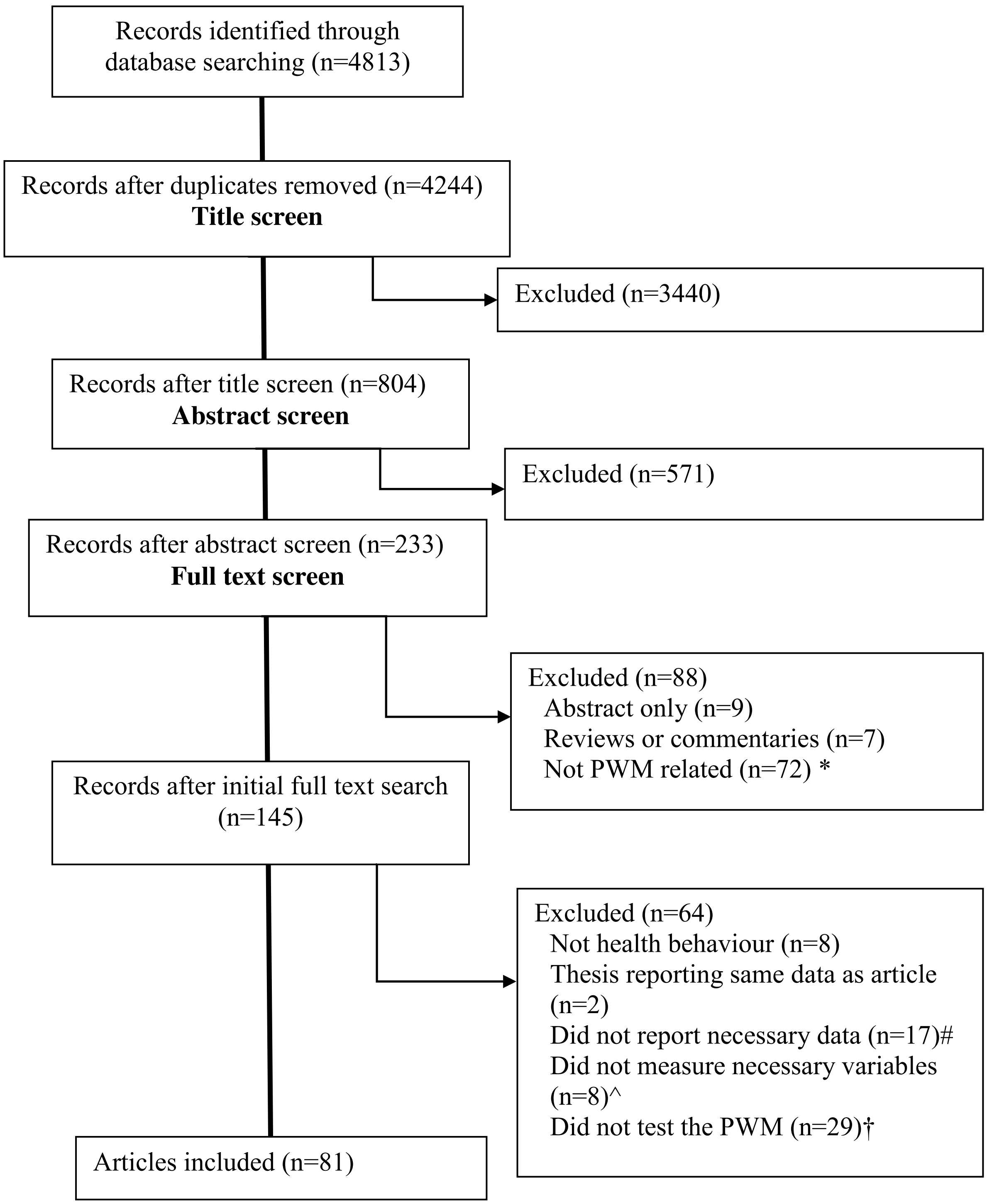


(Gibbons, Gerrard, Blanton, & Russell, 1998a; Gibbons, Gerrard, & Lane, 2003).

Notes. The reasoned path is represented by attitude, subjective norms, and intention. The heuristic path is represented by prototype perceptions and willingness (italicised).

SUPPLEMENTARY FILE 2

Study Selection Flow Diagram



Notes.

*Not PWM related: Did not include ‘prototype’ ‘willingness’ ‘Gibbons’ or ‘Gerrard’ in the text, or included only as additional information in the introduction or discussion

#Did not report necessary data: Variables measured, but correlational relationships not reported (and unable to be obtained from authors), or were measured across an intervention without being measured cross-sectionally

^Did not measure necessary variables: Key variables needed to calculate relationships of interest between prototypes or willingness not included

†Did not test the PWM: Made reference to the PWM but was not explicitly testing it and was therefore missing necessary variables and data (e.g., exploring willingness to engage in a behaviour but nothing elseno other constructs)

SUPPLEMENTARY FILE 4

Individual Study Data

Study Reference	Study No./ sub-Sample	Behaviour	Larger project?	N	Gender (%female)	Mean age/	Age category	Design (length of study)
(Andrews & Peterson, 2006)		Cigarette use, alcohol use, marijuana use	OYSUP	1075	Combined (50%)	9.0	Pre-adolescent	Prospective (4 years)
(Andrews et al., 2011a)		Cigarette use		2322	Combined (50%)	*5th grade	Pre-adolescent	Intervention (6 weeks)
(Andrews, Hampson, & Peterson, 2011b)		Alcohol use	OYSUP	1011	Combined (50%)	13.4	Adolescent	Prospective (4 years)
(Andrews, Hampson, Barckley, Gerrard, & Gibbons, 2008)		Alcohol use, cigarette use	OYSUP	712	Combined (50%)	9.5	Pre-adolescent	Prospective (7 years)
(Andrews, Hampson, & Barckley, 2008)		Cigarette use	OYSUP	1070	Combined (50%)	9	Pre-adolescent	Prospective (6 years)
(Atwell, Abraham, & Duka, 2011)		Alcohol use		230	Combined (52%)	19.4	Adult	Cross-sectional
(Cristea, Paran, & Delhomme, 2013)		Speeding	Christea	1192	Combined (50%)	24.2	Adult	Cross-sectional
(Cleveland, Gibbons, Gerrard, Pomery, &		Alcohol use, cigarette use, marijuana use	FACHS	714	Combined (54%)	10.5	Pre-adolescent	Prospective (5 years)

Brody, 2005)								
(Dal Cin et al., 2009)		Alcohol use		6522	Combined (49%)	12.1	Adolescent	Prospective (2 years)
(Delhomme, Cristea, & Paran, In press)		Speeding	Christea	1192	Combined (50%)	22	Adult	Prospective (2 years)
(Dodge, Stock, & Litt, 2013)		Performance enhancing substances		132	Male	-	Adult	Cross-sectional
(Eggleston, 1997)		Unsafe sex, condom use		230	Female	19	Adult	Intervention (single day)
(Gebhardt, Van Empelen, & Van Beurden, 2009)		Condom preparation		112	Female	18.7	Adult	Prospective (1 year)
(Gerrard et al., 2006)	Study 2	Alcohol use	SAAF	281	Combined (53%)	11.2	Pre-adolescent	Intervention (2 years)
(Gerrard et al., 2002a)		Alcohol use	IOWA	308	Combined (57%)	16.3	Adolescents	Prospective (2 years)
(Gerrard, Gibbons, Stock, Lune, & Cleveland, 2005)		Cigarette use	FACHS	742	Combined	10.5	Pre-adolescents	Prospective (20 months)
(Gerrard, Gibbons, Vande Lune, Pexa, & Gano, 2002b)		Alcohol use, cigarette use, illegal drugs	FACHS (siblings)	234	Combined (53%)	13.5	Adolescent	Prospective (20 months)

(Gerrard, Gibbons, Zhao, Russell, & Reis-Bergan, 1999)		Alcohol use		266	Combined	*15-17	Adolescent	Prospective (3 years)
(Gerrits, de Ridder, de Wit, & Kuijer, 2009)	Study 3	Unhealthy eating		97	Combined (66%)	15.9	Adolescent	Prospective (5 days)
(Gibbons et al., 2010a)		Substance use	FACHS	897	Combined (54%)	10.5	Pre-adolescent	Prospective (5 years)
(Gibbons, Gerrard, Blanton, & Russell, 1998)	Study 1	Cigarette use	IOWA	470	Combined (51%)	*13-15	Adolescent	Prospective (2 years)
	Study 2	Unsafe sex		628	Combined (56%)	18.0	Adult	Prospective (1 year)
	Study 3	Unsafe sex		297	Combined (59%)	21.0	Adult	Cross-sectional
(Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005)	Study 1	Tanning bed use		70	Combined (49%)	*University students	Adult	Intervention (4 weeks)
	Study 2	Tanning bed use		134	Combined (54%)	*University students	Adult	Intervention (3 weeks)
(Gibbons, Gerrard, Cleveland, Wills, & Brody, 2004a)		Substance use	FACHS	684	Combined (54%)	10.5	Pre-adolescent	Prospective (20 months)
(Gibbons et al., 2004b)		Alcohol use, drug use, cigarette use	FACHS	746	Combined (54%)	10.5	Pre-adolescent	Prospective (20 months)

(Gibbons, Gerrard, & McCoy, 1995)	Study 1	Unsafe sex		226	Combined (68%)	*13-15	Adolescent	Cross-sectional
	Study 2	Unsafe sex	IOWA	432	Combined (51%)	*13-15	Adolescent	Cross-sectional
(Gibbons, Gerrard, Ouellette, & Burzette, 1998)	Study 1	Cigarette use	IOWA	470	Combined (51%)	*13-15	Adolescent	Prospective (2 years)
	Study 2	Drink driving	IOWA	519	Combined (56%)	*College students	Adult	Prospective (2 years)
(Gibbons, Helweg-Larsen, & Gerrard, 1995)	American	Condom use, unsafe sex	IOWA	500	Combined (51%)	14.4	Adolescent	Cross-sectional
	Danish	Condom use, unsafe sex		224	Combined (48%)	14.2	Adolescent	Cross-sectional
(Gibbons et al., 2010b)	African American	Alcohol use	Dartmouth	704	Combined (49%)	12.1	Adolescent	Prospective (28 months)
	European American	Alcohol use	Dartmouth	4036	Combined (49%)	12.1	Adolescent	Prospective (28 months)
(Gibbons et al., 2012)		Substance use, unsafe sex	FACHS	889	Combined	10.5	Pre-adolescent	Prospective (11 years)
(Hampson, Andrews, & Barckley, 2007)		Cigarette use	OYSUP	809	Combined (50%)	9	Pre-adolescent	Prospective (4 years)
(Hampson, Andrews, & Barckley, 2008)		Marijuana use	OYSUP	420	Combined (47%)	*4th-5th grade	Pre-adolescent	Prospective (7 years)

(Houlihan et al., 2008)		Unsafe sex	FACHS	889	Combined (54%)	10.5	Pre-adolescent	Prospective (5 years)
(Hukkelberg & Dykstra, 2009)		Cigarette use		760	Combined (50%)	13.9	Adolescent	Prospective (1 year)
(Kalebić Maglica, 2011)		Alcohol use, cigarette use		341	Combined (61%)	16.4	Adolescent	Cross-sectional
(Keresztes, Piko, Gibbons, & Spielberger, 2009)		Physical Activity		541	Combined (58%)	16.5	Adolescent	Cross-sectional
(Kogan et al., 2011)		Unsafe sex, condom use	FACHS (siblings)	195	Combined	13.0	Adolescent	Prospective (6 years)
(Lane, Gibbons, O'Hara, & Gerrard, 2011)	Study 1	Alcohol use		217	Combined (55%)	19.4	Adult	Intervention (same day)
	Study 2	Alcohol use		55	Combined (60%)	19.5	Adult	Intervention (same day)
(Litt et al., 2013)		Alcohol use		275	Combined (56%)	20.1	Adult	Prospective (10 day)
(Litt & Stock, 2011)		Alcohol use		189	Combined (51%)	14.5	Adolescent	Intervention (same day)
(Litt, Stock, & Lewis, 2012)		Alcohol use		346	Combined (57%)	19.4	Adult	Cross-sectional
(Matterne, Diepgen, &		Sun protection		150	Combined	44.1	Adult	Intervention (7+

Weisshaar, 2011)					(39%)			weeks)
(Murry et al., 2011)		Unsafe sex, condom use	SAAF	332	Combined (54%)	11.2	Pre-adolescent	Intervention (65 months)
(Myklestad & Rise, 2007)	Male	Contraception use		88	Male	14.5**	Adolescent	Cross-sectional
	Female	Contraception use		108	Female	14.5**	Adolescent	Cross-sectional
(Myklestad & Rise, 2008)		Contraception use		154	Combined (55%)	14.5	Adolescent	Cross-sectional
(Norman, Armitage, & Quigley, 2007)		Alcohol use		94	Combined (86%)	20.1	Adult	Prospective (7 days)
(O'Hara, 2012)	Study 1	Alcohol use, flu vaccination		986	Combined (68%)	19.3	Adult	Prospective (3 months)
(Ohtomo, 2013)		Unhealthy eating		286	Female	19.0	Adult	Prospective (2 weeks)
(Ohtomo, Hirose, & Midden, 2011)	Dutch	Unhealthy eating		277	Combined (20%)	21.8	Adult	Cross-sectional
	Japanese	Unhealthy eating		321	Combined (67%)	19.1	Adult	Cross-sectional
(Ouellette, Gerrard, Gibbons, & Reis-Bergan, 1999)		Alcohol use	IOWA	357	Combined (51%)	15.0	Adolescent	Prospective (4 years)
(Peterson, 2013)		Sex following alcohol use		193	Combined (65%)	19.3	Adult	Intervention (same day)

(Pomery, 2008)		Unsafe sex		109	Combined (29%)	*College students	Adult	Intervention (same day)
(Pomery et al., 2005)		Alcohol use, cigarette use, marijuana use	FACHS	225	Combined (55%)	10.5	Pre-adolescent	Prospective (20 months)
(Pomery, Gibbons, Reis-Bergan, & Gerrard, 2009)	Study 2a	Alcohol use	IOWA	344	Combined	14.4	Adolescent	Prospective (5 years)
	Study 2b	Cigarette use	IOWA	186	Combined	14.4	Adolescent	Prospective (5 years)
(Reimer, 2009)	Study 1	Alcohol use, casual sex		139	Combined (51%)	20.1	Adult	Intervention (same day)
	Study 2	Alcohol use, casual sex		204	Combined (70%)	19.4	Adult	Intervention (same day)
(Rivis, Abraham, & Snook, 2011)	Young	Drink driving		100	male	23.3	Adult	Cross-sectional
	Older	Drink driving		100	male	46.3	Adult	Cross-sectional
(Rivis & Sheeran, 2003)		Physical activity		333	Combined	*University students	Adult	Prospective (2 weeks)
(Rivis, Sheeran, & Armitage, 2010)		Cigarette use		272	Combined (57%)	16.4	Adolescent	Prospective (2 weeks)
(Rivis, Sheeran, & Armitage, 2011)		14 health related behaviours		136	Combined (65%)	16.4	Adolescent	Prospective (2 weeks)
(Scott-Parker, Hyde, Watson, & King, 2013)		Speeding		1190	Combined (61%)	17.9	Adult	Prospective (6 months)

(Spijkerman, van den Eijnden, & Engels, 2005)		Cigarette use		2031	Combined (54%)	12.8	Adolescent	Prospective (1 year)
(Spijkerman, Larsen, Gibbons, & Engels, 2010)		Alcohol use		200	Combined (51%)	21.5	Adult	Cross-sectional
(Stock et al., 2013a)		Substance use	FACHS	720	Combined (53%)	15.6	Adolescent	Prospective (4 years 8 months)
(Stock, Gibbons, Peterson, & Gerrard,	Study 1	Alcohol use, marijuana, other drugs, unsafe sex	FACHS	833	Combined (54%)	18.8	Adult	Prospective (8 years)
2013b)	Study 2	Substance use, unsafe sex		110	Combined (52%)	22.1	Adult	Intervention (same day)
(Stock, Litt, Arlt, Peterson, & Sommerville, 2013c)		Nonmedical stimulant		555	Combined (56%)	19.4	Adult	Cross-sectional
(Stock, 2007)		Condom use		222	Combined (60%)	20.5	Adult	Intervention (same day)
(Stock, Gibbons, Walsh, & Gerrard, 2011)	Study 1	Substance use	FACHS	64	Combined (66%)	18.0	Adult	Cross-sectional
(Teunissen et al., 2014)		Alcohol use		599	Male	17.0	Adolescent	Intervention (same day)
(Teunissen et al., 2012)		Alcohol use		192	Combined (57%)	20.7	Adult	Intervention (same day)

(Thornton, Gibbons, & Gerrard, 2002)	Study 1	Unsafe sex	362	Combined (52%)	19.4	Adult	Cross-sectional
	Study 2	Unsafe sex	68	Female	19.8	Adult	Intervention (same day)
	Study 3	Unsafe sex	496	Combined (56%)	18.0	Adult	Prospective (1 year)
(Todd & Mullan, 2011)		Alcohol use	80	Female	19.0	Adult	Intervention (2 weeks)
(van den Eijnden, Spijkerman, & Engels, 2006)		Cigarette use	612	Combined (53%)	12.3	Adolescent	Prospective (1 year)
(van Empelen & Kok, 2006)		Condom use	140	Combined (34%)	15.0	Adolescent	Prospective (3 months)
(van Lettow, de Vries, Burdorf, Norman, & van Empelen, 2013)	Study 1	Alcohol use	140	Combined (63%)	*18-25	Adult	Cross-sectional
	Study 2	Alcohol use	451	Combined (72.6%)	21	Adult	Prospective (1 month)
(van Lettow, Vermunt, Vries, Burdorf, & Empelen, 2013)		Alcohol use	149	Combined (63%)	20.6	Adult	Cross-sectional
(Walls & Whitbeck, 2011)		Alcohol use, cigarette use, marijuana use	360	Female	11.0	Pre-adolescent	Cross-sectional

(Walsh & Stock, 2012)		Sun protection		152	Male	18.9	Adult	Intervention (2 weeks)
(Wills, Gibbons, Gerrard, Murry, & Brody, 2003)		Unsafe sex, substance use	SAAF	297	Combined (53%)	13.0	Adolescent	Cross-sectional
(Whitaker, Long, Petróczi, & Backhouse, 2013)		Performance enhancing substances		729	Combined (37%)	28.8	Adult	Cross-sectional
(Zimmermann & Sieverding, 2011a)		Alcohol use	Zimmermann	300	Combined (49%)	25	Adult	Prospective (4 days)
(Zimmermann & Sieverding, 2010)	Male	Alcohol use	Zimmermann	153	Male	24.7**		Prospective (4 days)
	Female	Alcohol use	Zimmermann	147	Female	24.7**		Prospective (4 days)
(Zimmermann & Sieverding, 2011b)		Alcohol use	Zimmermann	300	Combined (49%)	24.7	Adult	Cross-sectional

Note: Information reported in this table was based on the study as described in the manuscript. Where possible, more accurate descriptive information corresponding to data used in the meta-analysis (e.g., N for correlations used, length of follow-up for measures relevant to the PWM) was used in the analyses. *Where mean age was not provided, other age information is given

** Where age was given for entire sample but data was divided, the stated age was used across both samples.

SUPPLEMENTARY FILES 5 AND 6

Key for Funnel and Forest Plots

Constructs:

IB= intention –behaviour relationship

PB= prototype– behaviour relationship

PFB= prototype favourability– behaviour relationship

PSB= prototype similarity– behaviour relationship

PI= prototype–intention relationship

PFI= prototype favourability–intention relationship

PSI= prototype similarity–intention relationship

PW= prototype–willingness relationship

PFW= prototype favourability–willingness relationship

PSW= prototype similarity–willingness relationship

WB= willingness–behaviour relationship

WI= willingness–intention relationship

Studies included:

All= for all included studies

No-overlap= overlapping studies excluded

List of Funnel Plots

IB – All

IB – No Overlap

PB – All

PB – No Overlap

PFB – All

PFB – No Overlap

PFI – All

PFI – No overlap

PFW – All

PWF – No Overlap

PI – All

PI – No overlap

PSB – All

PSB – No overlap

PSI – All

PSI – No overlap

PSW – All

PSW – No overlap

PW – All

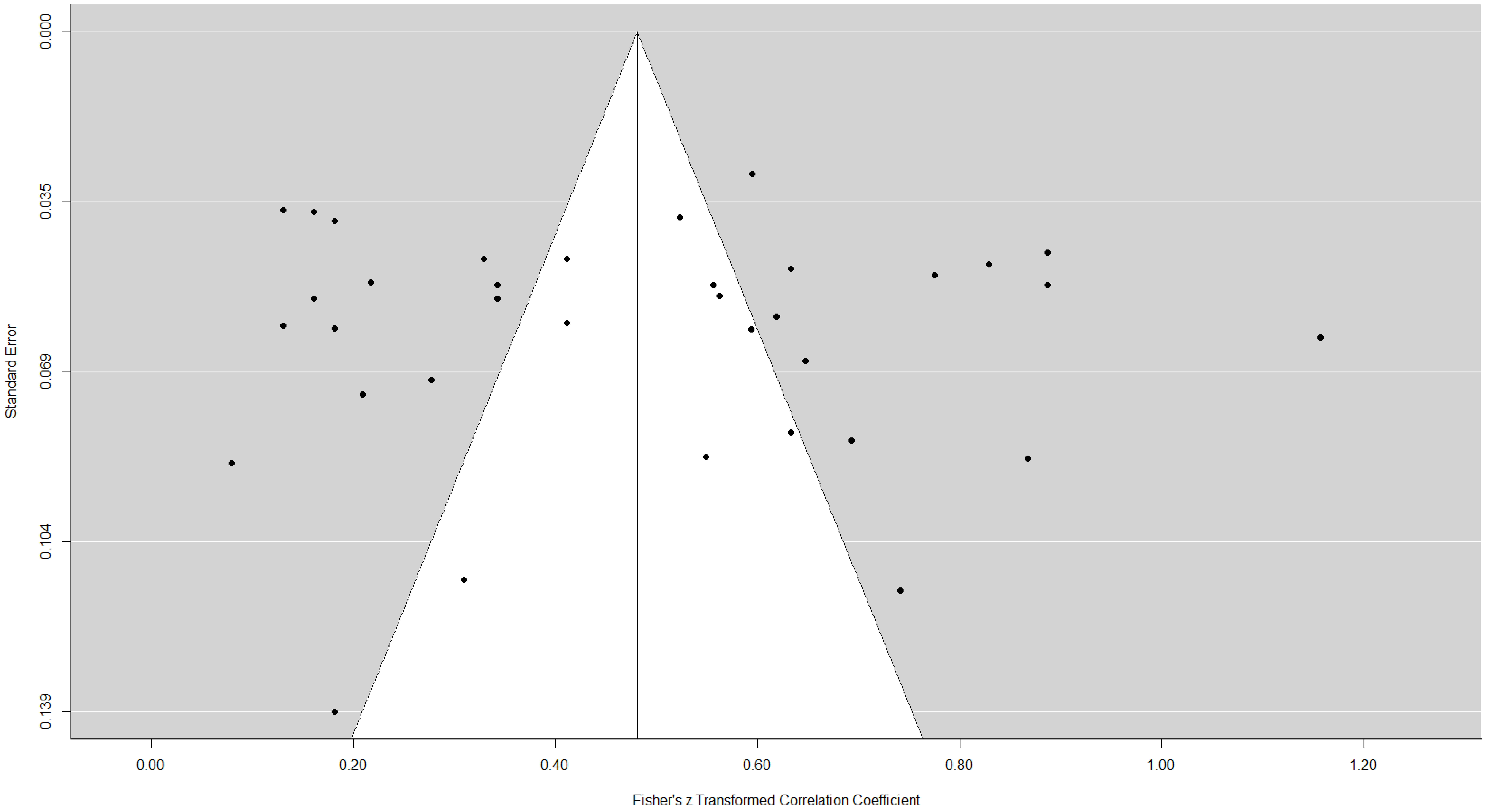
PW – No overlap

WB – All

WB – No Overall

WI – All

WI – No overlap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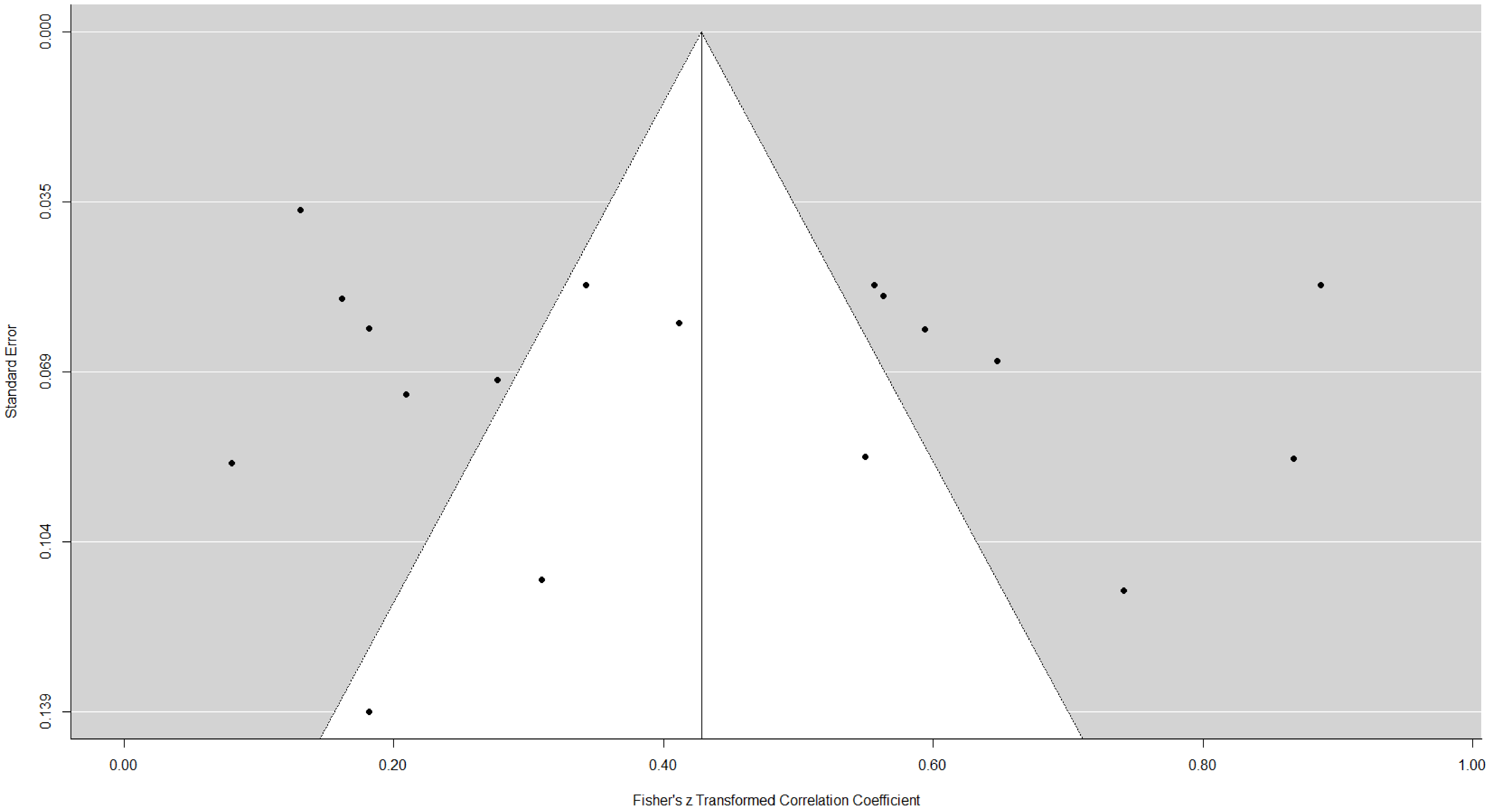
0.069
0.104
0.139
Standard Error
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Fisher's z Transformed Correlation Coefficient



0.000
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Standard Error
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0.60
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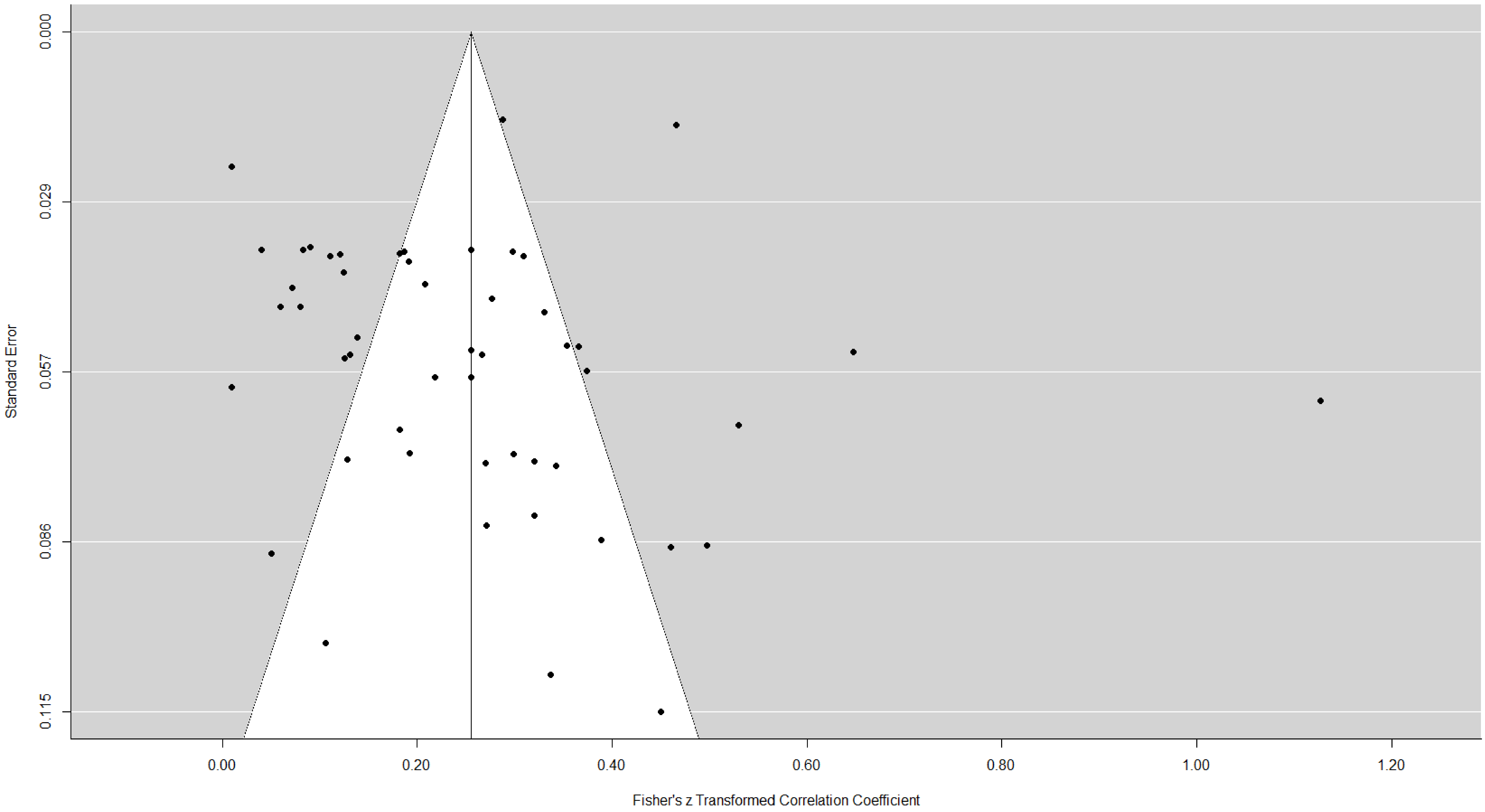
Fisher's z Transformed Correlation Coefficient



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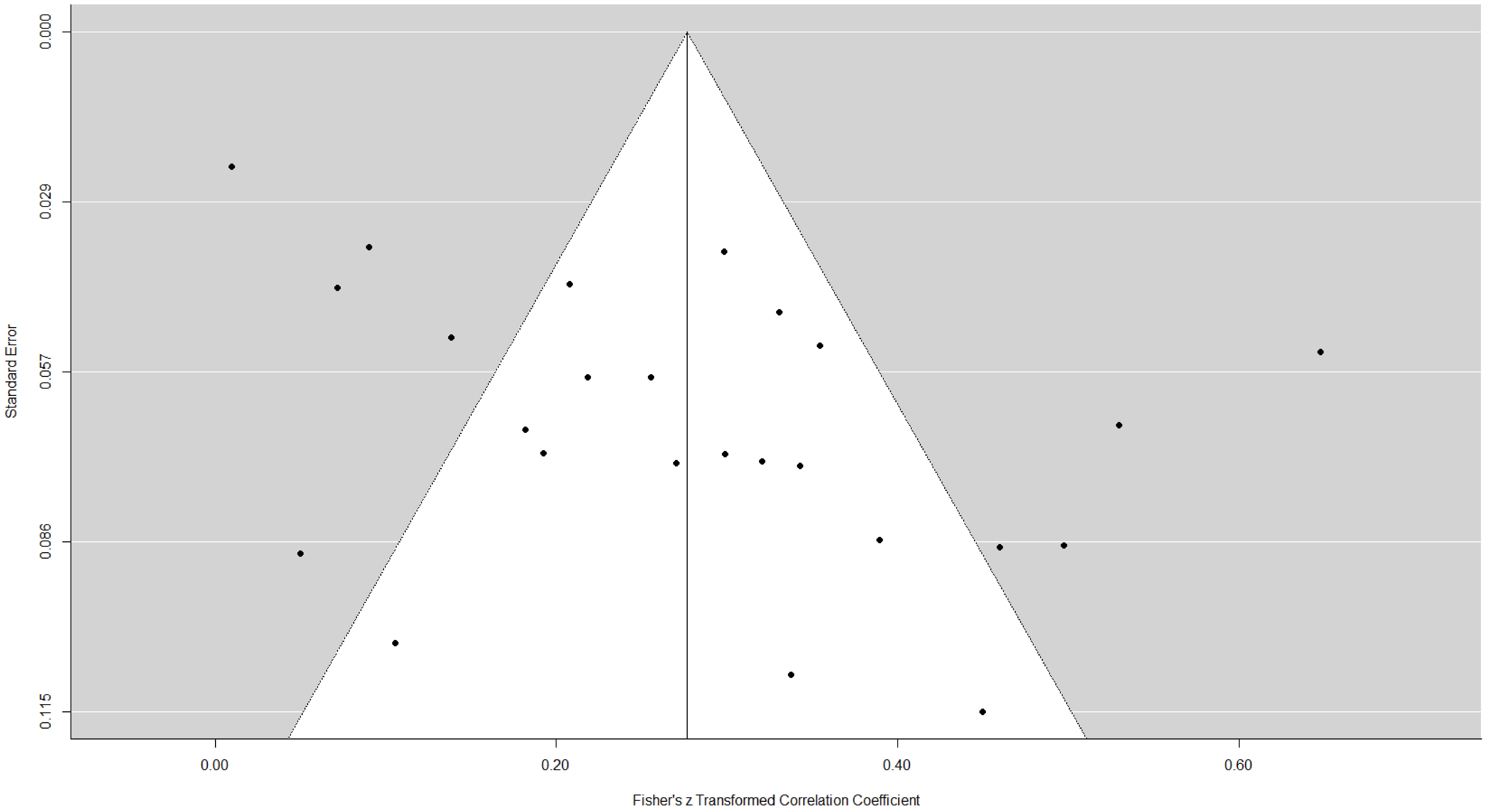
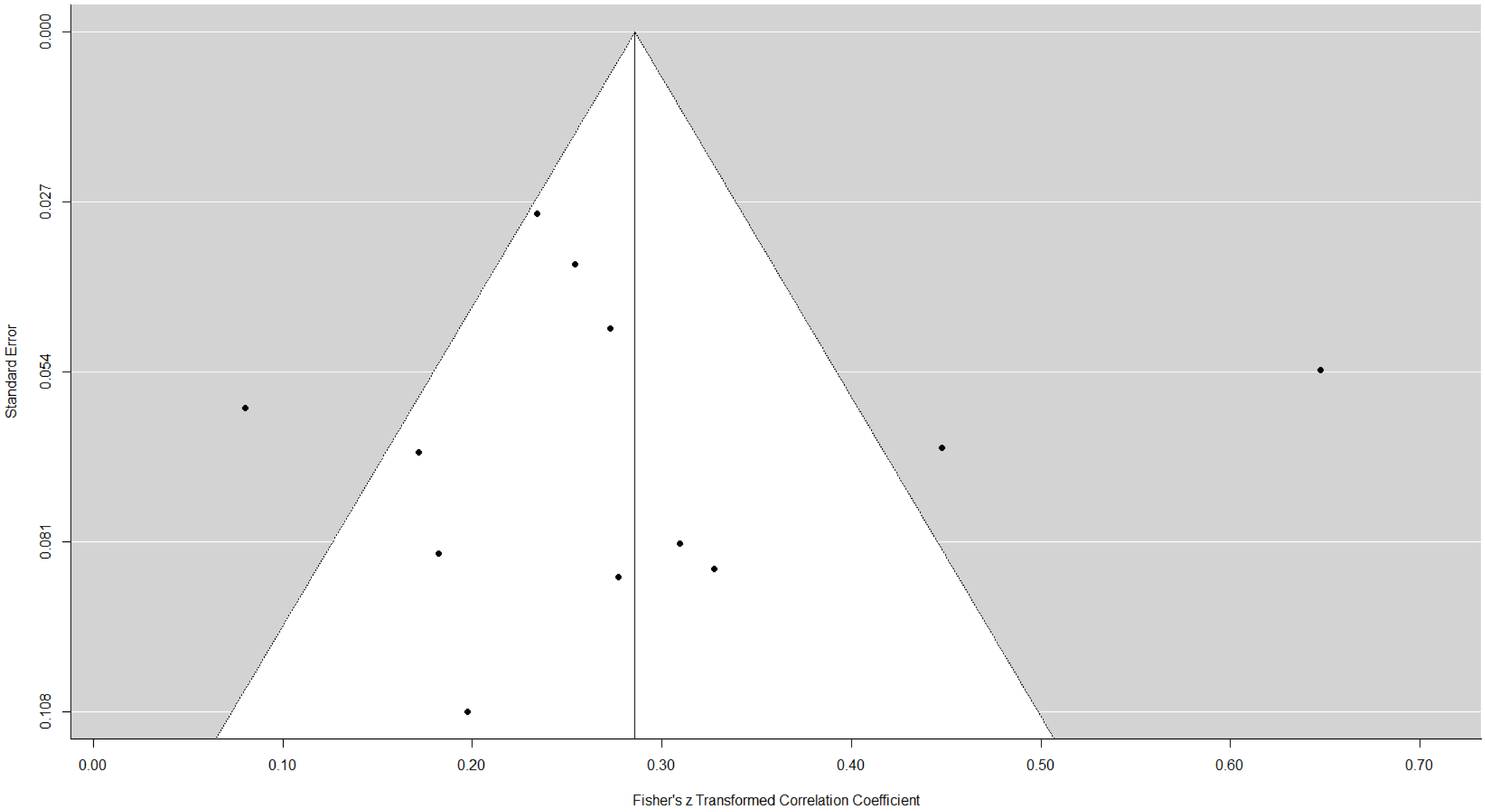
0.029
0.057
0.086
0.115
Standard Error
0.00
0.20
0.40
0.60
0.80
1.00
1.20
Fisher's z Transformed Correlation Coefficient



0.000
0.029
0.057
0.086
0.115
Standard Error
0.00
0.20
0.40
0.60
Fisher's z Transformed Correlation Coefficient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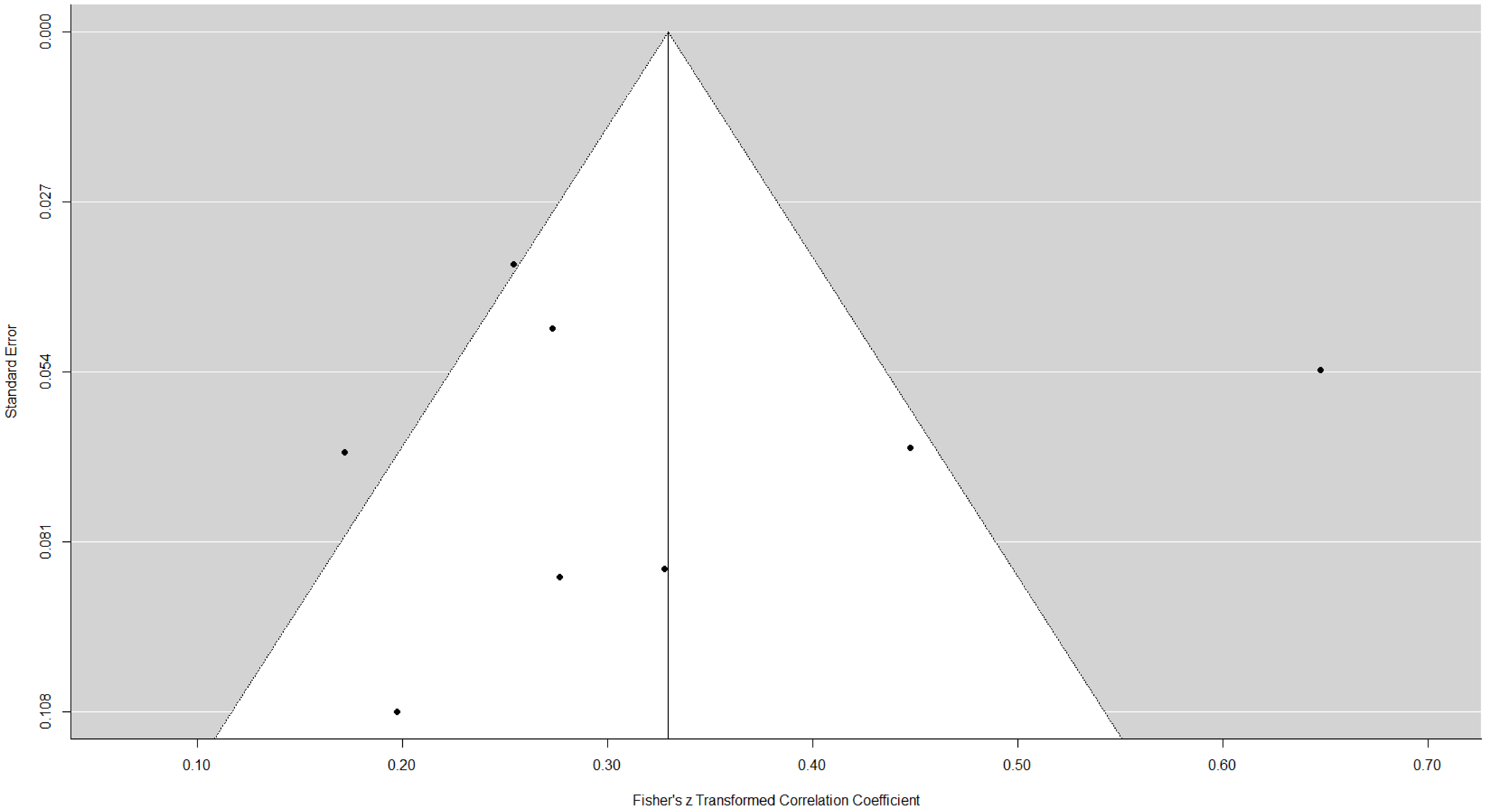
Fisher's z Transformed Correlation Coefficient



Standard Error
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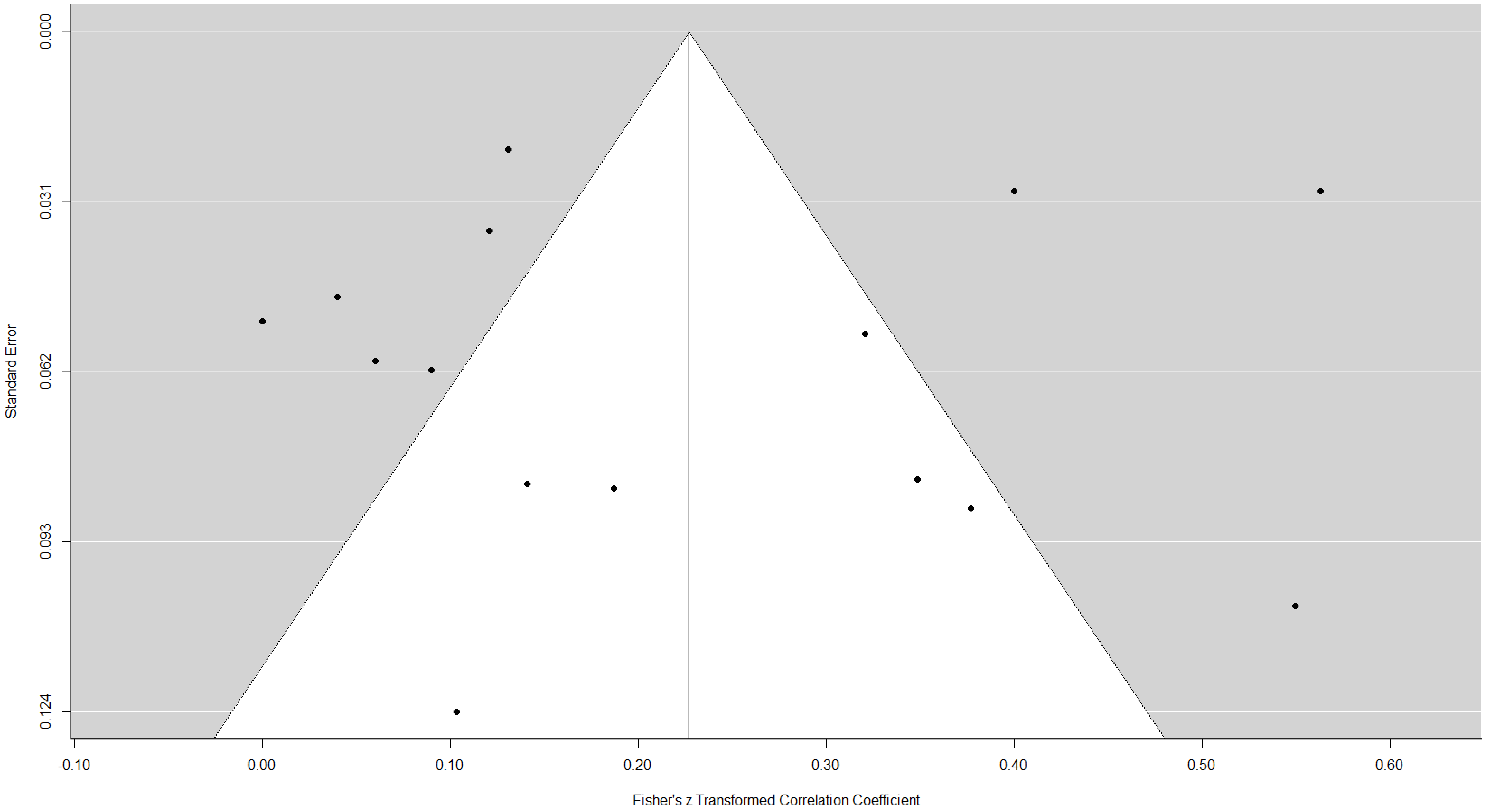
Fisher's z Transformed Correlation Coefficient



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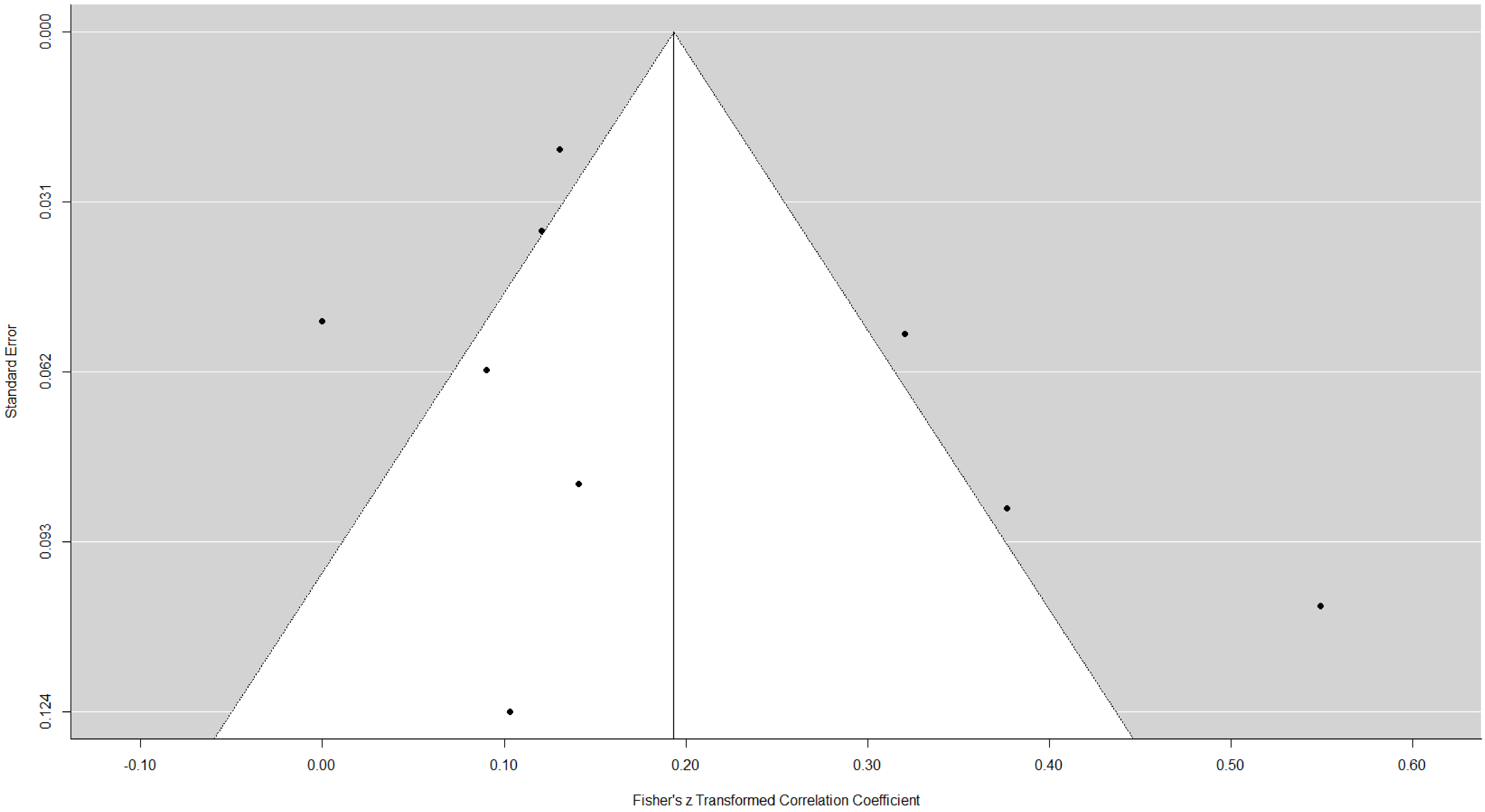
Fisher's z Transformed Correlation Coefficient



Standard Error
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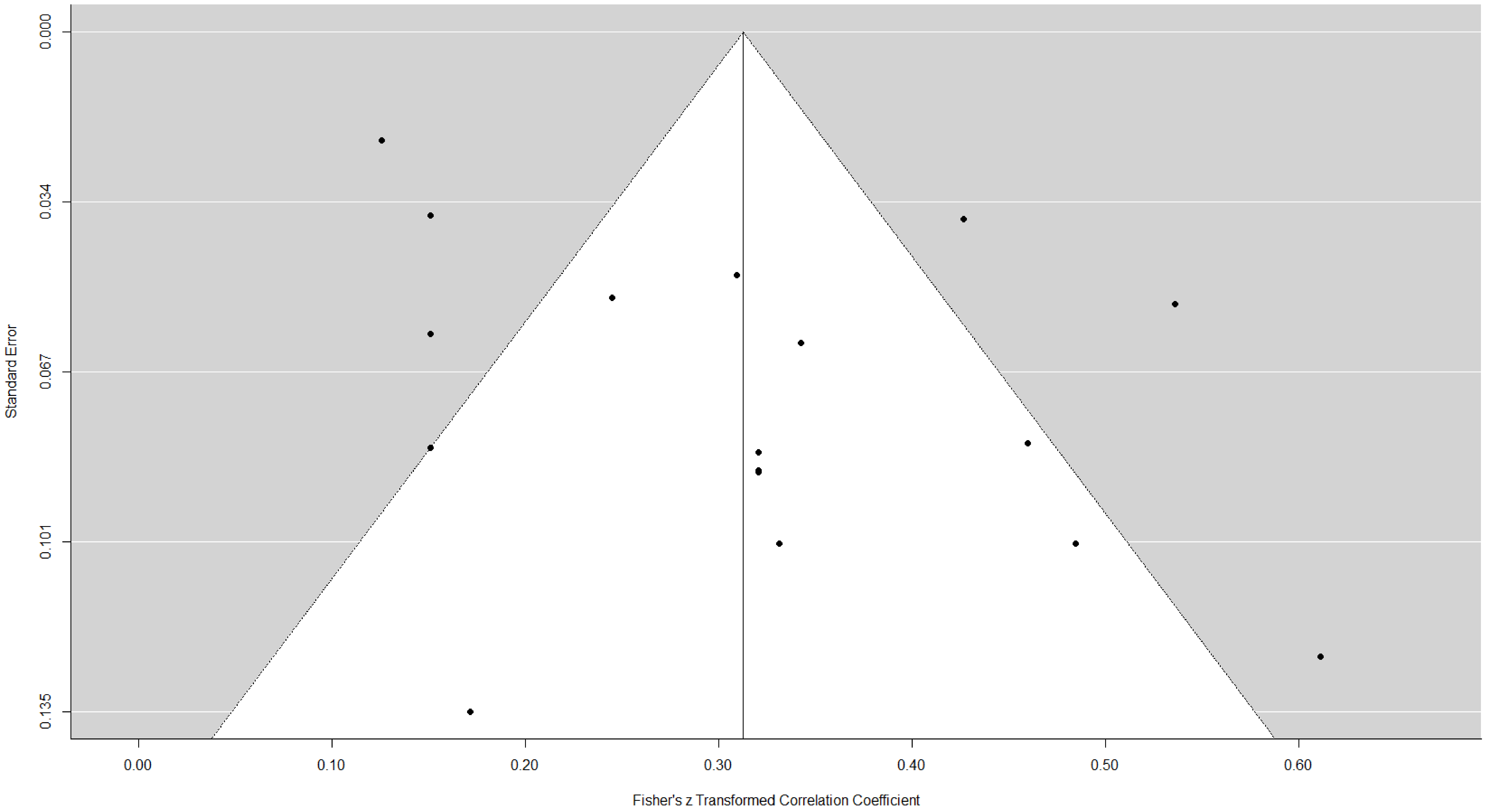
Fisher's z Transformed Correlation Coefficient



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Standard Error
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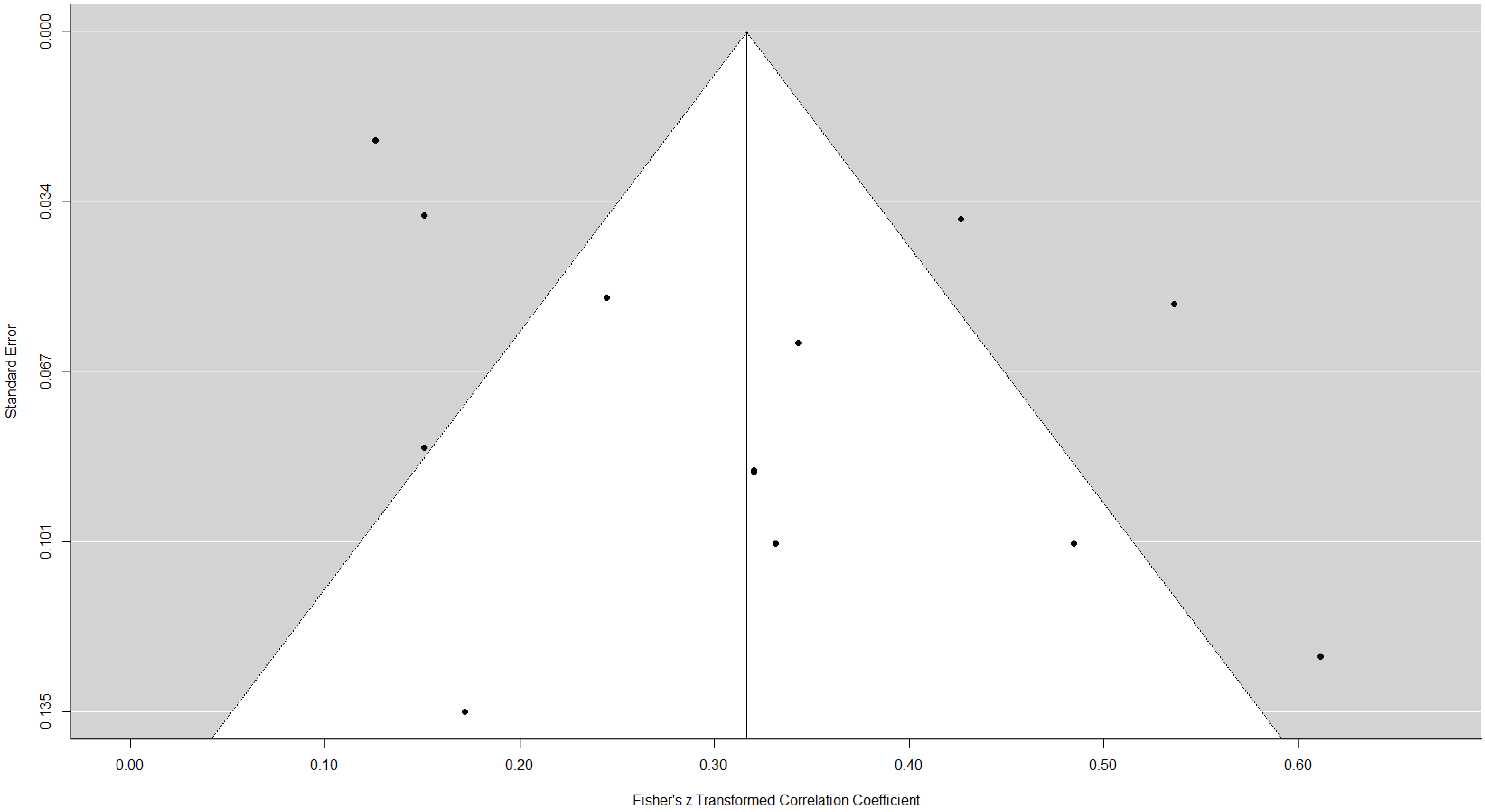
Fisher's z Transformed Correlation Coefficient



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0.067
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Standard Error
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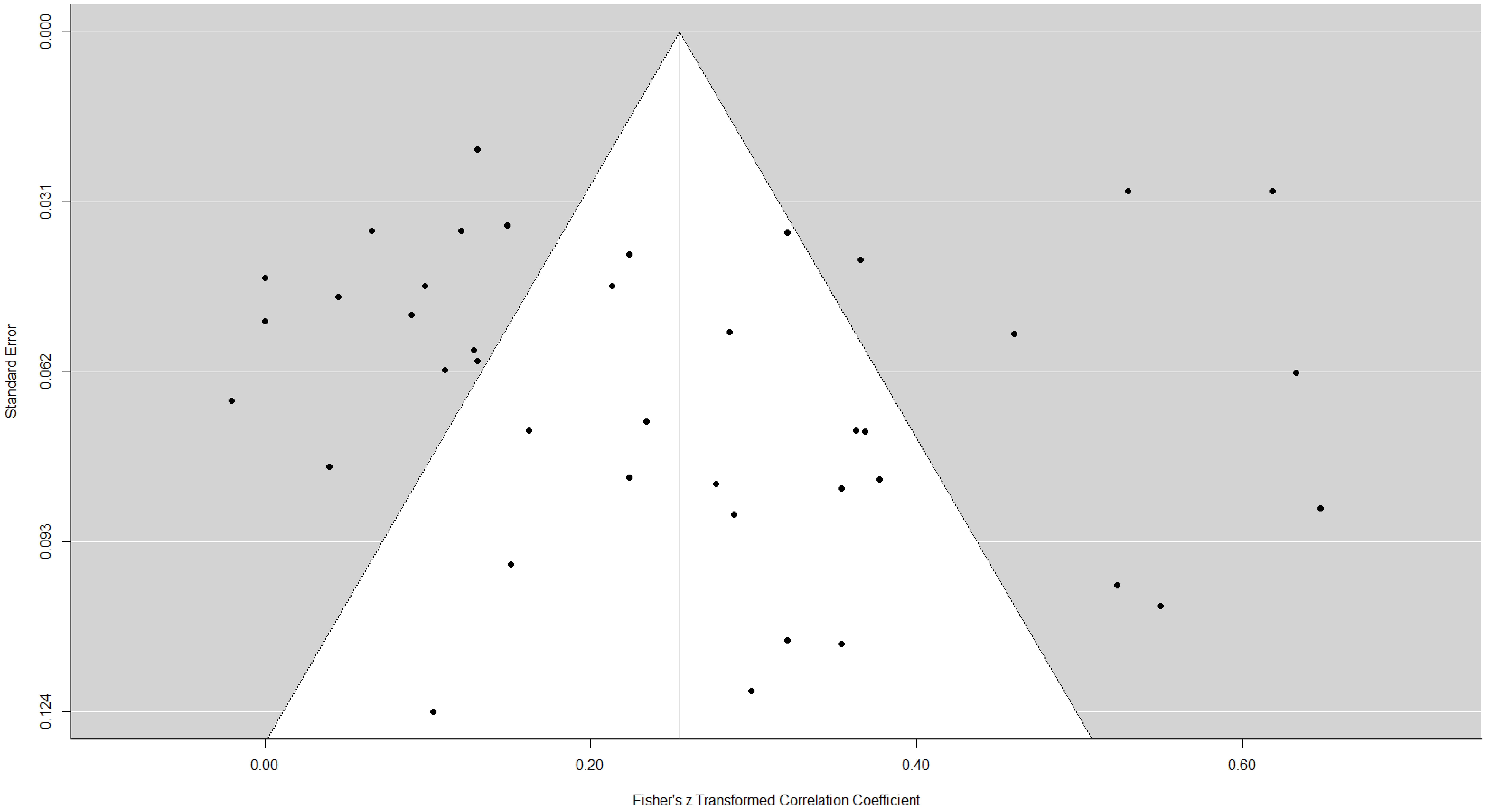
0.60
Fisher's z Transformed Correlation Coefficient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Standard Error
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0.20
0.40
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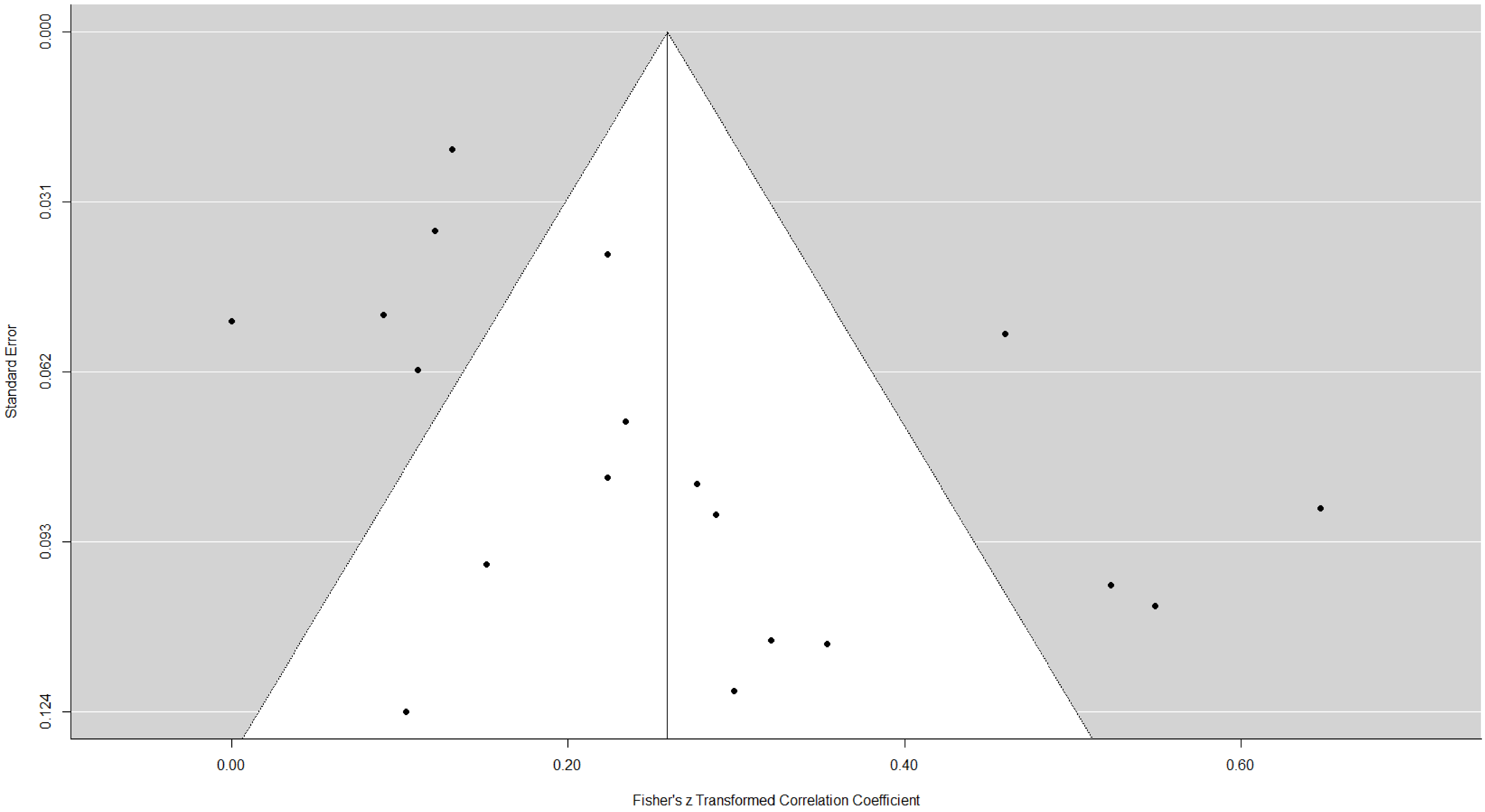
Fisher's z Transformed Correlation Coefficient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Standard Error
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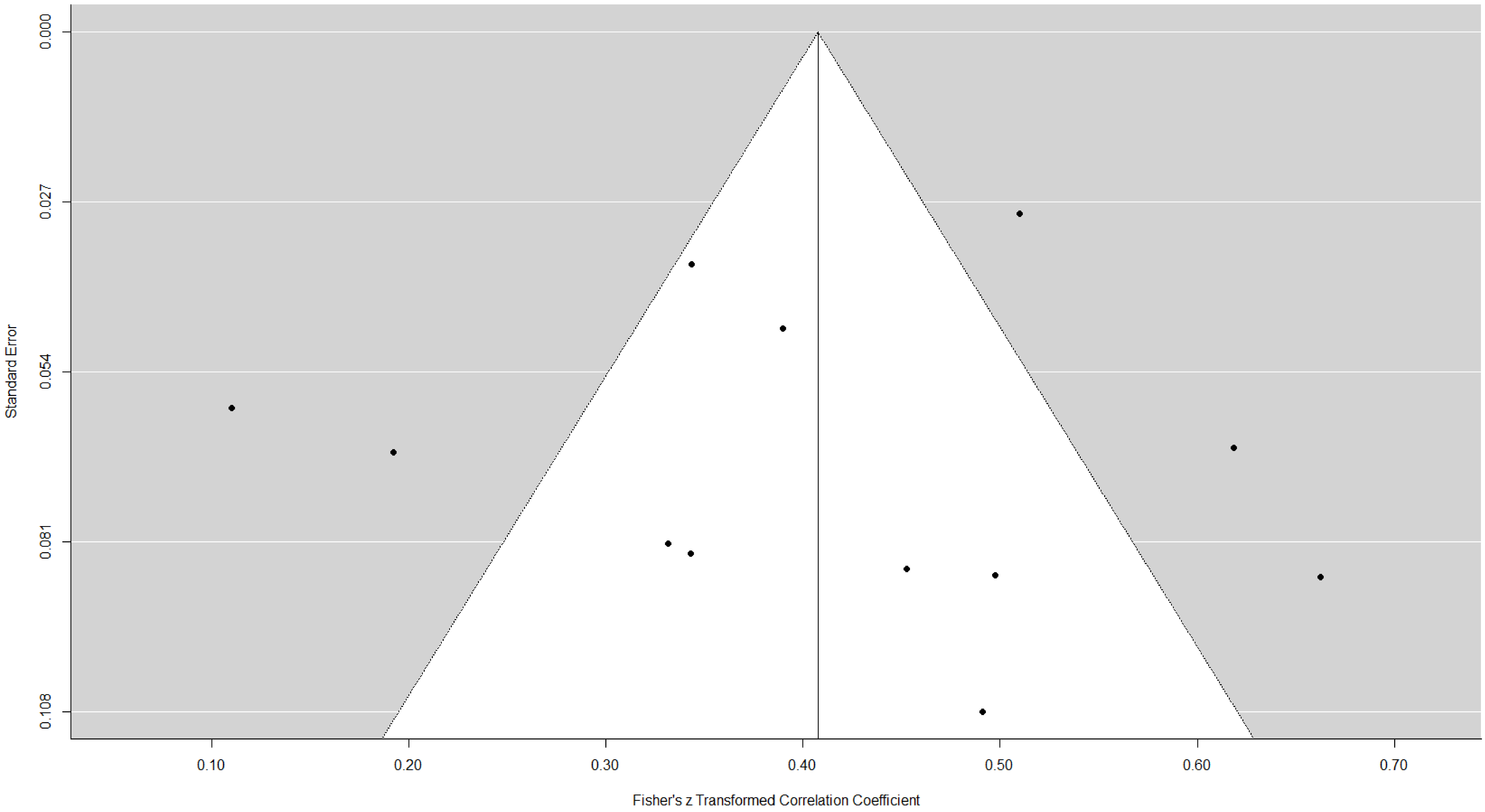
0.40
0.60
Fisher's z Transformed Correlation Coefficient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0.054
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0.108
0.10
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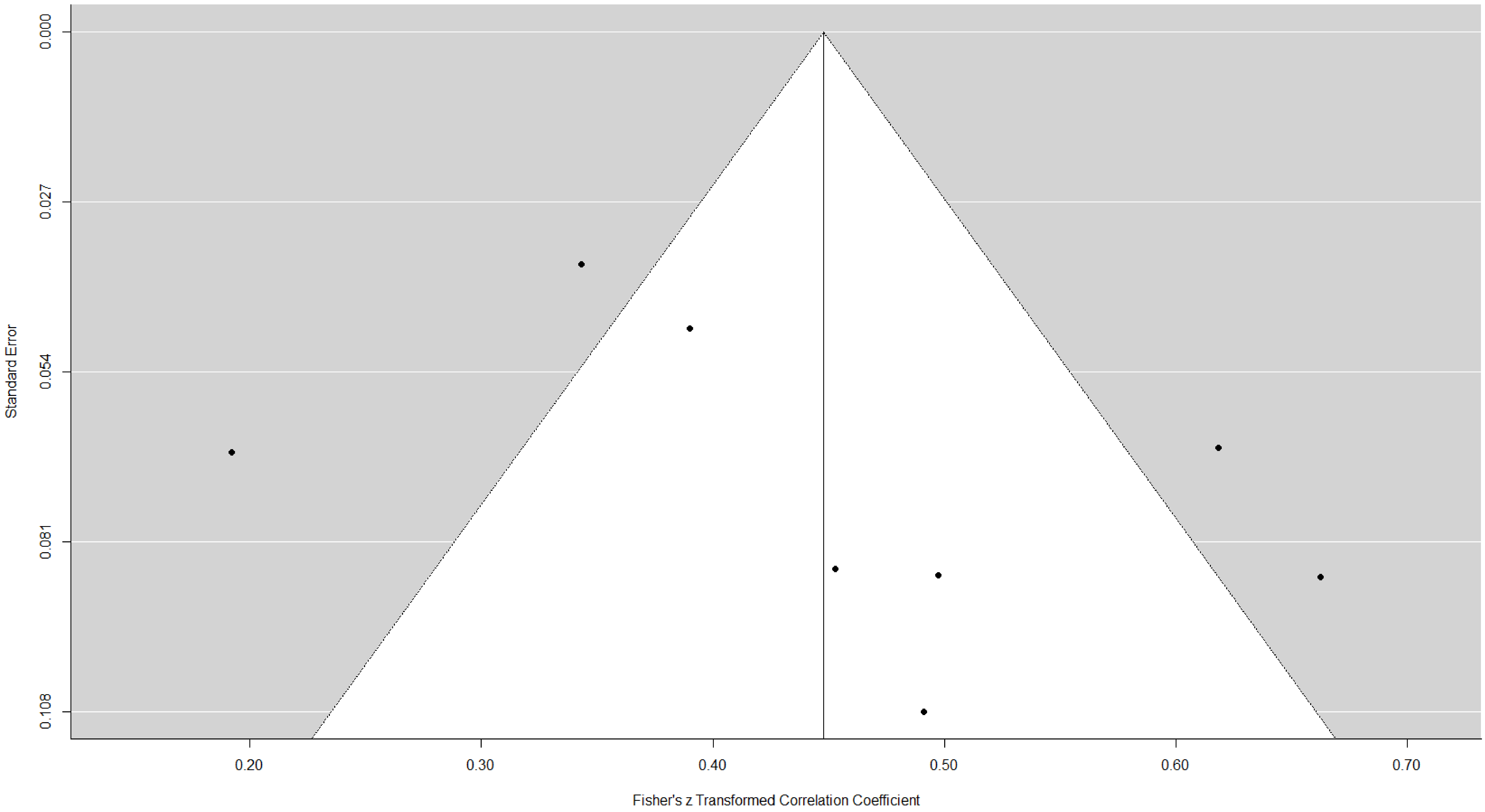
0.70
Fisher's z Transformed Correlation Coefficient



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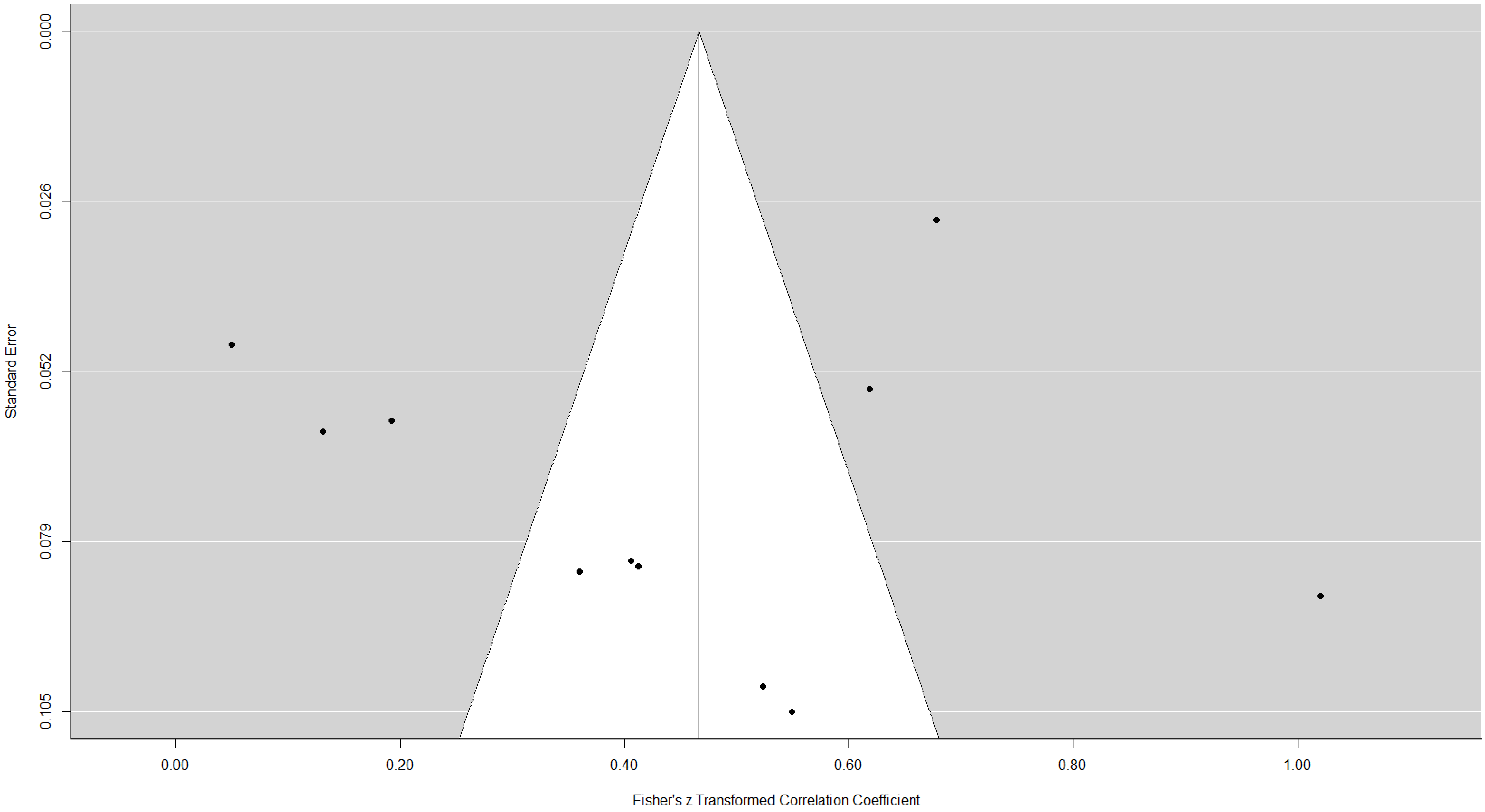
Fisher's z Transformed Correlation Coefficient



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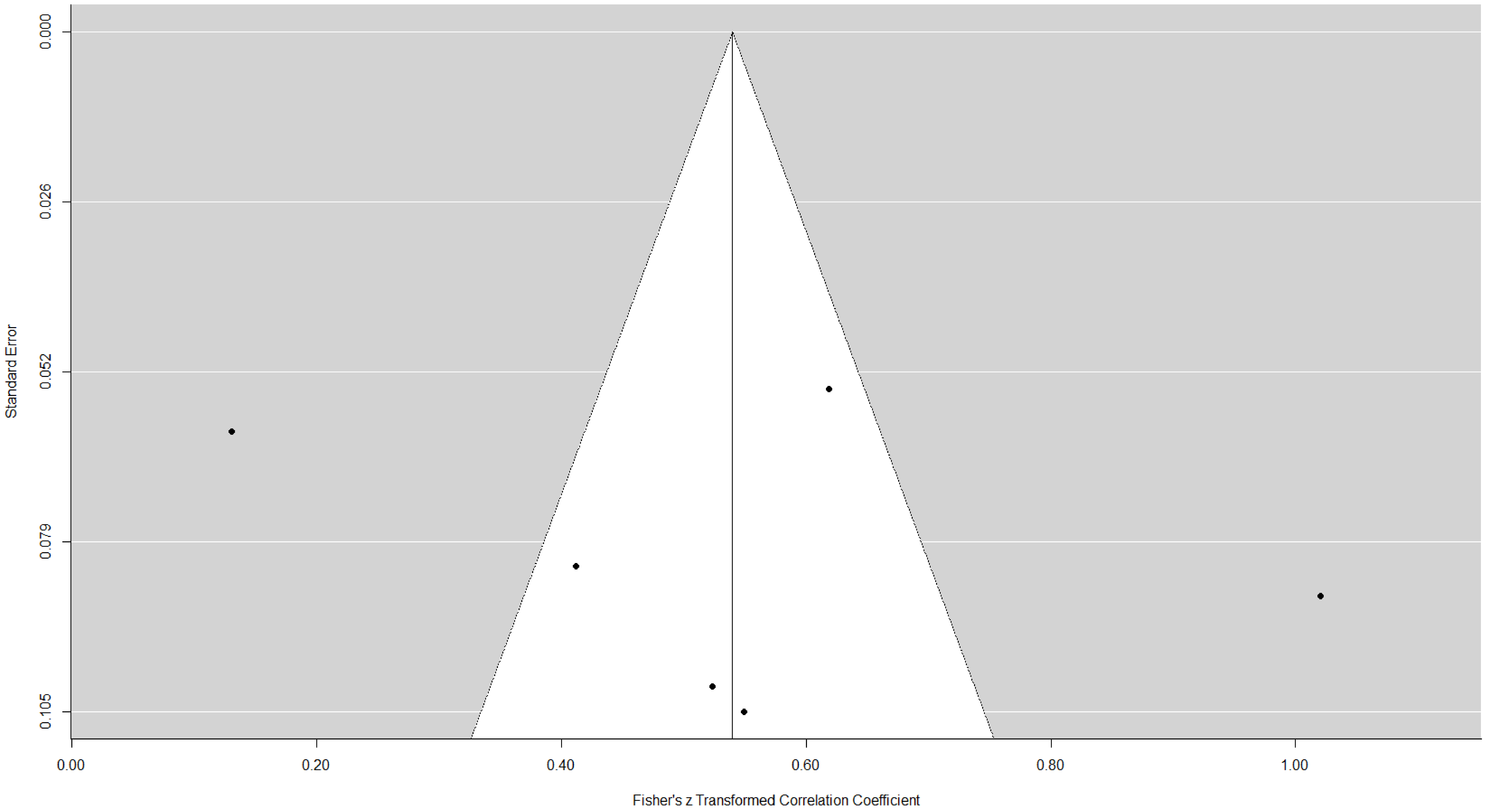
1.00
Fisher's z Transformed Correlation Coefficient



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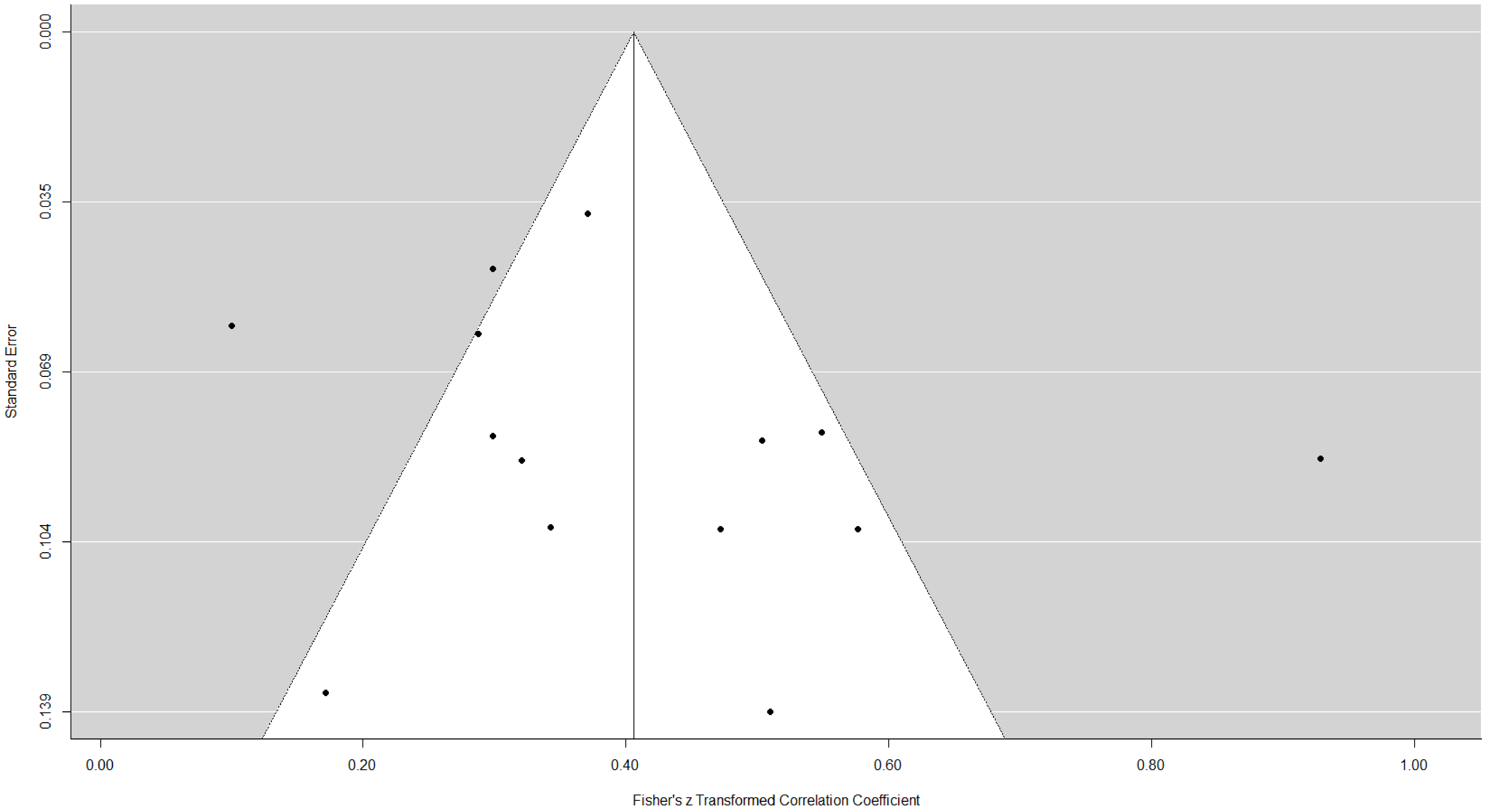
1.00
Fisher's z Transformed Correlation Coefficient



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0.139
0.00
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0.60
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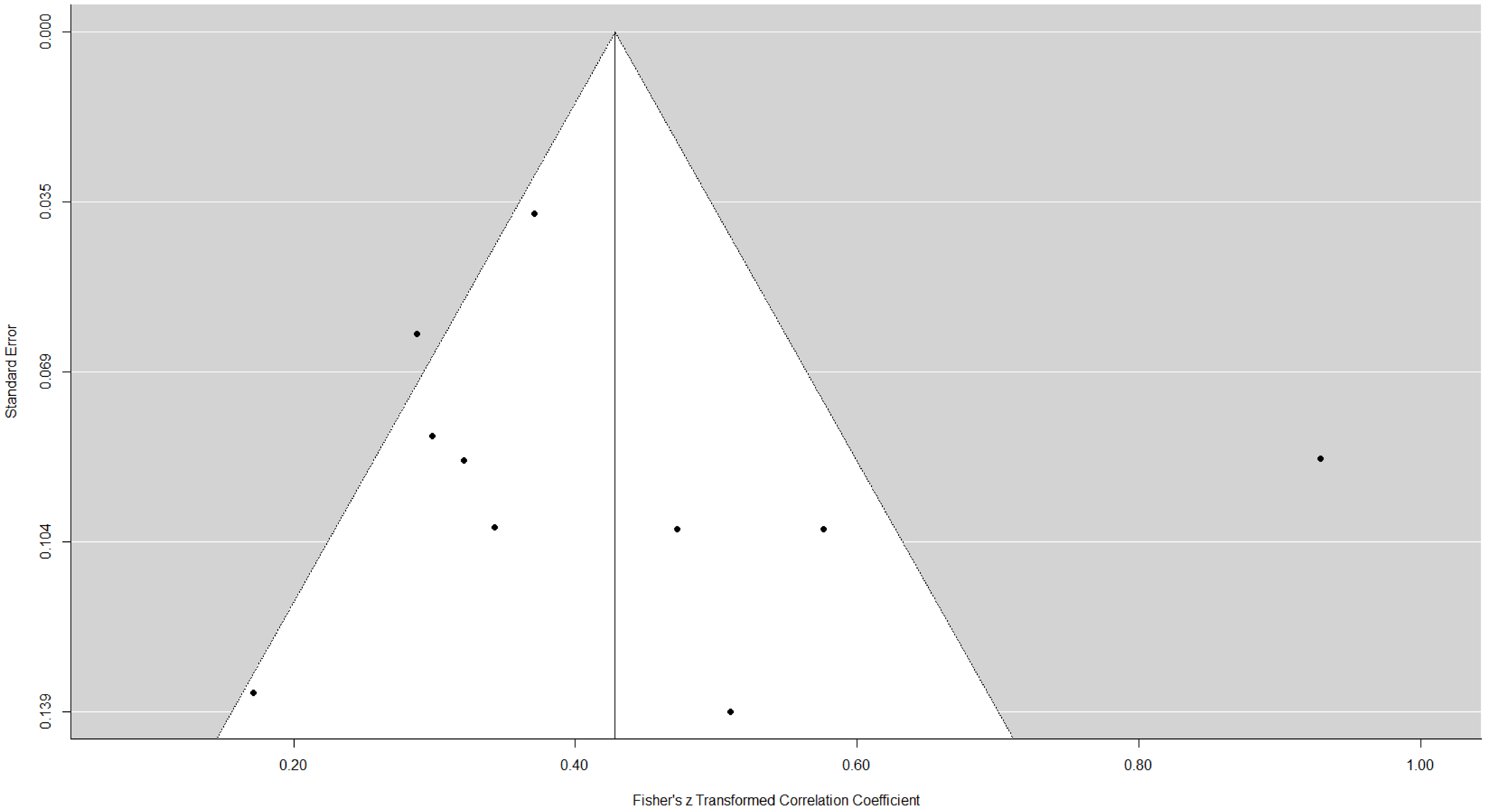
Fisher's z Transformed Correlation Coefficient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Standard Error
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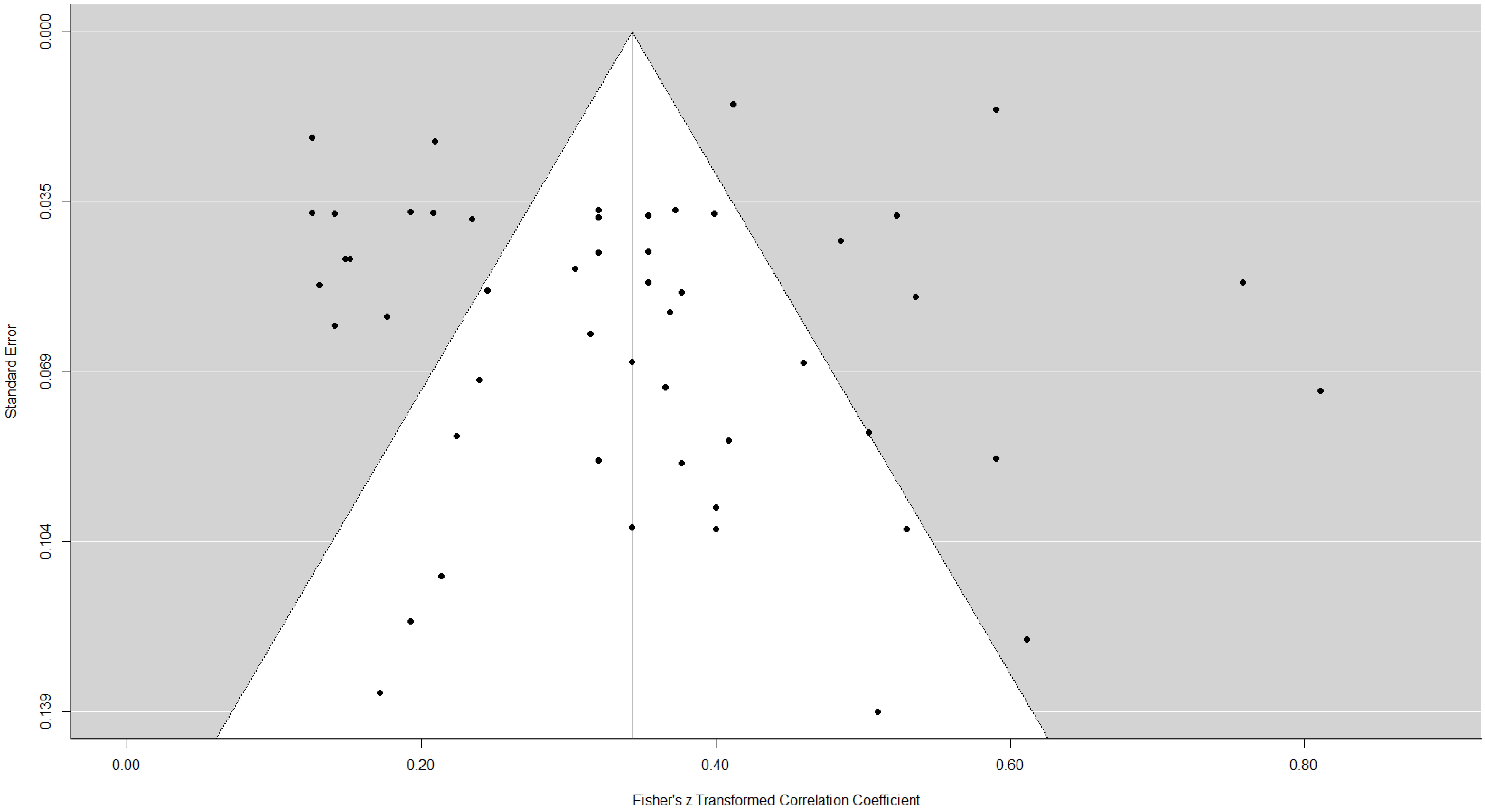
Fisher's z Transformed Correlation Coefficient



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0.139
0.00
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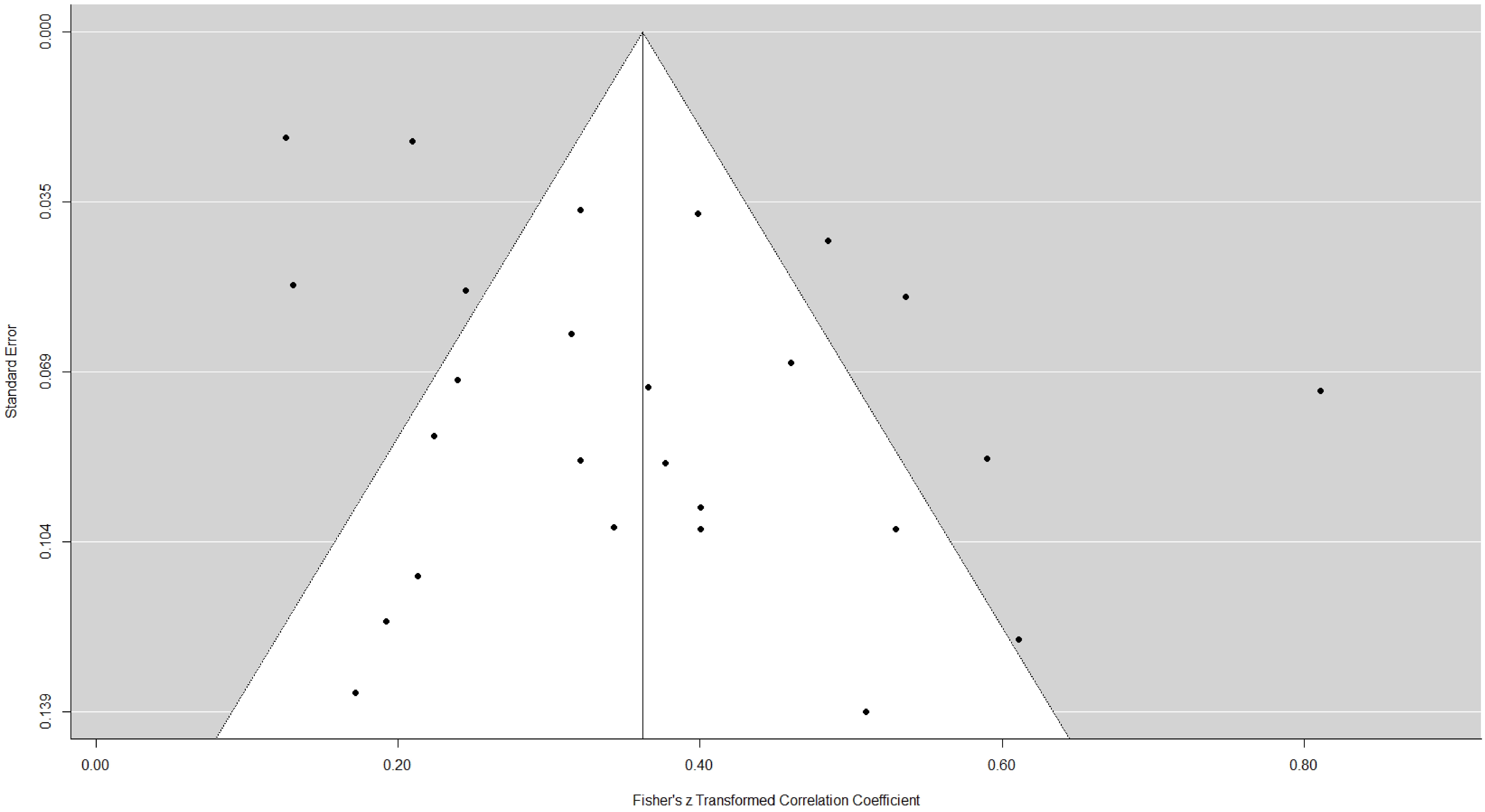
0.40
0.60
0.80
Fisher's z Transformed Correlation Coefficient



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Standard Error
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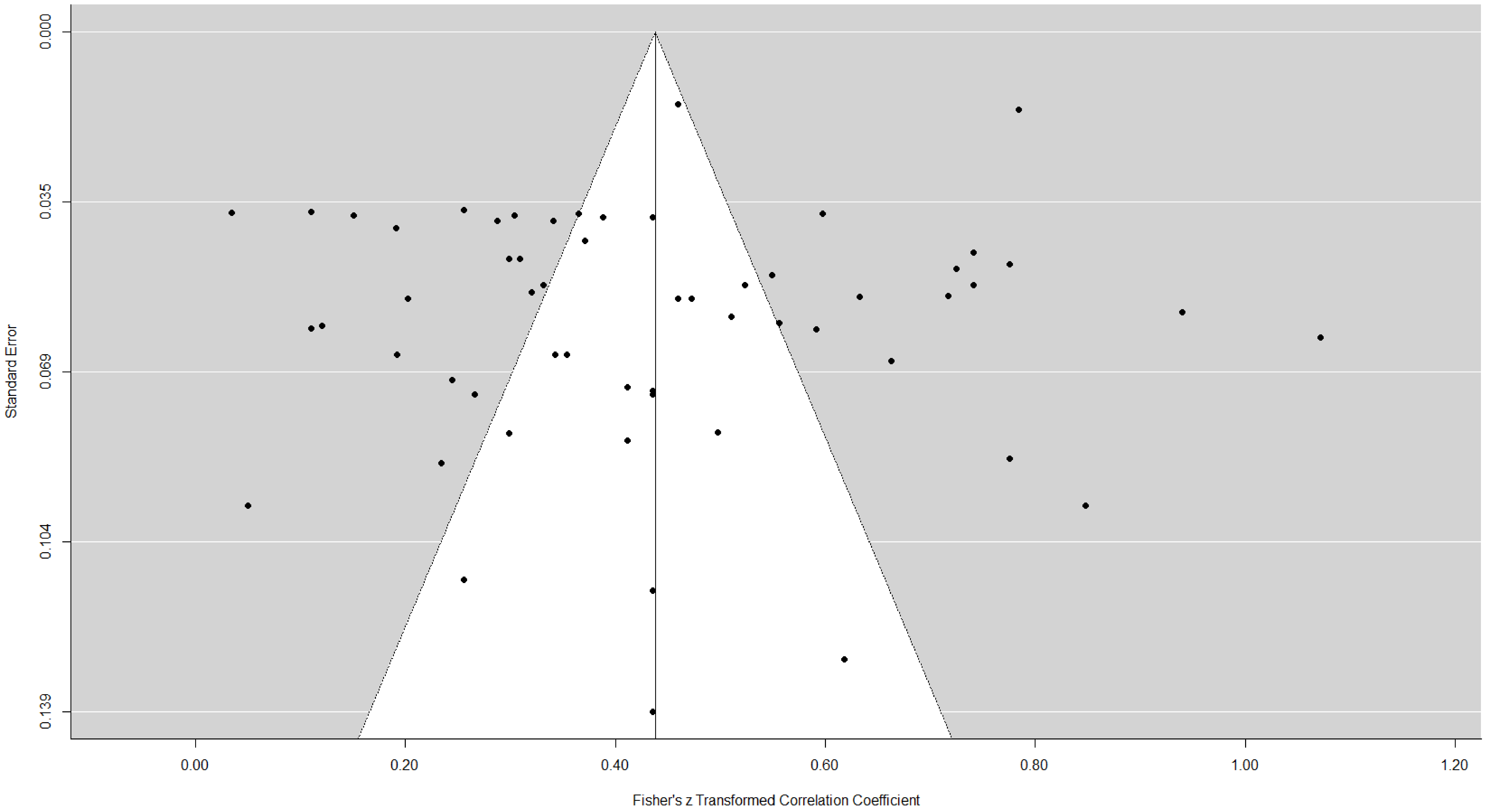
0.60
0.80
Fisher's z Transformed Correlation Coefficient



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Standard Error
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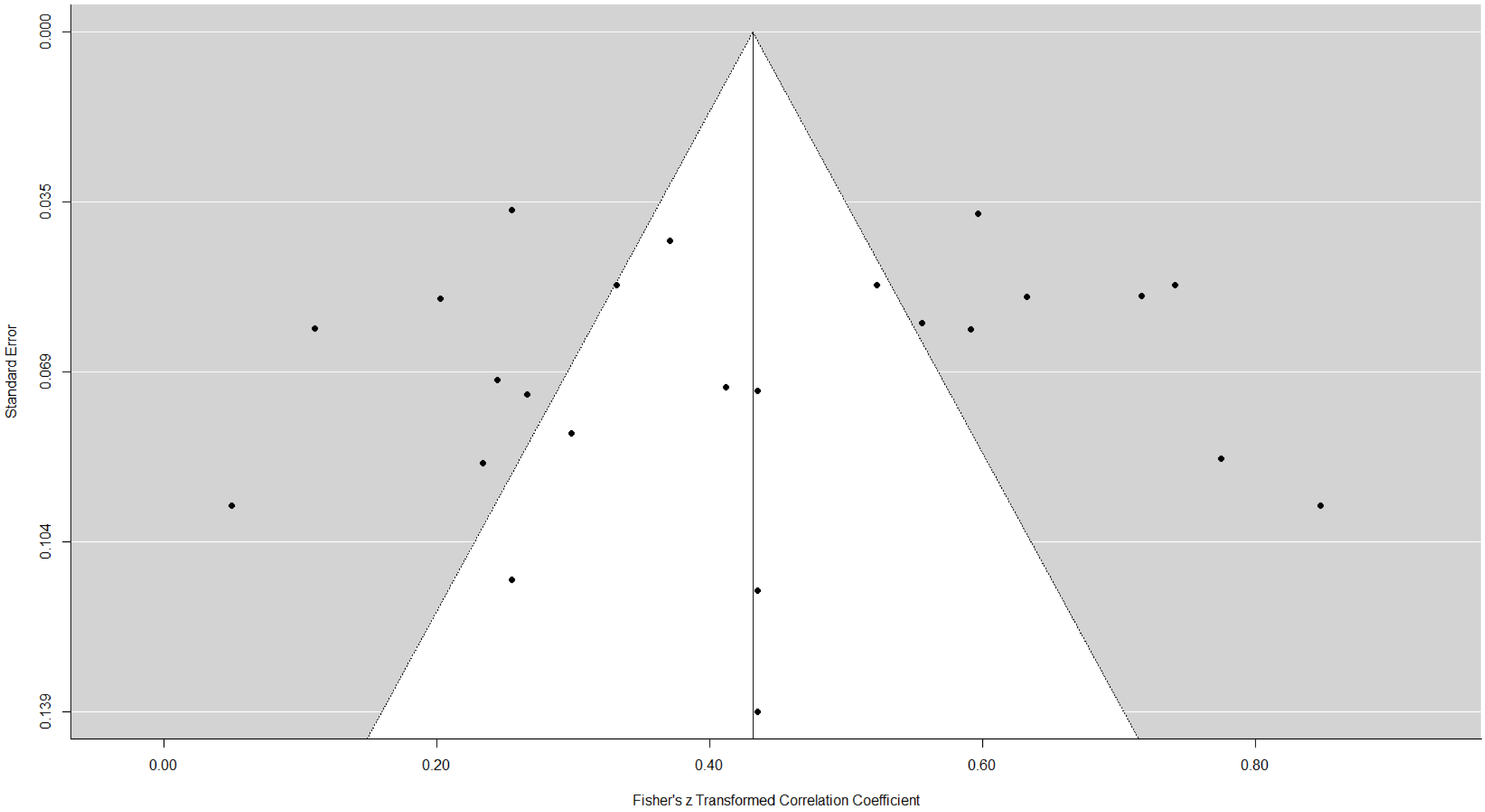
0.60
0.80
1.00
1.20
Fisher's z Transformed Correlation Coefficient



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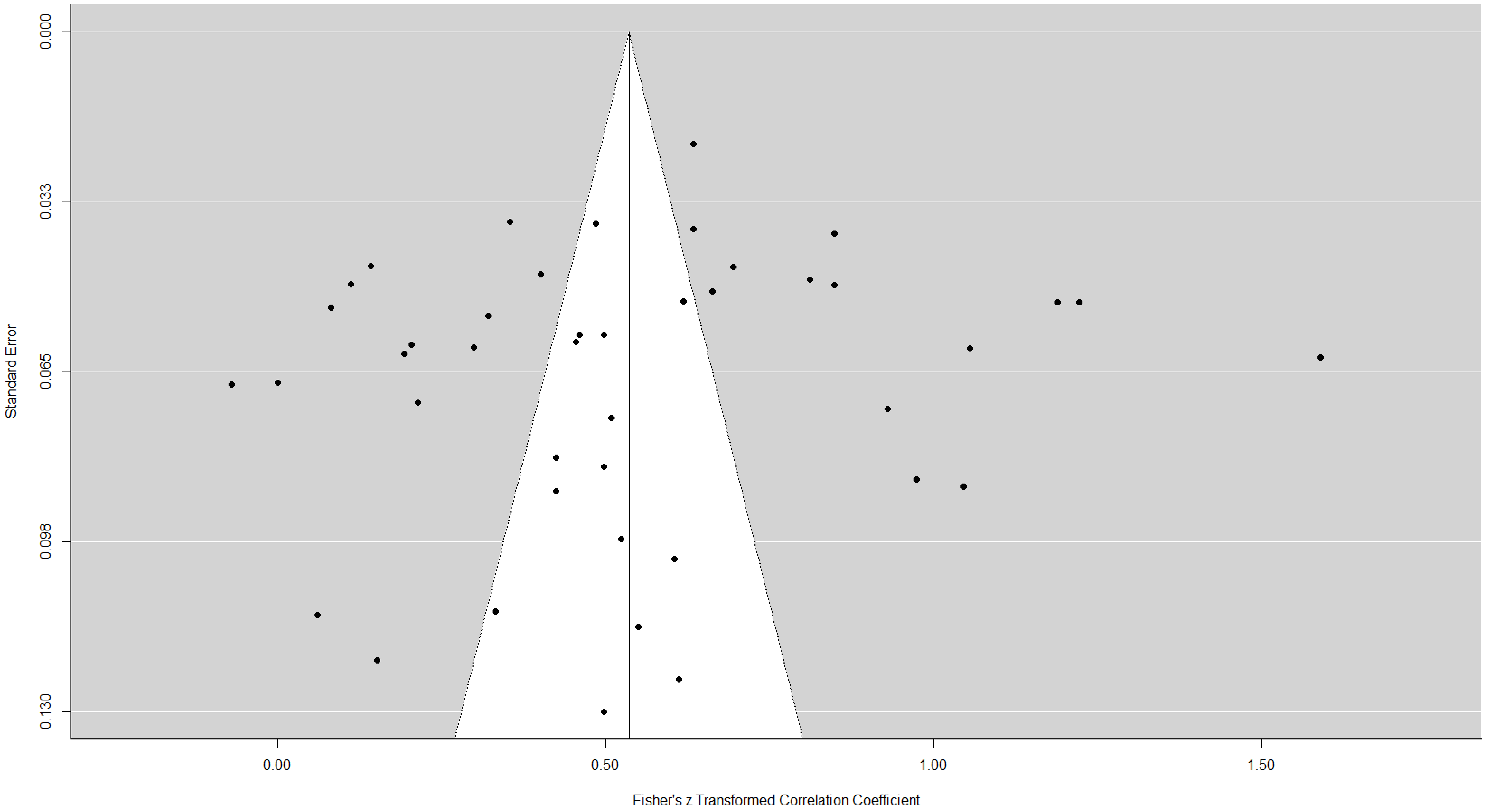
0.80
Fisher's z Transformed Correlation Coefficient



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0.130
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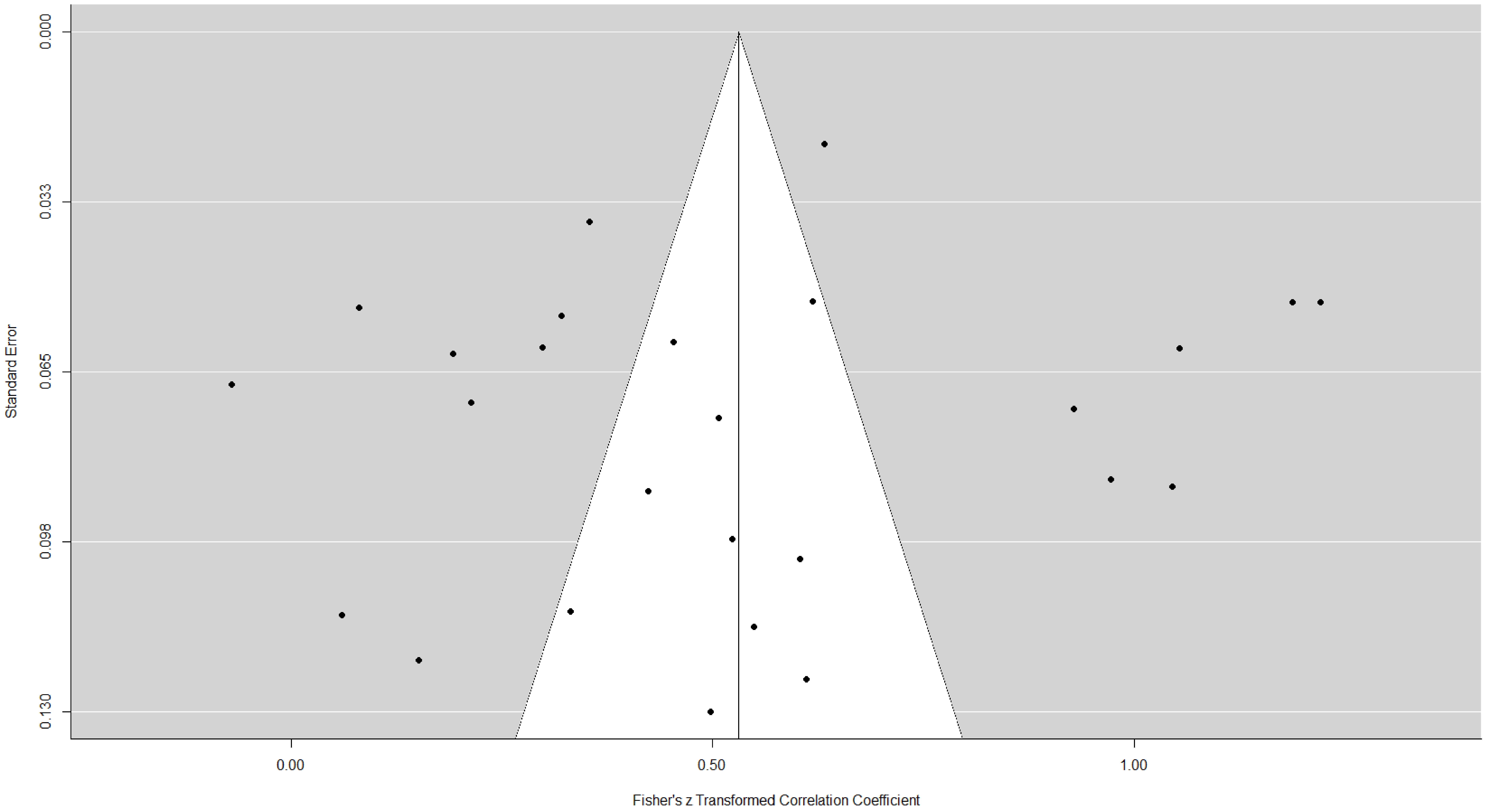
0.50
1.00
1.50
Fisher's z Transformed Correlation Coefficient



0.000
0.033
0.065
0.098
0.130
Standard Error
0.00
0.50
1.00
Fisher's z Transformed Correlation Coefficient

List of Forest Plots

IB – All

IB – No Overlap

PB – All

PB – No Overlap

PFB – All

PFB – No Overlap

PFI – All

PFI – No overlap

PFW – All

PWF – No Overlap

PI – All

PI – No overlap

PSB – All

PSB – No overlap

PSI – All

PSI – No overlap

PSW – All

PSW – No overlap

PW – All

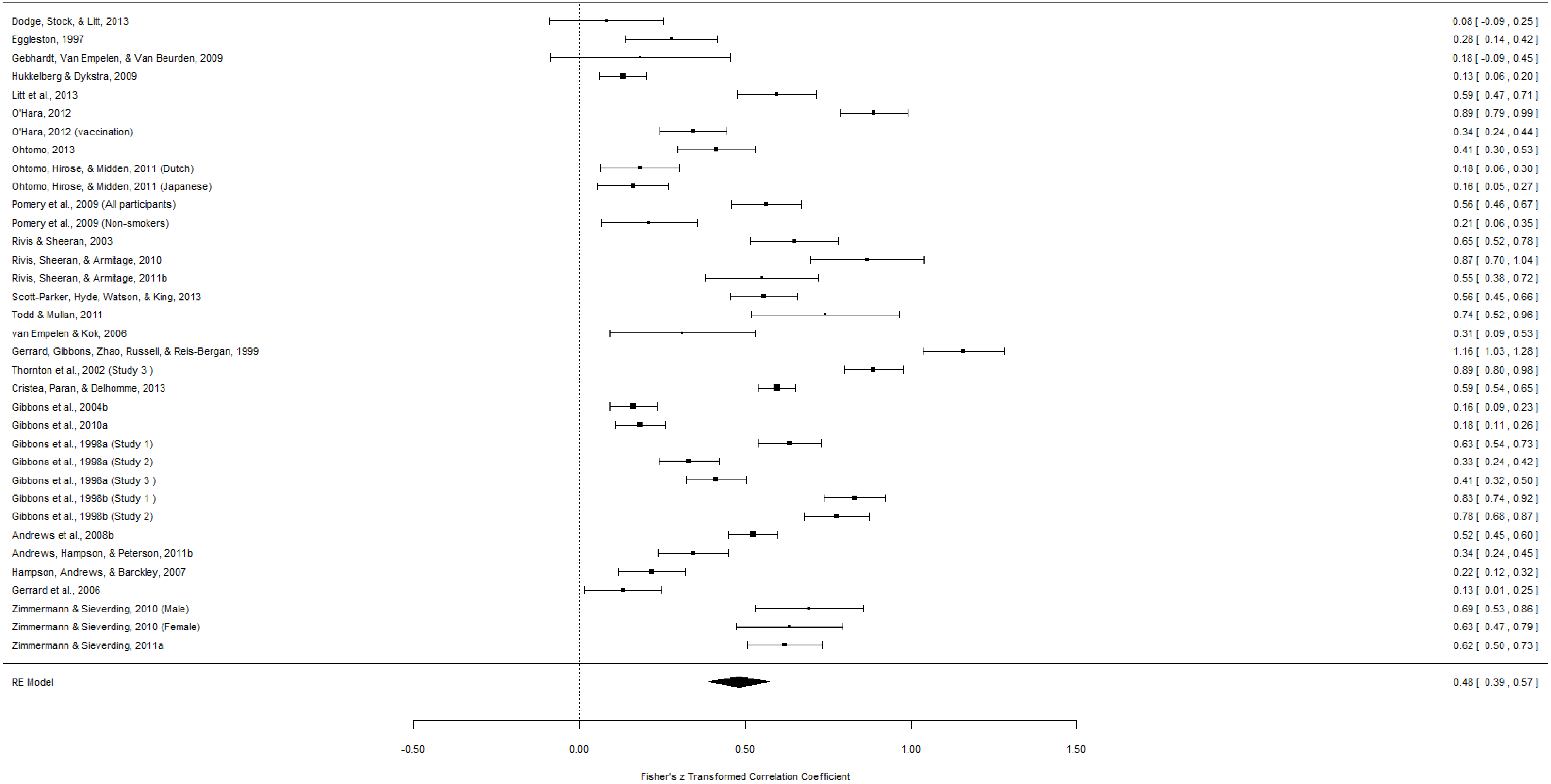
PW – No overlap

WB – All

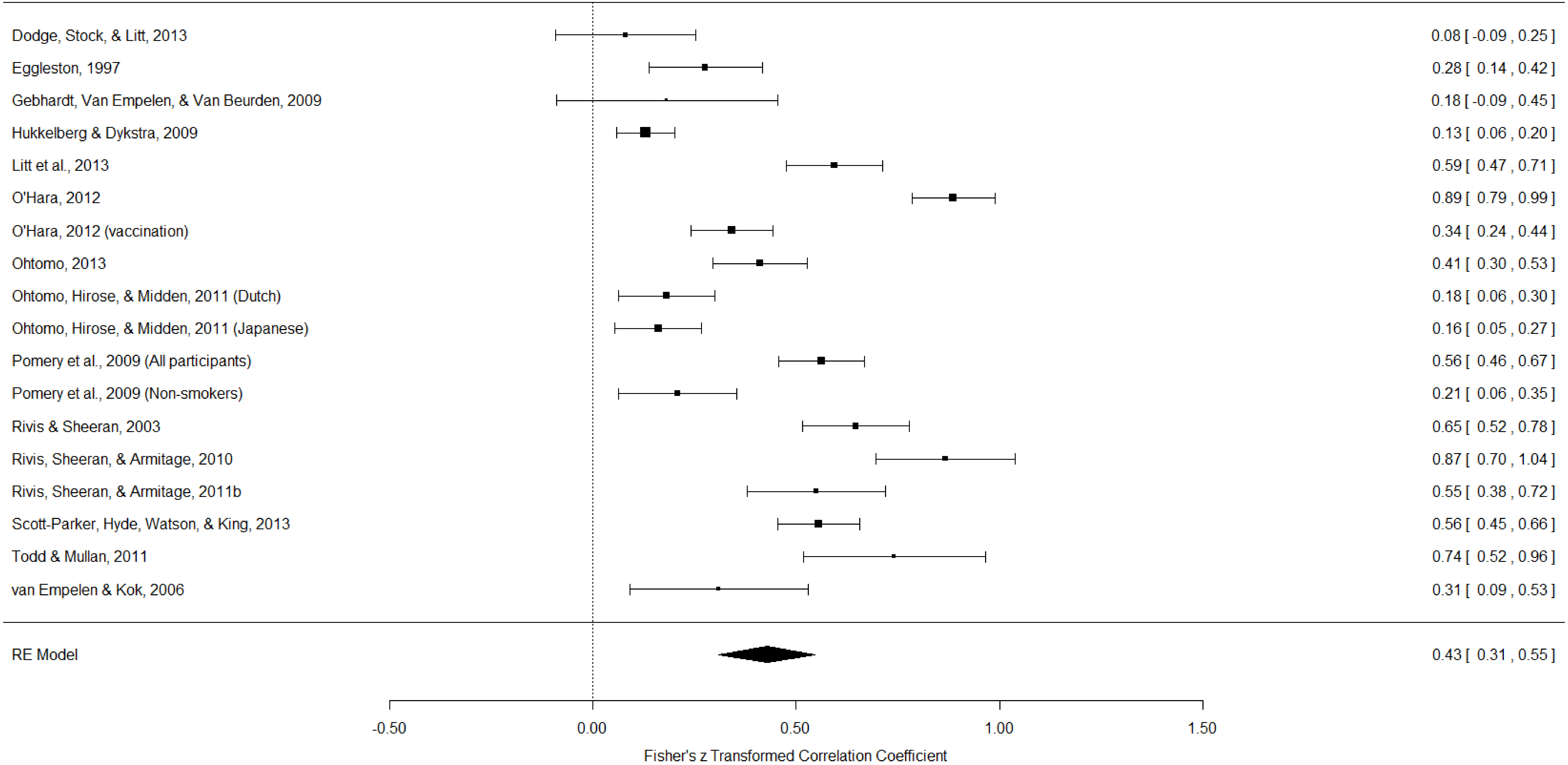
WB – No Overall

WI – All

WI – No overlap



Dodge, Stock, & Litt, 2013 0.08 [-0.09 , 0.25]
Eggleston, 1997 0.28 [0.14 , 0.42]
Gebhardt, Van Empelen, & Van Beurden, 2009 0.18 [-0.09 , 0.45]
Hukkelberg & Dykstra, 2009 0.13 [0.06 , 0.20]
Litt et al., 2013 0.59 [0.47 , 0.71]
O'Hara, 2012 0.89 [0.79 , 0.99]
O'Hara, 2012 (vaccination) 0.34 [0.24 , 0.44]
Ohtomo, 2013 0.41 [0.30 , 0.53]
Ohtomo, Hirose, & Midden, 2011 (Dutch) 0.18 [0.06 , 0.30]
Ohtomo, Hirose, & Midden, 2011 (Japanese) 0.16 [0.05 , 0.27]
Pomery et al., 2009 (All participants) 0.56 [0.46 , 0.67]
Pomery et al., 2009 (Non-smokers) 0.21 [0.06 , 0.35]
Rivis & Sheeran, 2003 0.65 [0.52 , 0.78]
Rivis, Sheeran, & Armitage, 2010 0.87 [0.70 , 1.04]
Rivis, Sheeran, & Armitage, 2011b 0.55 [0.38 , 0.72]
Scott-Parker, Hyde, Watson, & King, 2013 0.56 [0.45 , 0.66]
Todd & Mullan, 2011 0.74 [0.52 , 0.96]
van Empelen & Kok, 2006 0.31 [0.09 , 0.53]
Gerrard, Gibbons, Zhao, Russell, & Reis-Bergan, 1999 1.16 [1.03 , 1.28]
Thornton et al., 2002 (Study 3) 0.89 [0.80 , 0.98]
Cristea, Paran, & Delhomme, 2013 0.59 [0.54 , 0.65]
Gibbons et al., 2004b 0.16 [0.09 , 0.23]
Gibbons et al., 2010a 0.18 [0.11 , 0.26]
Gibbons et al., 1998a (Study 1) 0.63 [0.54 , 0.73]
Gibbons et al., 1998a (Study 2) 0.33 [0.24 , 0.42]
Gibbons et al., 1998a (Study 3) 0.41 [0.32 , 0.50]
Gibbons et al., 1998b (Study 1) 0.83 [0.74 , 0.92]
Gibbons et al., 1998b (Study 2) 0.78 [0.68 , 0.87]
Andrews et al., 2008b 0.52 [0.45 , 0.60]
Andrews, Hampson, & Peterson, 2011b 0.34 [0.24 , 0.45]
Hampson, Andrews, & Barckley, 2007 0.22 [0.12 , 0.32]
Gerrard et al., 2006 0.13 [0.01 , 0.25]
Zimmermann & Sieverding, 2010 (Male) 0.69 [0.53 , 0.86]
Zimmermann & Sieverding, 2010 (Female) 0.63 [0.47 , 0.79]
Zimmermann & Sieverding, 2011a 0.62 [0.50 , 0.73]
RE Model 0.48 [0.39 , 0.57]
-0.50
0.00
0.50
1.00
1.50
Fisher's z Transformed Correlation Coefficient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0.18 [-0.09 , 0.45]
Hukkelberg & Dykstra, 2009
0.13 [0.06 , 0.20]
Litt et al., 2013
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O'Hara, 2012
0.89 [0.79 , 0.99]
O'Hara, 2012 (vaccination)
0.34 [0.24 , 0.44]
Ohtomo, 2013
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Ohtomo, Hirose, & Midden, 2011 (Dutch)
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Ohtomo, Hirose, & Midden, 2011 (Japanese)
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Pomery et al., 2009 (Non-smokers)
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Rivis, Sheeran, & Armitage, 2011b
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Scott-Parker, Hyde, Watson, & King, 2013
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Todd & Mullan, 2011
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van Empelen & Kok, 2006
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RE Model
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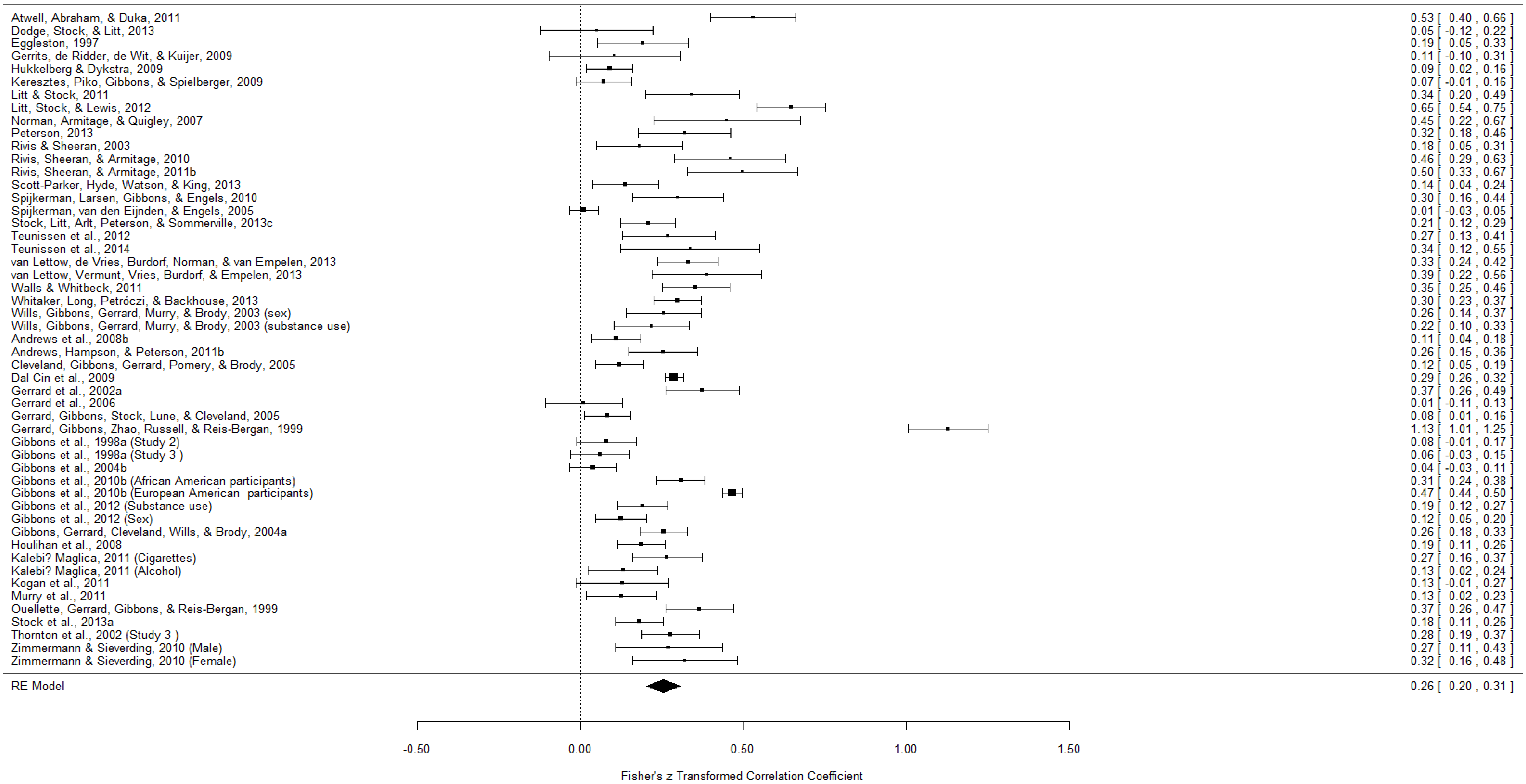
1.00
1.50
Fisher's z Transformed Correlation Coefficient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Gerrits, de Ridder, de Wit, & Kuijer, 2009 0.11 [-0.10 , 0.31]
Hukkelberg & Dykstra, 2009 0.09 [0.02 , 0.16]
Keresztes, Piko, Gibbons, & Spielberger, 2009 0.07 [-0.01 , 0.16]
Litt & Stock, 2011 0.34 [0.20 , 0.49]
Litt, Stock, & Lewis, 2012 0.65 [0.54 , 0.75]
Norman, Armitage, & Quigley, 2007 0.45 [0.22 , 0.67]
Peterson, 2013 0.32 [0.18 , 0.46]
Rivis & Sheeran, 2003 0.18 [0.05 , 0.31]
Rivis, Sheeran, & Armitage, 2010 0.46 [0.29 , 0.63]
Rivis, Sheeran, & Armitage, 2011b 0.50 [0.33 , 0.67]
Scott-Parker, Hyde, Watson, & King, 2013 0.14 [0.04 , 0.24]
Spijkerman, Larsen, Gibbons, & Engels, 2010 0.30 [0.16 , 0.44]
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Stock, Litt, Arlt, Peterson, & Sommerville, 2013c 0.21 [0.12 , 0.29]
Teunissen et al., 2012 0.27 [0.13 , 0.41]
Teunissen et al., 2014 0.34 [0.12 , 0.55]
van Lettow, de Vries, Burdorf, Norman, & van Empelen, 2013 0.33 [0.24 , 0.42]
van Lettow, Vermunt, Vries, Burdorf, & Empelen, 2013 0.39 [0.22 , 0.56]
Walls & Whitbeck, 2011 0.35 [0.25 , 0.46]
Whitaker, Long, Petróczi, & Backhouse, 2013 0.30 [0.23 , 0.37]
Wills, Gibbons, Gerrard, Murry, & Brody, 2003 (sex) 0.26 [0.14 , 0.37]
Wills, Gibbons, Gerrard, Murry, & Brody, 2003 (substance use) 0.22 [0.10 , 0.33]
Andrews et al., 2008b 0.11 [0.04 , 0.18]
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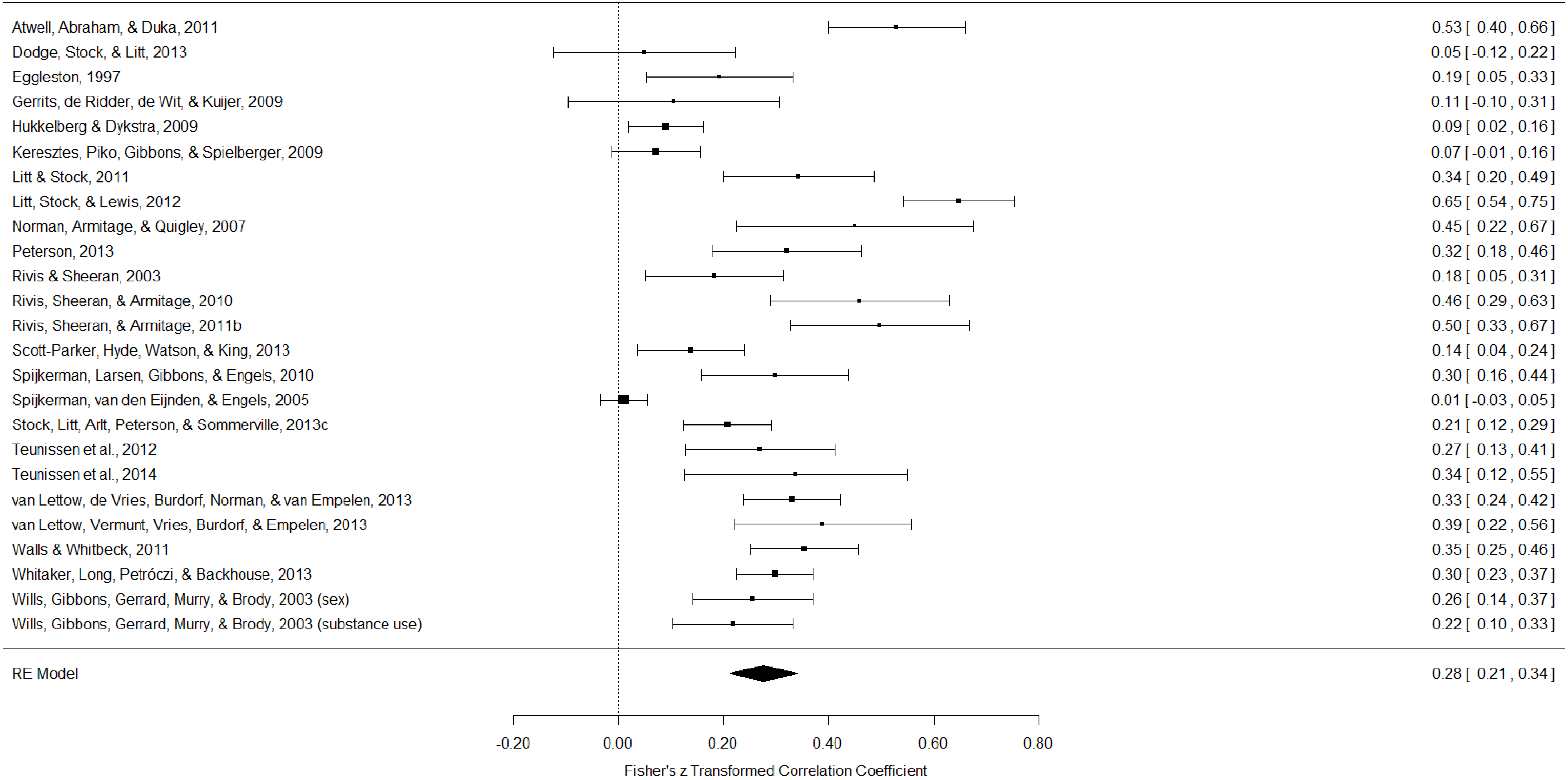
Cleveland, Gibbons, Gerrard, Pomery, & Brody, 2005 0.12 [0.05 , 0.19]
Dal Cin et al., 2009 0.29 [0.26 , 0.32]
Gerrard et al., 2002a 0.37 [0.26 , 0.49]
Gerrard et al., 2006 0.01 [-0.11 , 0.13]
Gerrard, Gibbons, Stock, Lune, & Cleveland, 2005 0.08 [0.01 , 0.16]
Gerrard, Gibbons, Zhao, Russell, & Reis-Bergan, 1999 1.13 [1.01 , 1.25]
Gibbons et al., 1998a (Study 2) 0.08 [-0.01 , 0.17]
Gibbons et al., 1998a (Study 3) 0.06 [-0.03 , 0.15]
Gibbons et al., 2004b 0.04 [-0.03 , 0.11]
Gibbons et al., 2010b (African American participants) 0.31 [0.24 , 0.38]
Gibbons et al., 2010b (European American participants) 0.47 [0.44 , 0.50]
Gibbons et al., 2012 (Substance use) 0.19 [0.12 , 0.27]
Gibbons et al., 2012 (Sex) 0.12 [0.05 , 0.20]
Gibbons, Gerrard, Cleveland, Wills, & Brody, 2004a 0.26 [0.18 , 0.33]
Houlihan et al., 2008 0.19 [0.11 , 0.26]
Kalebi? Maglica, 2011 (Cigarettes) 0.27 [0.16 , 0.37]
Kalebi? Maglica, 2011 (Alcohol) 0.13 [0.02 , 0.24]
Kogan et al., 2011 0.13 [-0.01 , 0.27]
Murry et al., 2011 0.13 [0.02 , 0.23]
Ouellette, Gerrard, Gibbons, & Reis-Bergan, 1999 0.37 [0.26 , 0.47]
Stock et al., 2013a 0.18 [0.11 , 0.26]
Thornton et al., 2002 (Study 3) 0.28 [0.19 , 0.37]
Zimmermann & Sieverding, 2010 (Male) 0.27 [0.11 , 0.43]
Zimmermann & Sieverding, 2010 (Female) 0.32 [0.16 , 0.48]
RE Model 0.26 [0.20 , 0.31]
-0.50
0.00
0.50
1.00
1.50
Fisher's z Transformed Correlation Coefficient


Atwell, Abraham, & Duka, 2011
0.53 [0.40 , 0.66]
Dodge, Stock, & Litt, 2013
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Gerrits, de Ridder, de Wit, & Kuijer, 2009
0.11 [-0.10 , 0.31]
Hukkelberg & Dykstra, 2009
0.09 [0.02 , 0.16]
Keresztes, Piko, Gibbons, & Spielberger, 2009
0.07 [-0.01 , 0.16]
Litt & Stock, 2011
0.34 [0.20 , 0.49]
Litt, Stock, & Lewis, 2012
0.65 [0.54 , 0.75]
Norman, Armitage, & Quigley, 2007
0.45 [0.22 , 0.67]
Peterson, 2013
0.32 [0.18 , 0.46]
Rivis & Sheeran, 2003
0.18 [0.05 , 0.31]
Rivis, Sheeran, & Armitage, 2010
0.46 [0.29 , 0.63]
Rivis, Sheeran, & Armitage, 2011b
0.50 [0.33 , 0.67]
Scott-Parker, Hyde, Watson, & King, 2013
0.14 [0.04 , 0.24]
Spijkerman, Larsen, Gibbons, & Engels, 2010
0.30 [0.16 , 0.44]
Spijkerman, van den Eijnden, & Engels, 2005
0.01 [-0.03 , 0.05]
Stock, Litt, Arlt, Peterson, & Sommerville, 2013c
0.21 [0.12 , 0.29]
Teunissen et al., 2012
0.27 [0.13 , 0.41]
Teunissen et al., 2014
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van Lettow, de Vries, Burdorf, Norman, & van Empelen, 2013
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van Lettow, Vermunt, Vries, Burdorf, & Empelen, 2013
0.39 [0.22 , 0.56]
Walls & Whitbeck, 2011
0.35 [0.25 , 0.46]
Whitaker, Long, Petróczi, & Backhouse, 2013
0.30 [0.23 , 0.37]
Wills, Gibbons, Gerrard, Murry, & Brody, 2003 (sex)
0.26 [0.14 , 0.37]
Wills, Gibbons, Gerrard, Murry, & Brody, 2003 (substance use)
0.22 [0.10 , 0.33]
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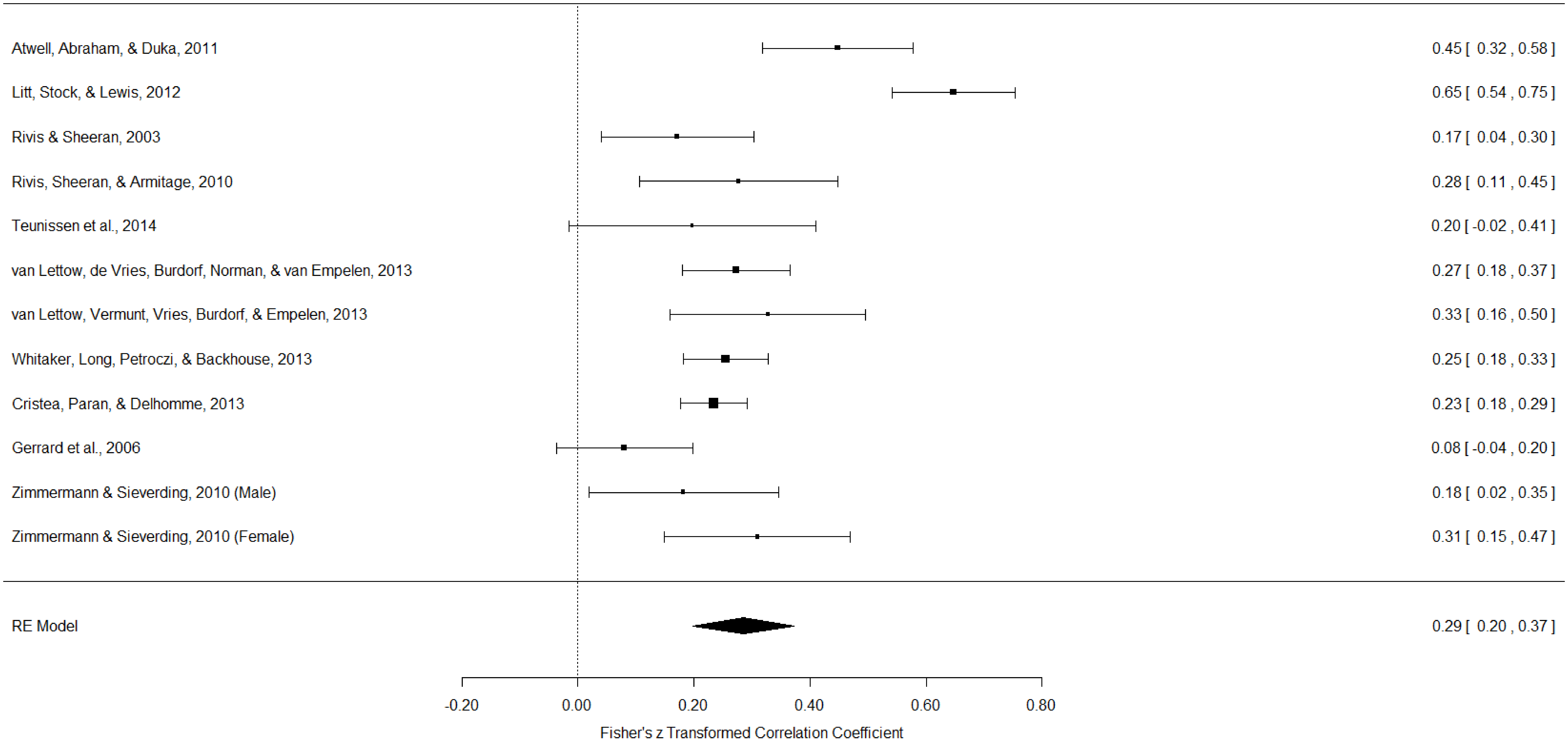
0.40
0.60
0.80
Fisher's z Transformed Correlation Coefficient



Atwell, Abraham, & Duka, 2011
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0.65 [0.54 , 0.75]
Rivis & Sheeran, 2003
0.17 [0.04 , 0.30]
Rivis, Sheeran, & Armitage, 2010
0.28 [0.11 , 0.45]
Teunissen et al., 2014
0.20 [-0.02 , 0.41]
van Lettow, de Vries, Burdorf, Norman, & van Empelen, 2013
0.27 [0.18 , 0.37]
van Lettow, Vermunt, Vries, Burdorf, & Empelen, 2013
0.33 [0.16 , 0.50]
Whitaker, Long, Petroczi, & Backhouse, 2013
0.25 [0.18 , 0.33]
Cristea, Paran, & Delhomme, 2013
0.23 [0.18 , 0.29]
Gerrard et al., 2006
0.08 [-0.04 , 0.20]
Zimmermann & Sieverding, 2010 (Male)
0.18 [0.02 , 0.35]
Zimmermann & Sieverding, 2010 (Female)
0.31 [0.15 , 0.47]
RE Model
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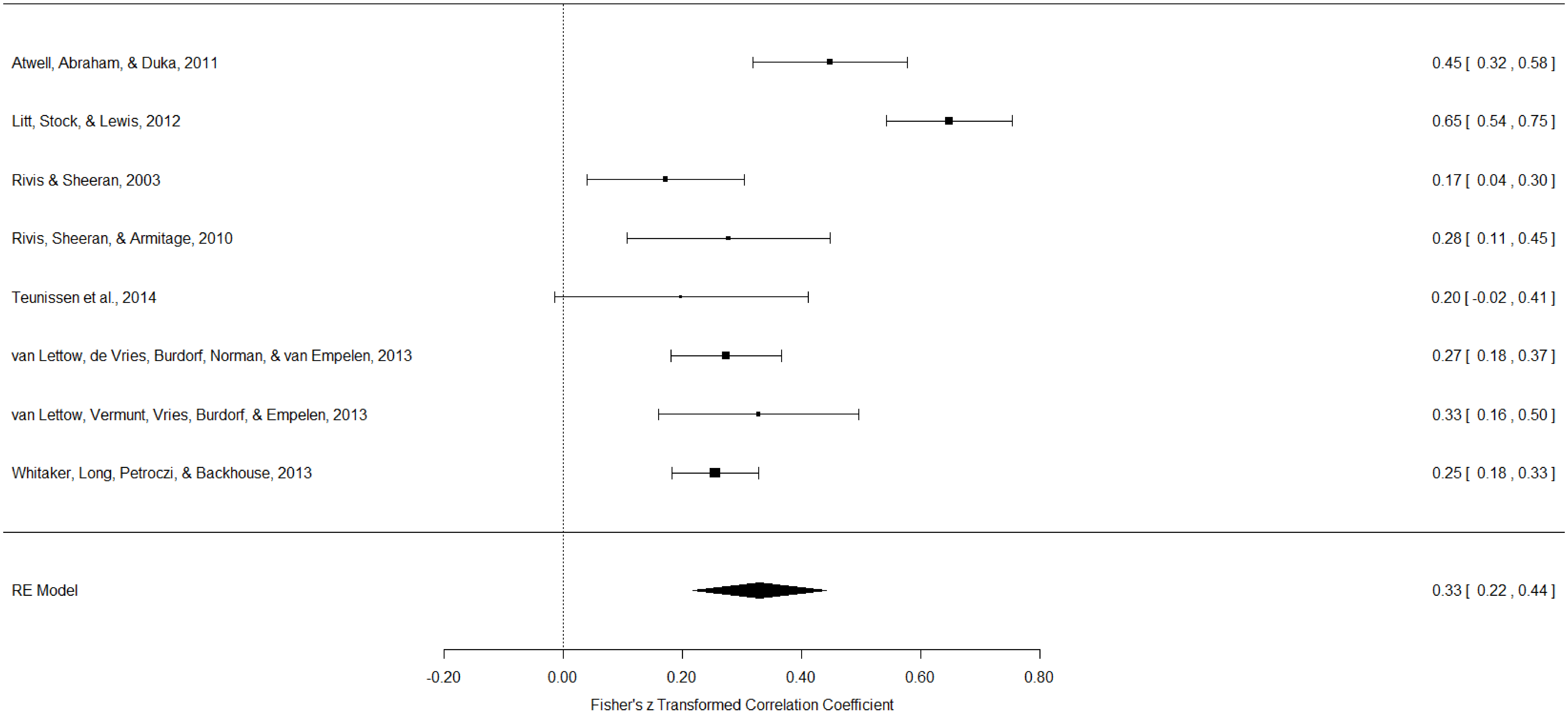
0.40
0.60
0.80
Fisher's z Transformed Correlation Coefficient


Atwell, Abraham, & Duka, 2011
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Rivis & Sheeran, 2003
0.17 [0.04 , 0.30]
Rivis, Sheeran, & Armitage, 2010
0.28 [0.11 , 0.45]
Teunissen et al., 2014
0.20 [-0.02 , 0.41]
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0.33 [0.16 , 0.50]
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0.00
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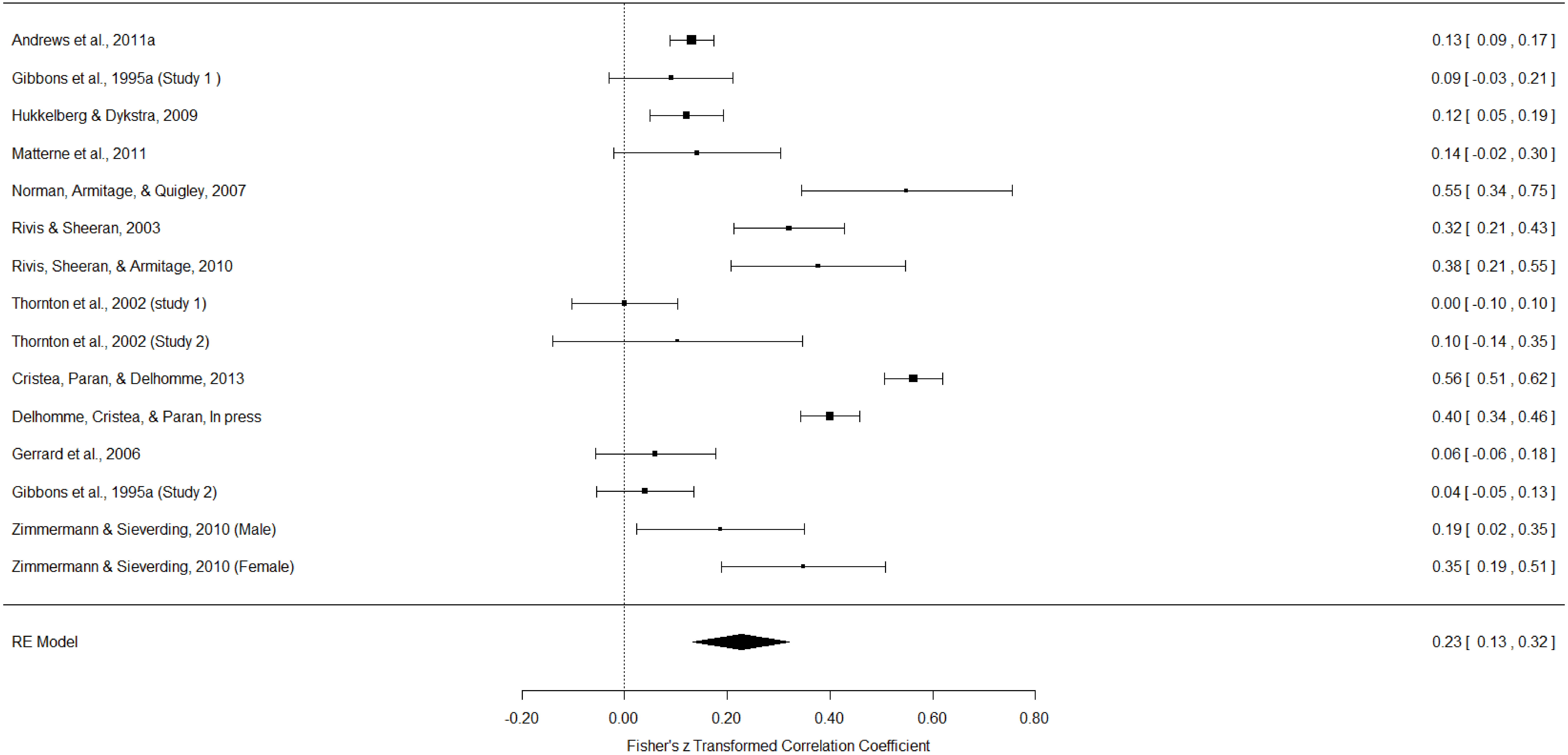
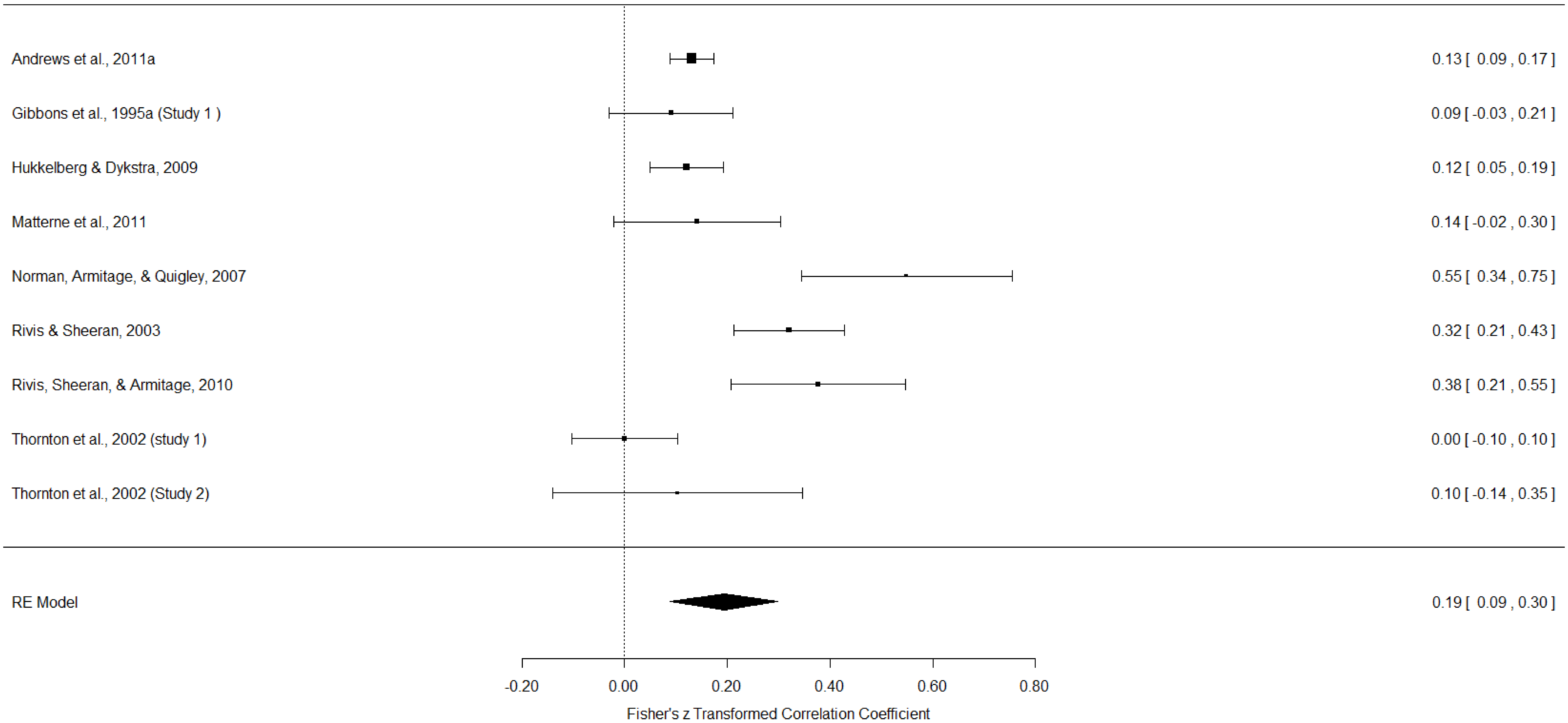
0.40
0.60
0.80
Fisher's z Transformed Correlation Coefficient



Andrews et al., 2011a 0.13 [0.09 , 0.17]
Gibbons et al., 1995a (Study 1) 0.09 [-0.03 , 0.21]
Hukkelberg & Dykstra, 2009 0.12 [0.05 , 0.19]
Matterne et al., 2011 0.14 [-0.02 , 0.30]
Norman, Armitage, & Quigley, 2007 0.55 [0.34 , 0.75]
Rivis & Sheeran, 2003 0.32 [0.21 , 0.43]
Rivis, Sheeran, & Armitage, 2010 0.38 [0.21 , 0.55]
Thornton et al., 2002 (study 1) 0.00 [-0.10 , 0.10]
Thornton et al., 2002 (Study 2) 0.10 [-0.14 , 0.35]
Cristea, Paran, & Delhomme, 2013 0.56 [0.51 , 0.62]
Delhomme, Cristea, & Paran, In press 0.40 [0.34 , 0.46]
Gerrard et al., 2006 0.06 [-0.06 , 0.18]
Gibbons et al., 1995a (Study 2) 0.04 [-0.05 , 0.13]
Zimmermann & Sieverding, 2010 (Male) 0.19 [0.02 , 0.35]
Zimmermann & Sieverding, 2010 (Female) 0.35 [0.19 , 0.51]
RE Model 0.23 [0.13 , 0.32]
-0.20
0.00
0.20
0.40
0.60
0.80
Fisher's z Transformed Correlation Coefficient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0.55 [0.34 , 0.75]
Rivis & Sheeran, 2003
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Thornton et al., 2002 (study 1)
0.00 [-0.10 , 0.10]
Thornton et al., 2002 (Study 2)
0.10 [-0.14 , 0.35]
RE Model
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0.40
0.60
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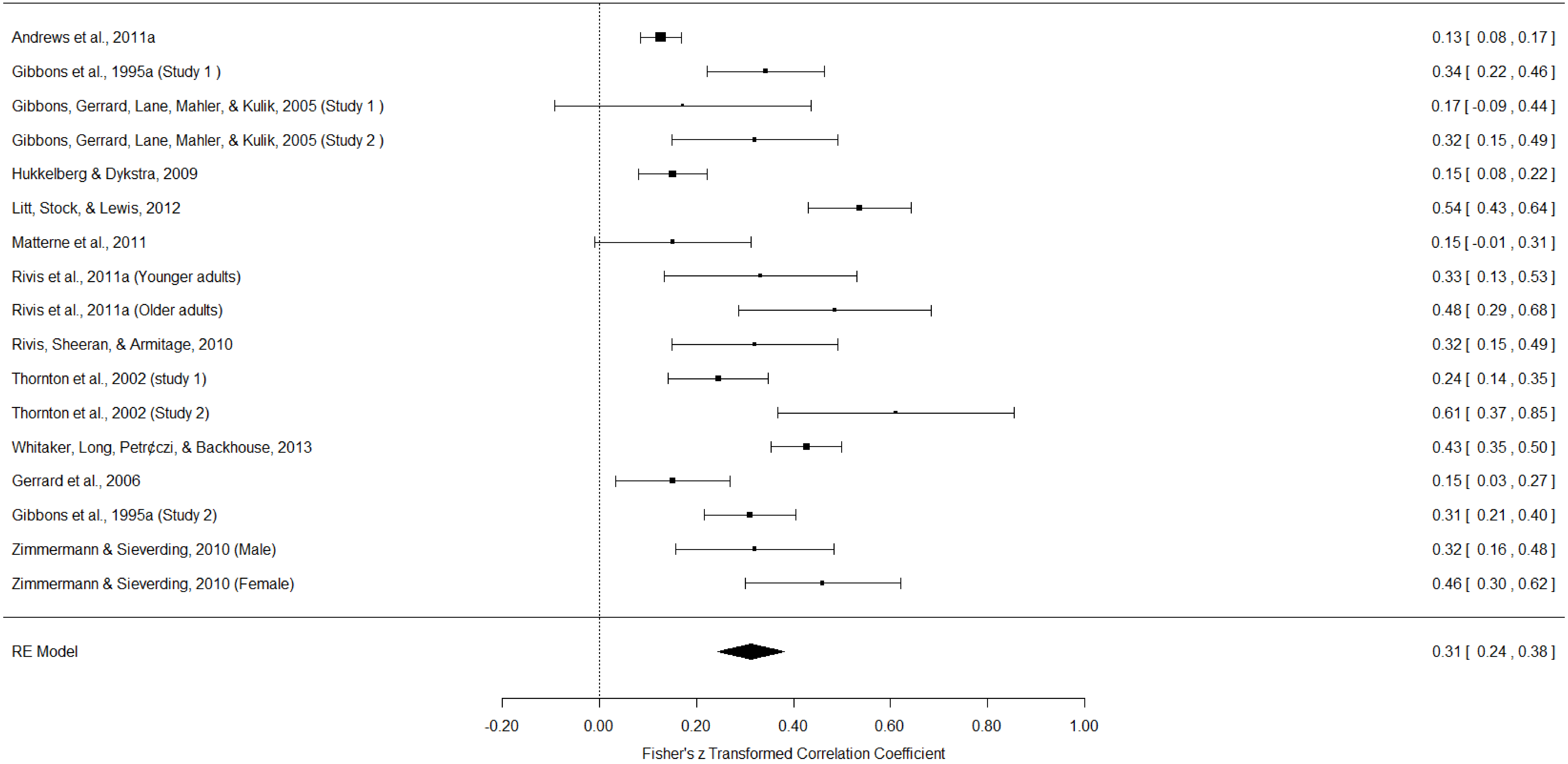
Fisher's z Transformed Correlation Coefficient



Andrews et al., 2011a
0.13 [0.08 , 0.17]
Gibbons et al., 1995a (Study 1)
0.34 [0.22 , 0.46]
Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005 (Study 1)
0.17 [-0.09 , 0.44]
Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005 (Study 2)
0.32 [0.15 , 0.49]
Hukkelberg & Dykstra, 2009
0.15 [0.08 , 0.22]
Litt, Stock, & Lewis, 2012
0.54 [0.43 , 0.64]
Matterne et al., 2011
0.15 [-0.01 , 0.31]
Rivis et al., 2011a (Younger adults)
0.33 [0.13 , 0.53]
Rivis et al., 2011a (Older adults)
0.48 [0.29 , 0.68]
Rivis, Sheeran, & Armitage, 2010
0.32 [0.15 , 0.49]
Thornton et al., 2002 (study 1)
0.24 [0.14 , 0.35]
Thornton et al., 2002 (Study 2)
0.61 [0.37 , 0.85]
Whitaker, Long, Petr¢czi, & Backhouse, 2013
0.43 [0.35 , 0.50]
Gerrard et al., 2006
0.15 [0.03 , 0.27]
Gibbons et al., 1995a (Study 2)
0.31 [0.21 , 0.40]
Zimmermann & Sieverding, 2010 (Male)
0.32 [0.16 , 0.48]
Zimmermann & Sieverding, 2010 (Female)
0.46 [0.30 , 0.62]
RE Model
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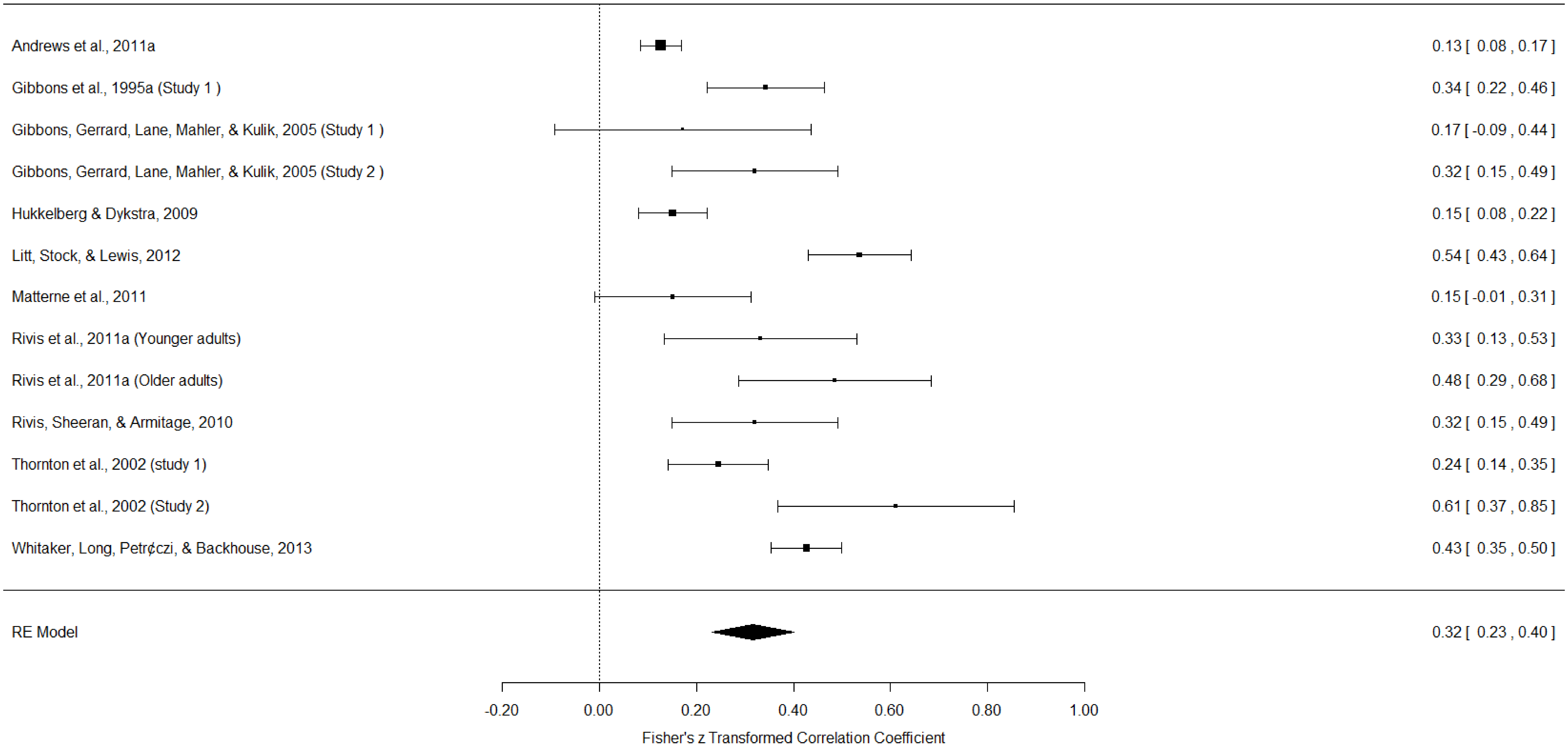
0.60
0.80
1.00
Fisher's z Transformed Correlation Coefficient



Andrews et al., 2011a
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Matterne et al., 2011
0.15 [-0.01 , 0.31]
Rivis et al., 2011a (Younger adults)
0.33 [0.13 , 0.53]
Rivis et al., 2011a (Older adults)
0.48 [0.29 , 0.68]
Rivis, Sheeran, & Armitage, 2010
0.32 [0.15 , 0.49]
Thornton et al., 2002 (study 1)
0.24 [0.14 , 0.35]
Thornton et al., 2002 (Study 2)
0.61 [0.37 , 0.85]
Whitaker, Long, Petr¢czi, & Backhouse, 2013
0.43 [0.35 , 0.50]
RE Model
0.32 [0.23 , 0.40]
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0.00
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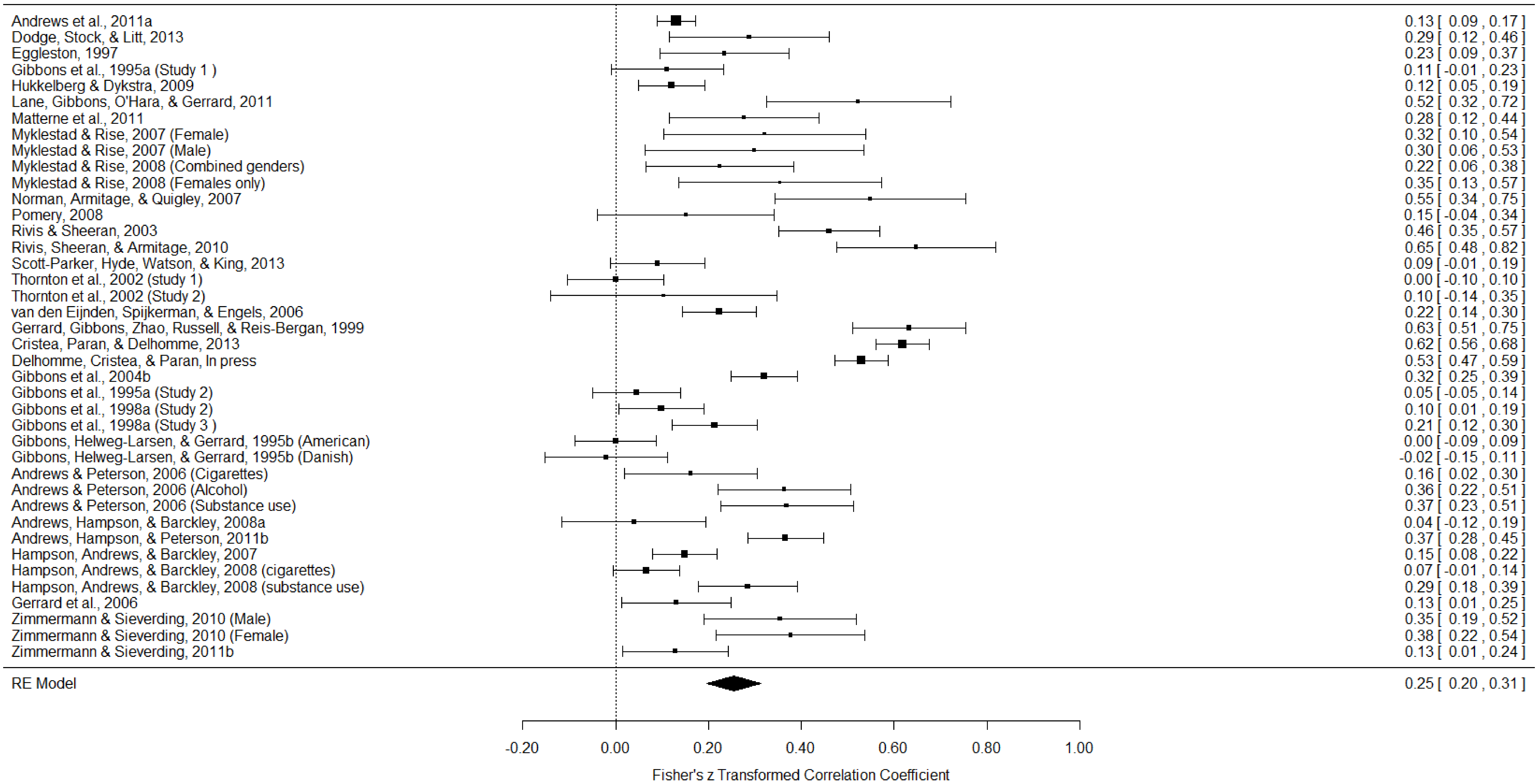
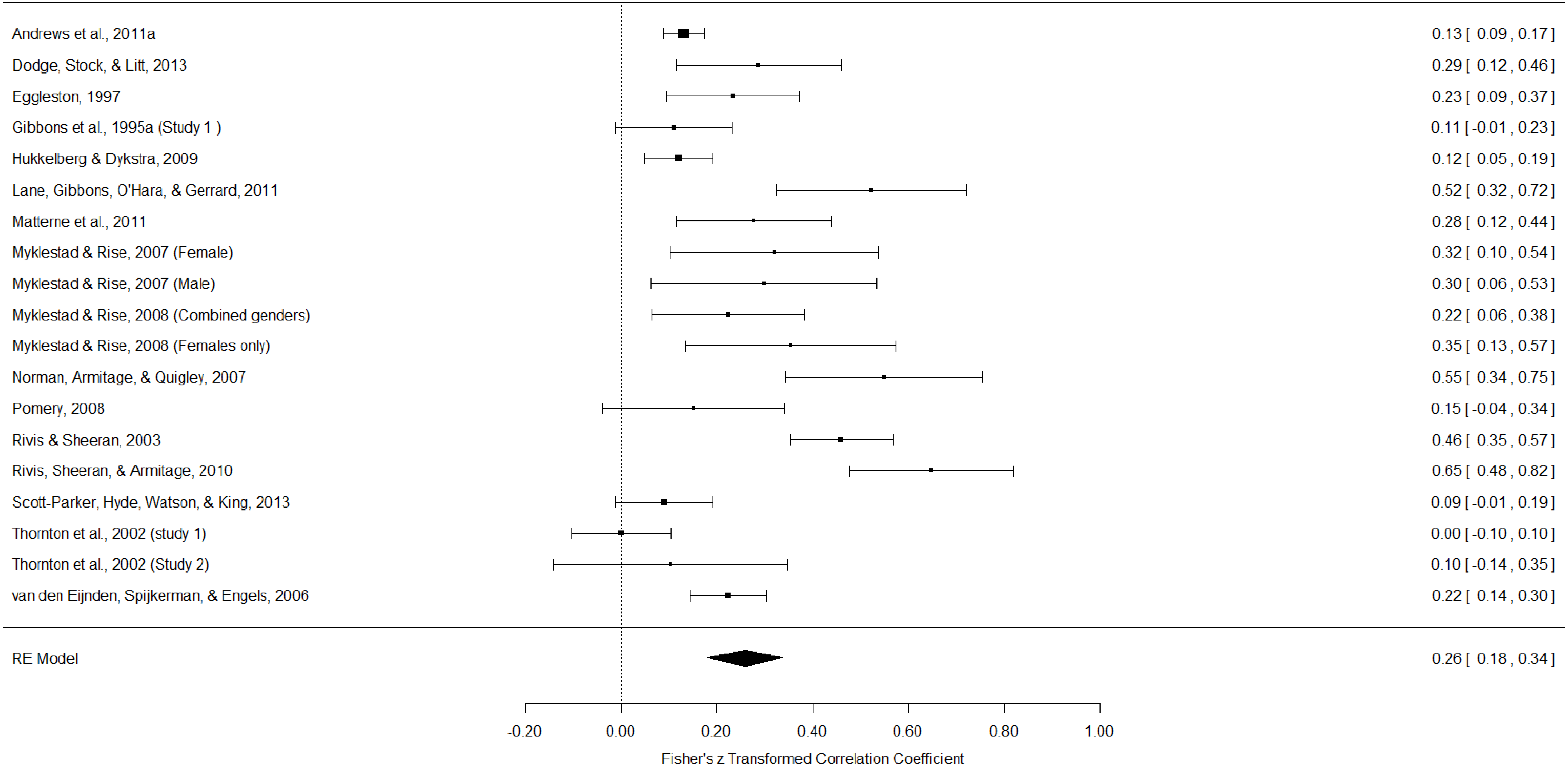
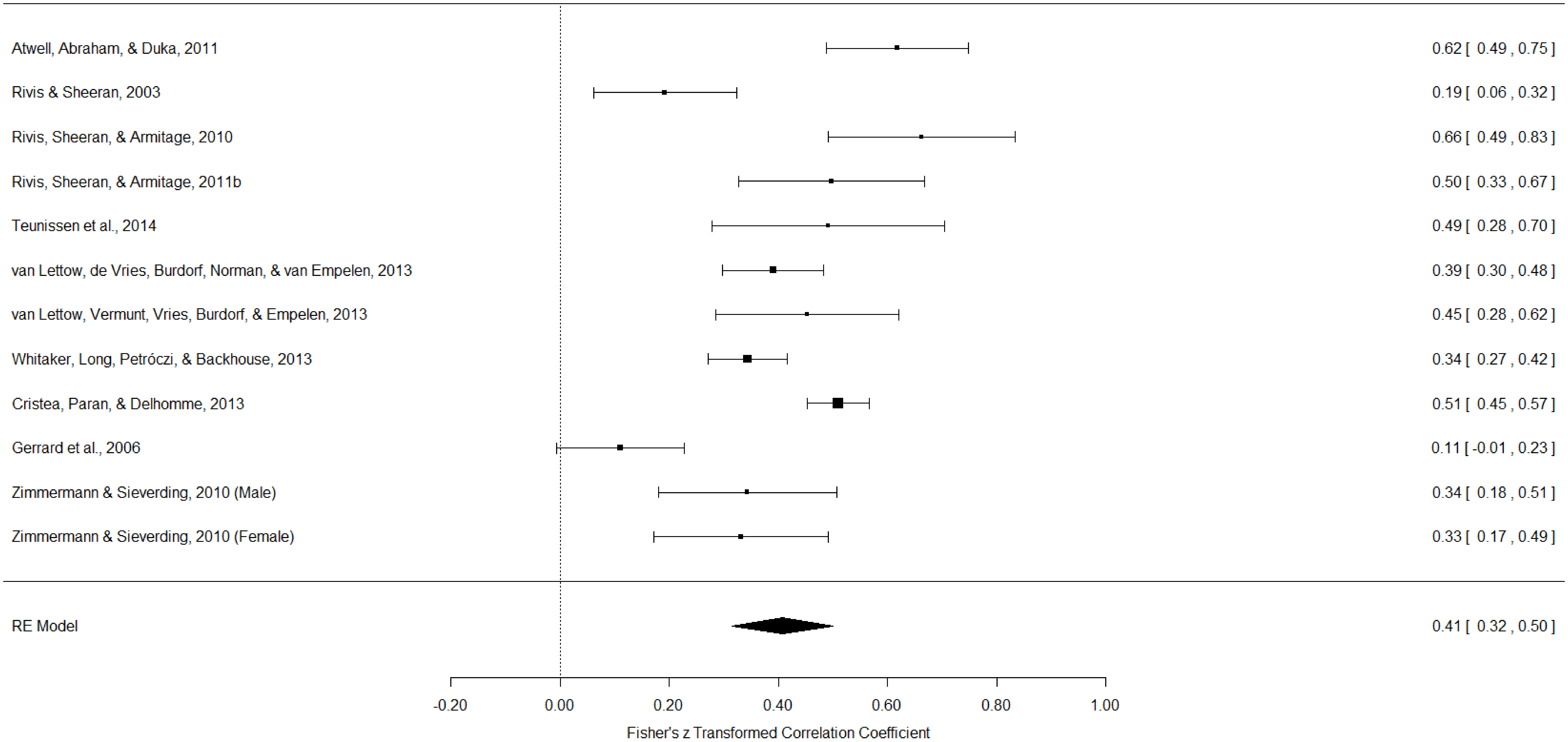
0.60
0.80
1.00
Fisher's z Transformed Correlation Coefficient


Andrews et al., 2011a 0.13 [0.09 , 0.17]
Dodge, Stock, & Litt, 2013 0.29 [0.12 , 0.46]
Eggleston, 1997 0.23 [0.09 , 0.37]
Gibbons et al., 1995a (Study 1) 0.11 [-0.01 , 0.23]
Hukkelberg & Dykstra, 2009 0.12 [0.05 , 0.19]
Lane, Gibbons, O'Hara, & Gerrard, 2011 0.52 [0.32 , 0.72]
Matterne et al., 2011 0.28 [0.12 , 0.44]
Myklestad & Rise, 2007 (Female) 0.32 [0.10 , 0.54]
Myklestad & Rise, 2007 (Male) 0.30 [0.06 , 0.53]
Myklestad & Rise, 2008 (Combined genders) 0.22 [0.06 , 0.38]
Myklestad & Rise, 2008 (Females only) 0.35 [0.13 , 0.57]
Norman, Armitage, & Quigley, 2007 0.55 [0.34 , 0.75]
Pomery, 2008 0.15 [-0.04 , 0.34]
Rivis & Sheeran, 2003 0.46 [0.35 , 0.57]
Rivis, Sheeran, & Armitage, 2010 0.65 [0.48 , 0.82]
Scott-Parker, Hyde, Watson, & King, 2013 0.09 [-0.01 , 0.19]
Thornton et al., 2002 (study 1) 0.00 [-0.10 , 0.10]
Thornton et al., 2002 (Study 2) 0.10 [-0.14 , 0.35]
van den Eijnden, Spijkerman, & Engels, 2006 0.22 [0.14 , 0.30]
Gerrard, Gibbons, Zhao, Russell, & Reis-Bergan, 1999 0.63 [0.51 , 0.75]
Cristea, Paran, & Delhomme, 2013 0.62 [0.56 , 0.68]
Delhomme, Cristea, & Paran, In press 0.53 [0.47 , 0.59]
Gibbons et al., 2004b 0.32 [0.25 , 0.39]
Gibbons et al., 1995a (Study 2) 0.05 [-0.05 , 0.14]
Gibbons et al., 1998a (Study 2) 0.10 [0.01 , 0.19]
Gibbons et al., 1998a (Study 3) 0.21 [0.12 , 0.30]
Gibbons, Helweg-Larsen, & Gerrard, 1995b (American) 0.00 [-0.09 , 0.09]
Gibbons, Helweg-Larsen, & Gerrard, 1995b (Danish) -0.02 [-0.15 , 0.11]
Andrews & Peterson, 2006 (Cigarettes) 0.16 [0.02 , 0.30]
Andrews & Peterson, 2006 (Alcohol) 0.36 [0.22 , 0.51]
Andrews & Peterson, 2006 (Substance use) 0.37 [0.23 , 0.51]
Andrews, Hampson, & Barckley, 2008a 0.04 [-0.12 , 0.19]
Andrews, Hampson, & Peterson, 2011b 0.37 [0.28 , 0.45]
Hampson, Andrews, & Barckley, 2007 0.15 [0.08 , 0.22]
Hampson, Andrews, & Barckley, 2008 (cigarettes) 0.07 [-0.01 , 0.14]
Hampson, Andrews, & Barckley, 2008 (substance use) 0.29 [0.18 , 0.39]
Gerrard et al., 2006 0.13 [0.01 , 0.25]
Zimmermann & Sieverding, 2010 (Male) 0.35 [0.19 , 0.52]
Zimmermann & Sieverding, 2010 (Female) 0.38 [0.22 , 0.54]
Zimmermann & Sieverding, 2011b 0.13 [0.01 , 0.24]
RE Model 0.25 [0.20 , 0.31]
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
Fisher's z Transformed Correlation Coefficient



Andrews et al., 2011a 0.13 [0.09 , 0.17]
Dodge, Stock, & Litt, 2013 0.29 [0.12 , 0.46]
Eggleston, 1997 0.23 [0.09 , 0.37]
Gibbons et al., 1995a (Study 1) 0.11 [-0.01 , 0.23]
Hukkelberg & Dykstra, 2009 0.12 [0.05 , 0.19]
Lane, Gibbons, O'Hara, & Gerrard, 2011 0.52 [0.32 , 0.72]
Matterne et al., 2011 0.28 [0.12 , 0.44]
Myklestad & Rise, 2007 (Female) 0.32 [0.10 , 0.54]
Myklestad & Rise, 2007 (Male) 0.30 [0.06 , 0.53]
Myklestad & Rise, 2008 (Combined genders) 0.22 [0.06 , 0.38]
Myklestad & Rise, 2008 (Females only) 0.35 [0.13 , 0.57]
Norman, Armitage, & Quigley, 2007 0.55 [0.34 , 0.75]
Pomery, 2008 0.15 [-0.04 , 0.34]
Rivis & Sheeran, 2003 0.46 [0.35 , 0.57]
Rivis, Sheeran, & Armitage, 2010 0.65 [0.48 , 0.82]
Scott-Parker, Hyde, Watson, & King, 2013 0.09 [-0.01 , 0.19]
Thornton et al., 2002 (study 1) 0.00 [-0.10 , 0.10]
Thornton et al., 2002 (Study 2) 0.10 [-0.14 , 0.35]
van den Eijnden, Spijkerman, & Engels, 2006 0.22 [0.14 , 0.30]
RE Model 0.26 [0.18 , 0.34]
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
Fisher's z Transformed Correlation Coefficient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Rivis, Sheeran, & Armitage, 2011b
0.50 [0.33 , 0.67]
Teunissen et al., 2014
0.49 [0.28 , 0.70]
van Lettow, de Vries, Burdorf, Norman, & van Empelen, 2013
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van Lettow, Vermunt, Vries, Burdorf, & Empelen, 2013
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Whitaker, Long, Petróczi, & Backhouse, 2013
0.34 [0.27 , 0.42]
Cristea, Paran, & Delhomme, 2013
0.51 [0.45 , 0.57]
Gerrard et al., 2006
0.11 [-0.01 , 0.23]
Zimmermann & Sieverding, 2010 (Male)
0.34 [0.18 , 0.51]
Zimmermann & Sieverding, 2010 (Female)
0.33 [0.17 , 0.49]
RE Model
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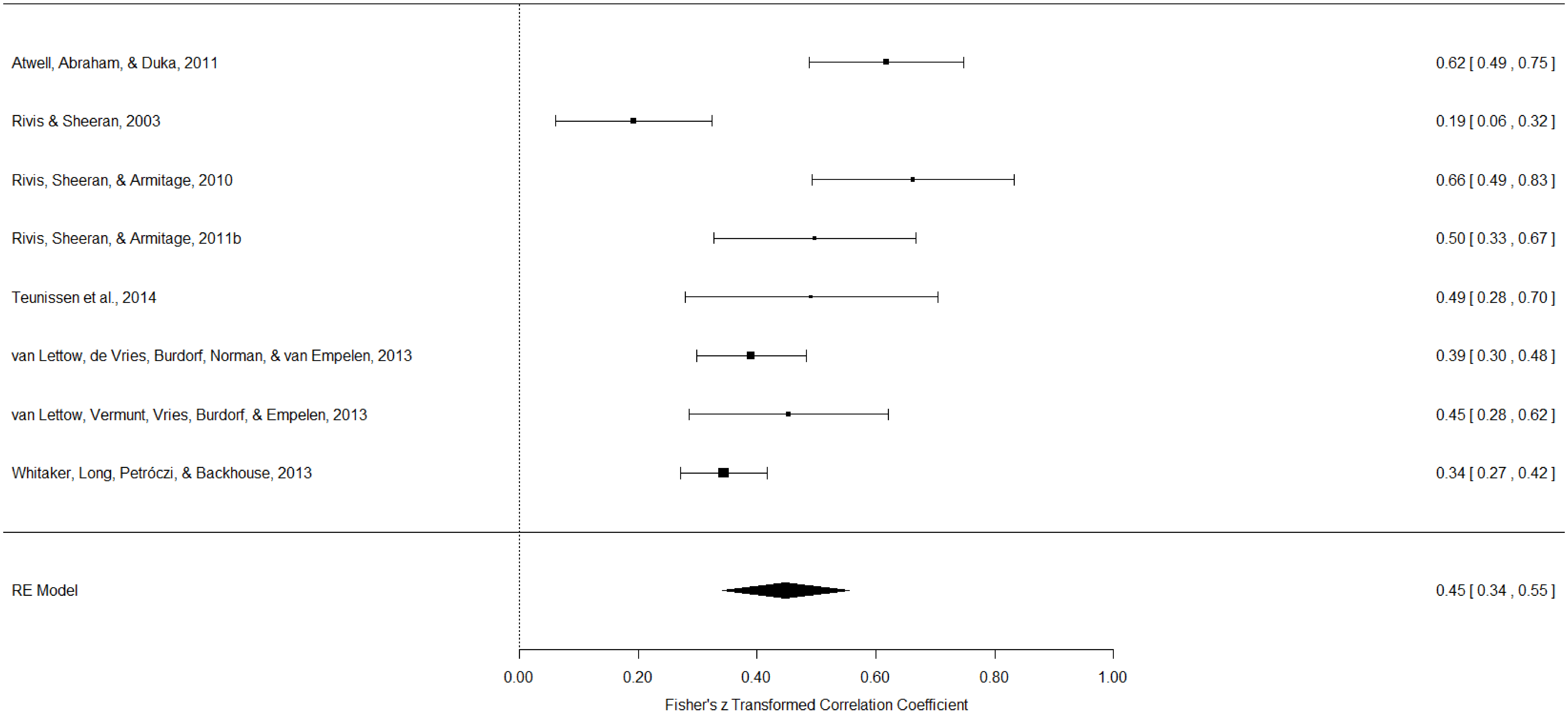
0.20
0.40
0.60
0.80
1.00
Fisher's z Transformed Correlation Coefficient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Rivis, Sheeran, & Armitage, 2010
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Rivis, Sheeran, & Armitage, 2011b
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Whitaker, Long, Petróczi, & Backhouse, 2013
0.34 [0.27 , 0.42]
RE Model
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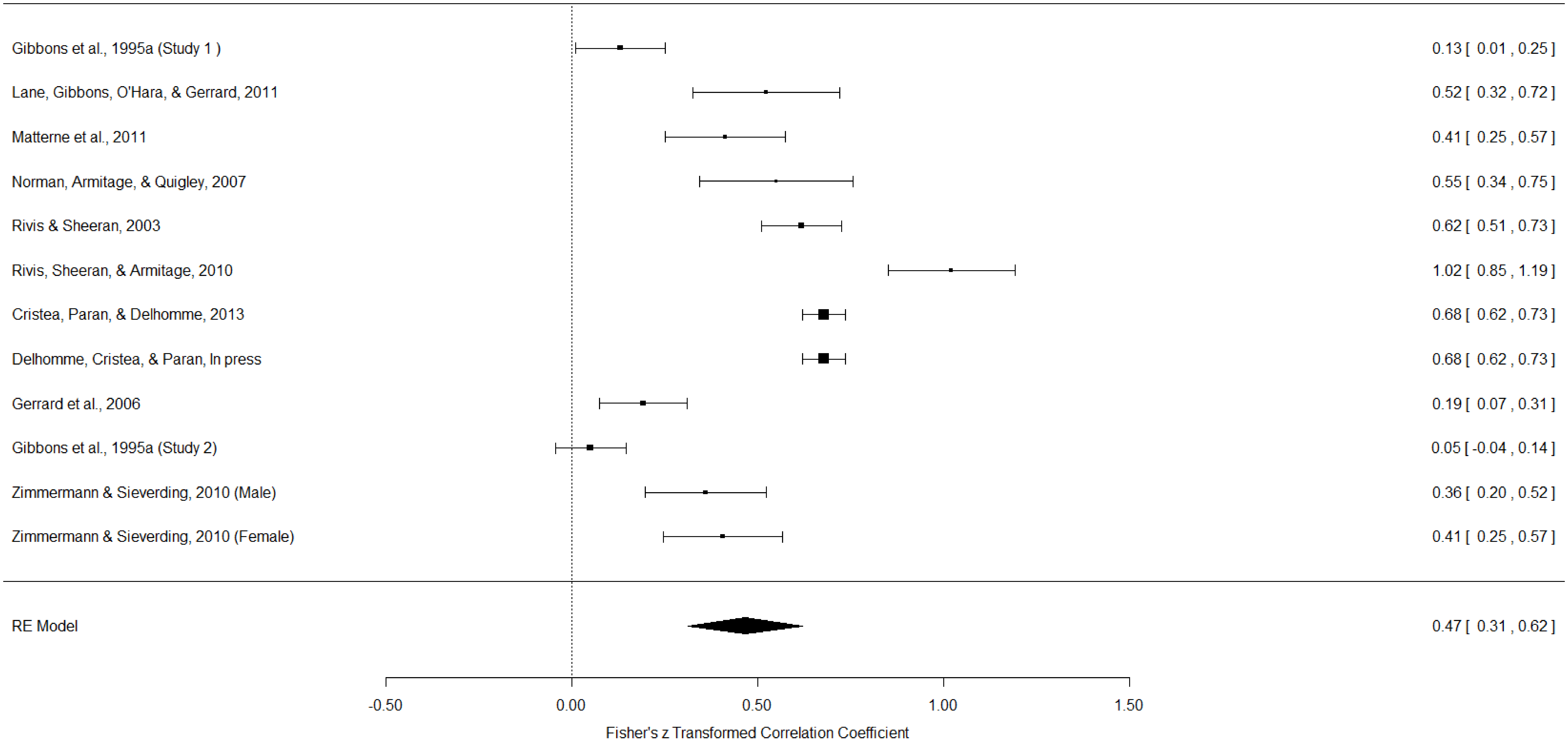
0.00
0.20
0.40
0.60
0.80
1.00
Fisher's z Transformed Correlation Coefficient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Matterne et al., 2011
0.41 [0.25 , 0.57]
Norman, Armitage, & Quigley, 2007
0.55 [0.34 , 0.75]
Rivis & Sheeran, 2003
0.62 [0.51 , 0.73]
Rivis, Sheeran, & Armitage, 2010
1.02 [0.85 , 1.19]
Cristea, Paran, & Delhomme, 2013
0.68 [0.62 , 0.73]
Delhomme, Cristea, & Paran, In press
0.68 [0.62 , 0.73]
Gerrard et al., 2006
0.19 [0.07 , 0.31]
Gibbons et al., 1995a (Study 2)
0.05 [-0.04 , 0.14]
Zimmermann & Sieverding, 2010 (Male)
0.36 [0.20 , 0.52]
Zimmermann & Sieverding, 2010 (Female)
0.41 [0.25 , 0.57]
RE Model
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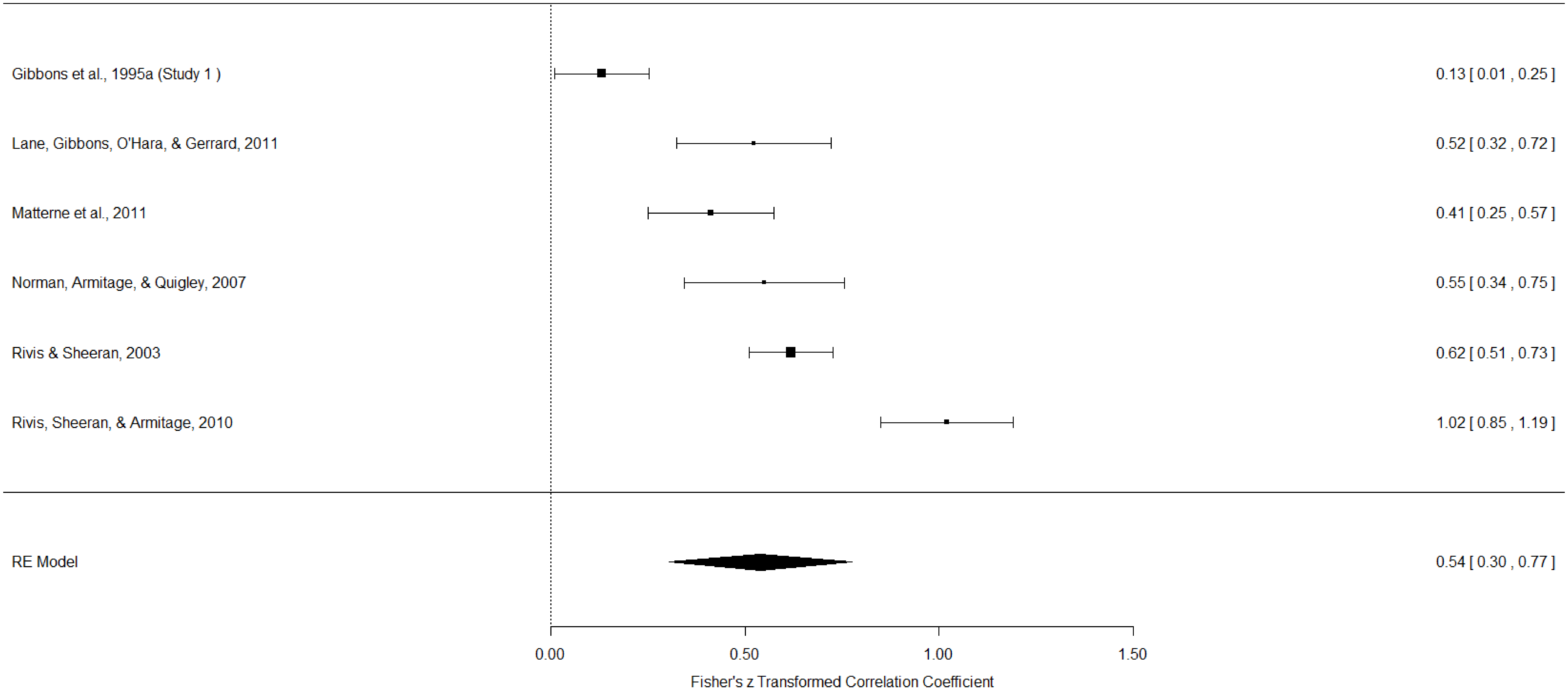
-0.50
0.00
0.50
1.00
1.50
Fisher's z Transformed Correlation Coefficient



Gibbons et al., 1995a (Study 1)
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Lane, Gibbons, O'Hara, & Gerrard, 2011
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Matterne et al., 2011
0.41 [0.25 , 0.57]
Norman, Armitage, & Quigley, 2007
0.55 [0.34 , 0.75]
Rivis & Sheeran, 2003
0.62 [0.51 , 0.73]
Rivis, Sheeran, & Armitage, 2010
1.02 [0.85 , 1.19]
RE Model
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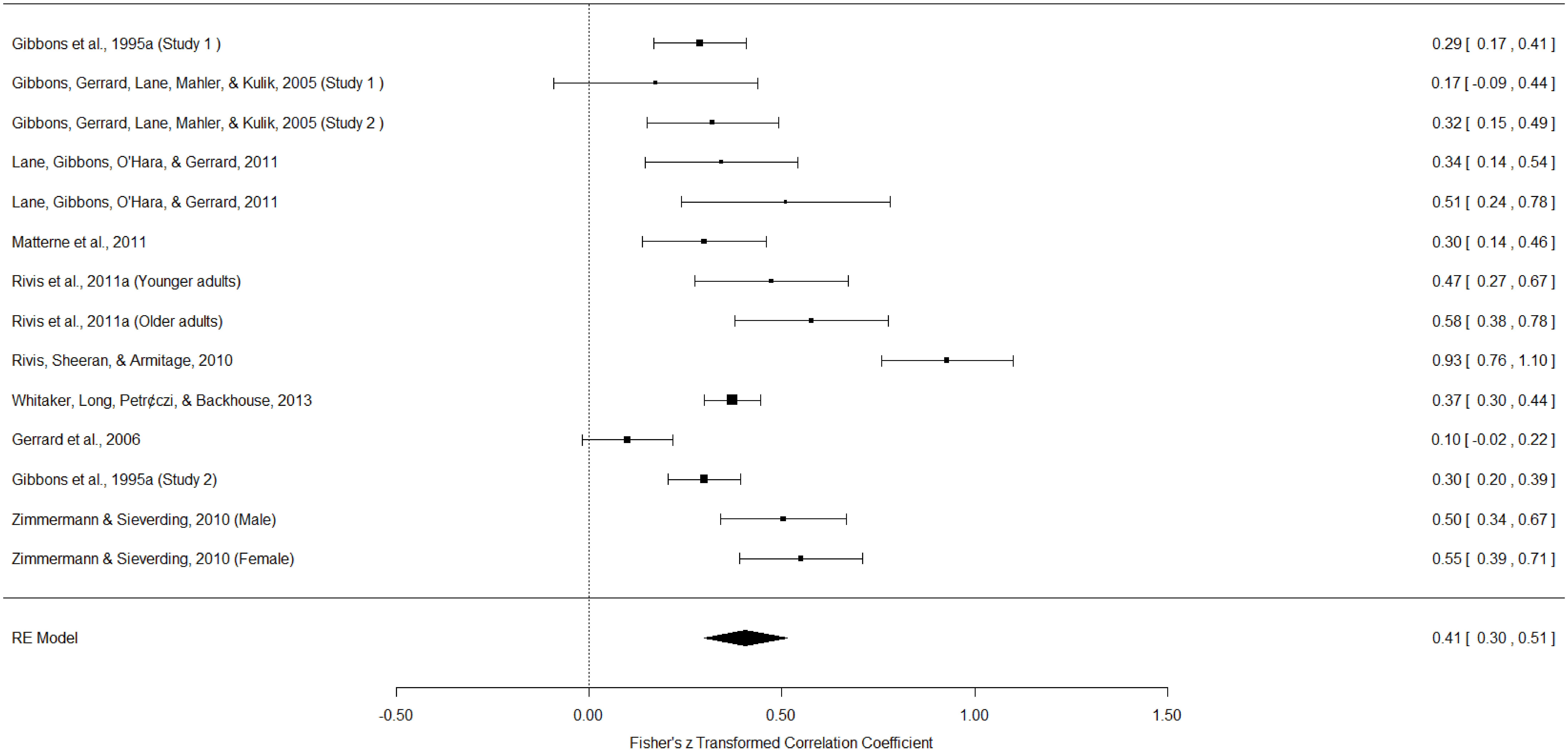
Fisher's z Transformed Correlation Coefficient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0.32 [0.15 , 0.49]
Lane, Gibbons, O'Hara, & Gerrard, 2011
0.34 [0.14 , 0.54]
Lane, Gibbons, O'Hara, & Gerrard, 2011
0.51 [0.24 , 0.78]
Matterne et al., 2011
0.30 [0.14 , 0.46]
Rivis et al., 2011a (Younger adults)
0.47 [0.27 , 0.67]
Rivis et al., 2011a (Older adults)
0.58 [0.38 , 0.78]
Rivis, Sheeran, & Armitage, 2010
0.93 [0.76 , 1.10]
Whitaker, Long, Petr¢czi, & Backhouse, 2013
0.37 [0.30 , 0.44]
Gerrard et al., 2006
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Gibbons et al., 1995a (Study 2)
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Zimmermann & Sieverding, 2010 (Male)
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Zimmermann & Sieverding, 2010 (Female)
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RE Model
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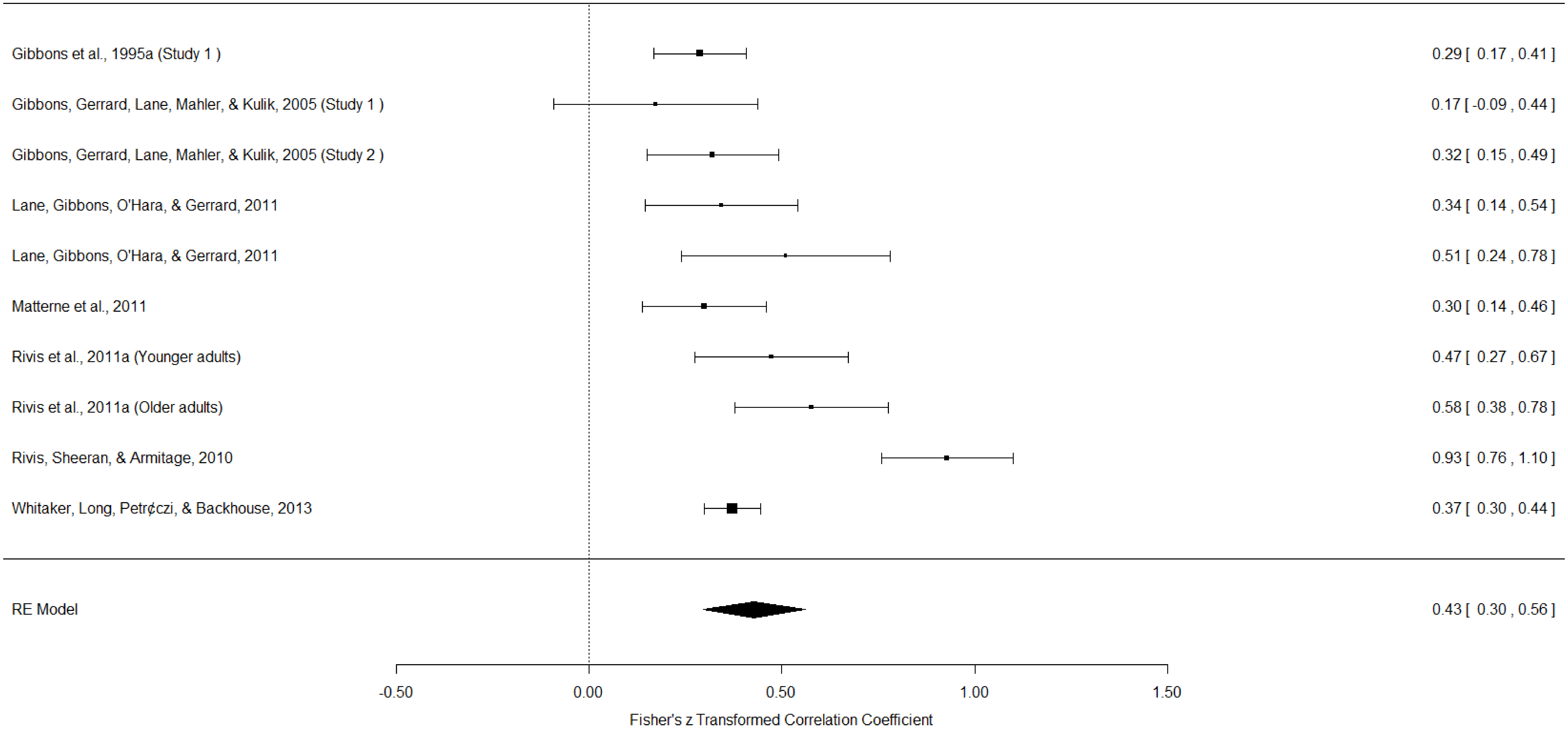
1.50
Fisher's z Transformed Correlation Coefficient



Gibbons et al., 1995a (Study 1)
0.29 [0.17 , 0.41]
Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005 (Study 1)
0.17 [-0.09 , 0.44]
Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005 (Study 2)
0.32 [0.15 , 0.49]
Lane, Gibbons, O'Hara, & Gerrard, 2011
0.34 [0.14 , 0.54]
Lane, Gibbons, O'Hara, & Gerrard, 2011
0.51 [0.24 , 0.78]
Matterne et al., 2011
0.30 [0.14 , 0.46]
Rivis et al., 2011a (Younger adults)
0.47 [0.27 , 0.67]
Rivis et al., 2011a (Older adults)
0.58 [0.38 , 0.78]
Rivis, Sheeran, & Armitage, 2010
0.93 [0.76 , 1.10]
Whitaker, Long, Petr¢czi, & Backhouse, 2013
0.37 [0.30 , 0.44]
RE Model
0.43 [0.30 , 0.56]
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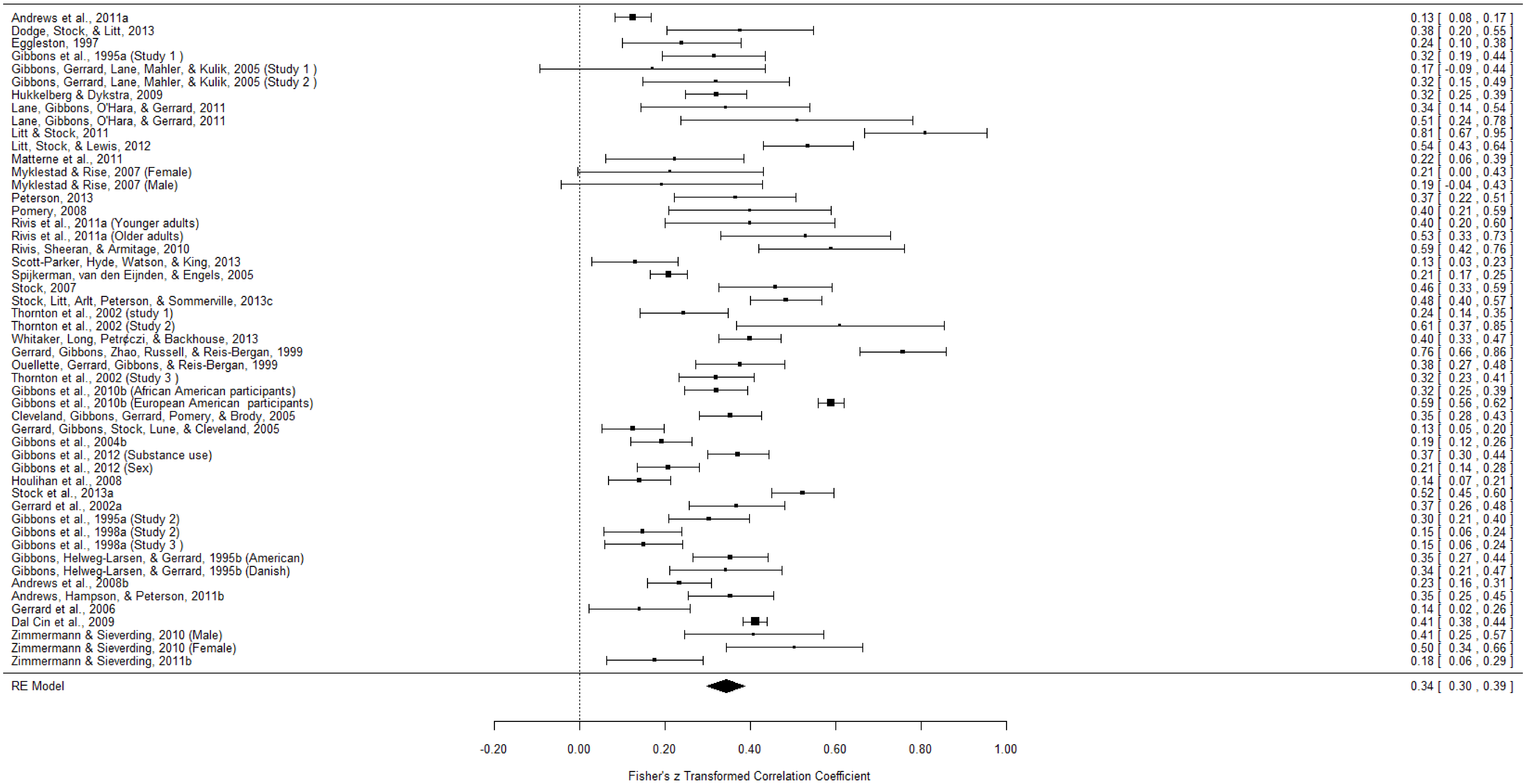
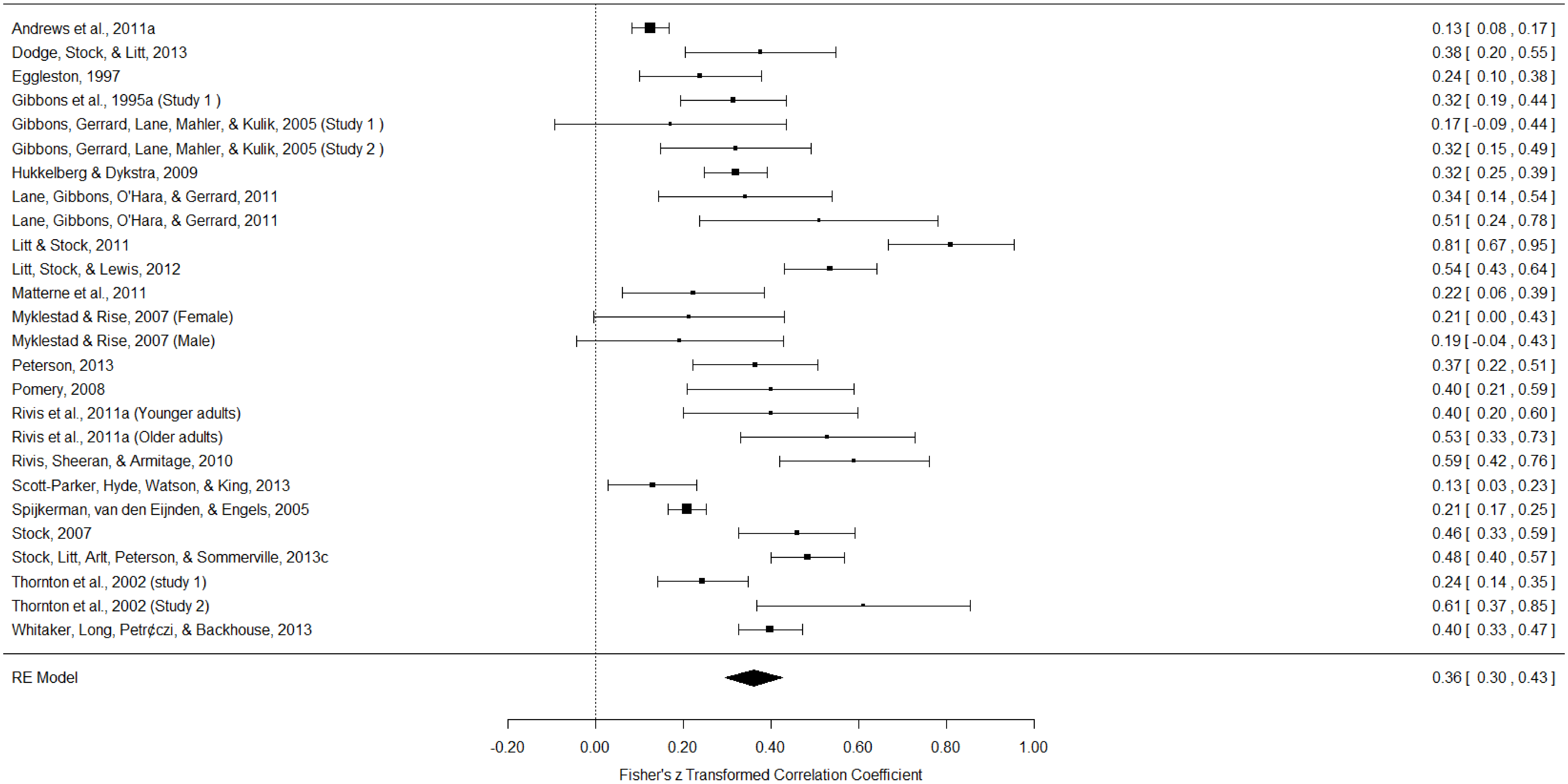
0.00
0.50
1.00
1.50
Fisher's z Transformed Correlation Coefficient


Andrews et al., 2011a 0.13 [0.08 , 0.17]
Dodge, Stock, & Litt, 2013 0.38 [0.20 , 0.55]
Eggleston, 1997 0.24 [0.10 , 0.38]
Gibbons et al., 1995a (Study 1) 0.32 [0.19 , 0.44]
Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005 (Study 1) 0.17 [-0.09 , 0.44]
Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005 (Study 2) 0.32 [0.15 , 0.49]
Hukkelberg & Dykstra, 2009 0.32 [0.25 , 0.39]
Lane, Gibbons, O'Hara, & Gerrard, 2011 0.34 [0.14 , 0.54]
Lane, Gibbons, O'Hara, & Gerrard, 2011 0.51 [0.24 , 0.78]
Litt & Stock, 2011 0.81 [0.67 , 0.95]
Litt, Stock, & Lewis, 2012 0.54 [0.43 , 0.64]
Matterne et al., 2011 0.22 [0.06 , 0.39]
Myklestad & Rise, 2007 (Female) 0.21 [0.00 , 0.43]
Myklestad & Rise, 2007 (Male) 0.19 [-0.04 , 0.43]
Peterson, 2013 0.37 [0.22 , 0.51]
Pomery, 2008 0.40 [0.21 , 0.59]
Rivis et al., 2011a (Younger adults) 0.40 [0.20 , 0.60]
Rivis et al., 2011a (Older adults) 0.53 [0.33 , 0.73]
Rivis, Sheeran, & Armitage, 2010 0.59 [0.42 , 0.76]
Scott-Parker, Hyde, Watson, & King, 2013 0.13 [0.03 , 0.23]
Spijkerman, van den Eijnden, & Engels, 2005 0.21 [0.17 , 0.25]
Stock, 2007 0.46 [0.33 , 0.59]
Stock, Litt, Arlt, Peterson, & Sommerville, 2013c 0.48 [0.40 , 0.57]
Thornton et al., 2002 (study 1) 0.24 [0.14 , 0.35]
Thornton et al., 2002 (Study 2) 0.61 [0.37 , 0.85]
Whitaker, Long, Petróczi, & Backhouse, 2013 0.40 [0.33 , 0.47]
Gerrard, Gibbons, Zhao, Russell, & Reis-Bergan, 1999 0.76 [0.66 , 0.86]
Ouellette, Gerrard, Gibbons, & Reis-Bergan, 1999 0.38 [0.27 , 0.48]
Thornton et al., 2002 (Study 3) 0.32 [0.23 , 0.41]
Gibbons et al., 2010b (African American participants) 0.32 [0.25 , 0.39]
Gibbons et al., 2010b (European American participants) 0.59 [0.56 , 0.62]
Cleveland, Gibbons, Gerrard, Pomery, & Brody, 2005 0.35 [0.28 , 0.43]
Gerrard, Gibbons, Stock, Lune, & Cleveland, 2005 0.13 [0.05 , 0.20]
Gibbons et al., 2004b 0.19 [0.12 , 0.26]
Gibbons et al., 2012 (Substance use) 0.37 [0.30 , 0.44]
Gibbons et al., 2012 (Sex) 0.21 [0.14 , 0.28]
Houlihan et al., 2008 0.14 [0.07 , 0.21]
Stock et al., 2013a 0.52 [0.45 , 0.60]
Gerrard et al., 2002a 0.37 [0.26 , 0.48]
Gibbons et al., 1995a (Study 2) 0.30 [0.21 , 0.40]
Gibbons et al., 1998a (Study 2) 0.15 [0.06 , 0.24]
Gibbons et al., 1998a (Study 3) 0.15 [0.06 , 0.24]
Gibbons, Helweg-Larsen, & Gerrard, 1995b (American) 0.35 [0.27 , 0.44]
Gibbons, Helweg-Larsen, & Gerrard, 1995b (Danish) 0.34 [0.21 , 0.47]
Andrews et al., 2008b 0.23 [0.16 , 0.31]
Andrews, Hampson, & Peterson, 2011b 0.35 [0.25 , 0.45]
Gerrard et al., 2006 0.14 [0.02 , 0.26]
Dal Cin et al., 2009 0.41 [0.38 , 0.44]
Zimmermann & Sieverding, 2010 (Male) 0.41 [0.25 , 0.57]
Zimmermann & Sieverding, 2010 (Female) 0.50 [0.34 , 0.66]
Zimmermann & Sieverding, 2011b 0.18 [0.06 , 0.29]
RE Model 0.34 [0.30 , 0.39]
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
Fisher's z Transformed Correlation Coefficient


Andrews et al., 2011a 0.13 [0.08 , 0.17]
Dodge, Stock, & Litt, 2013 0.38 [0.20 , 0.55]
Eggleston, 1997 0.24 [0.10 , 0.38]
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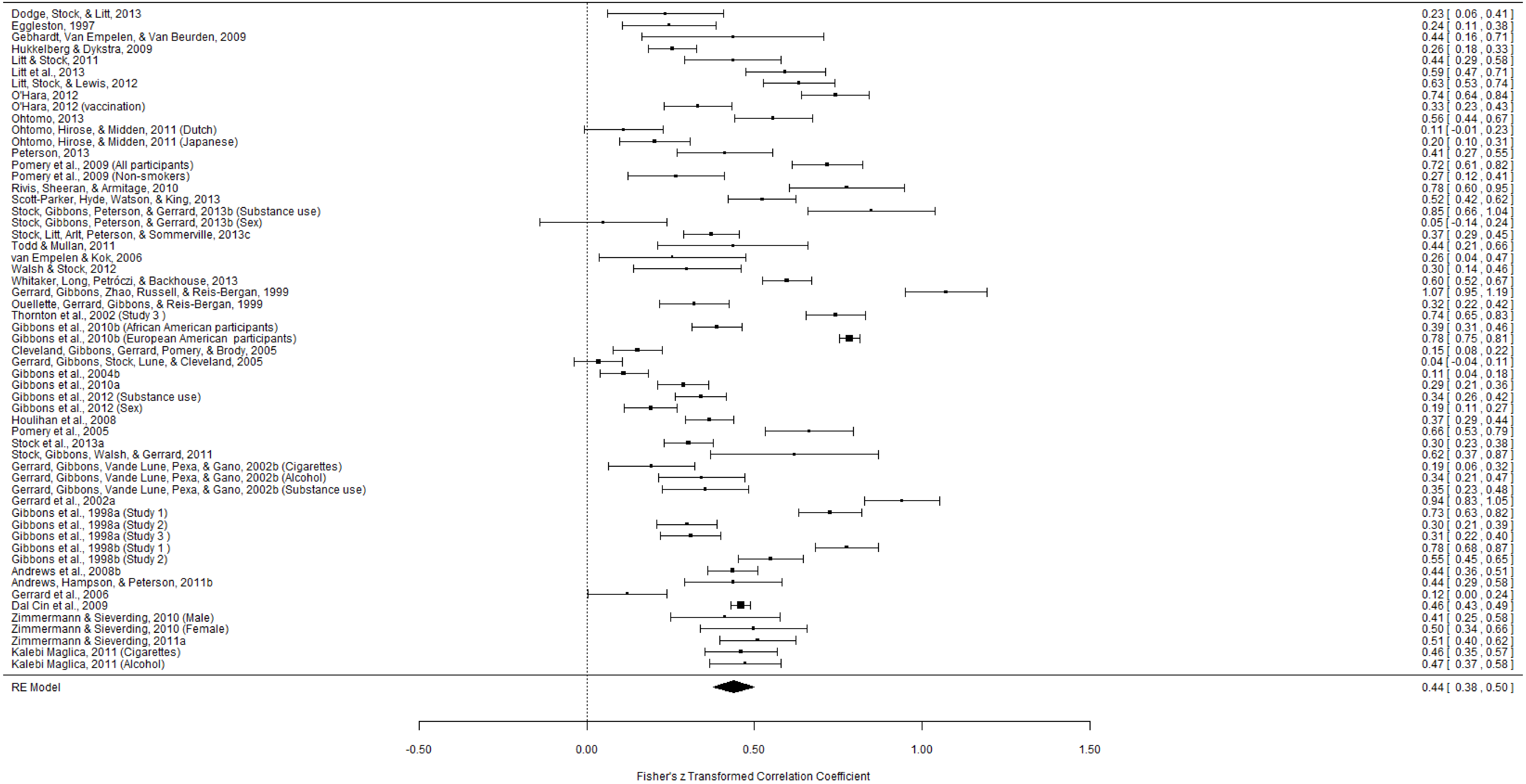
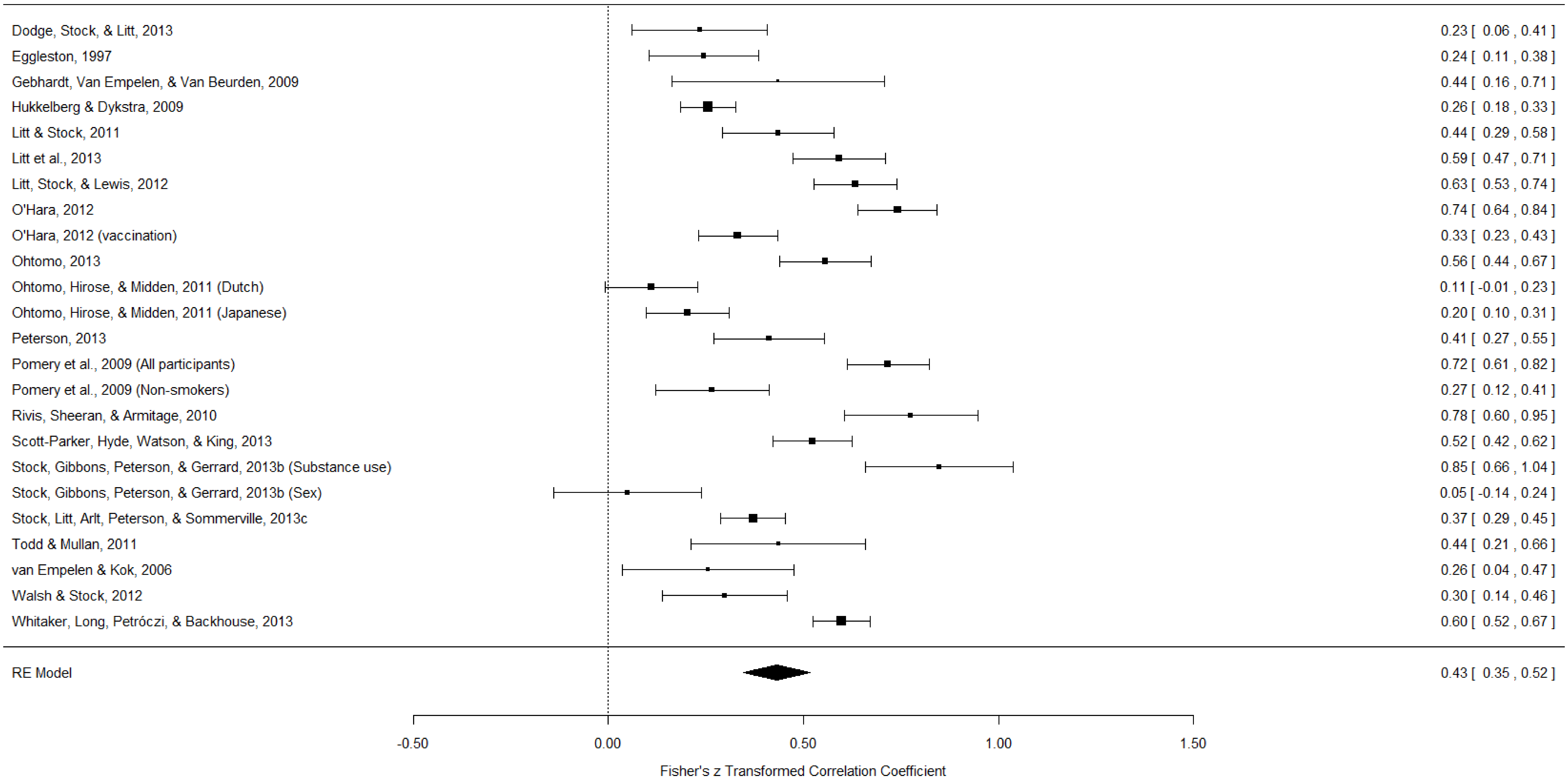
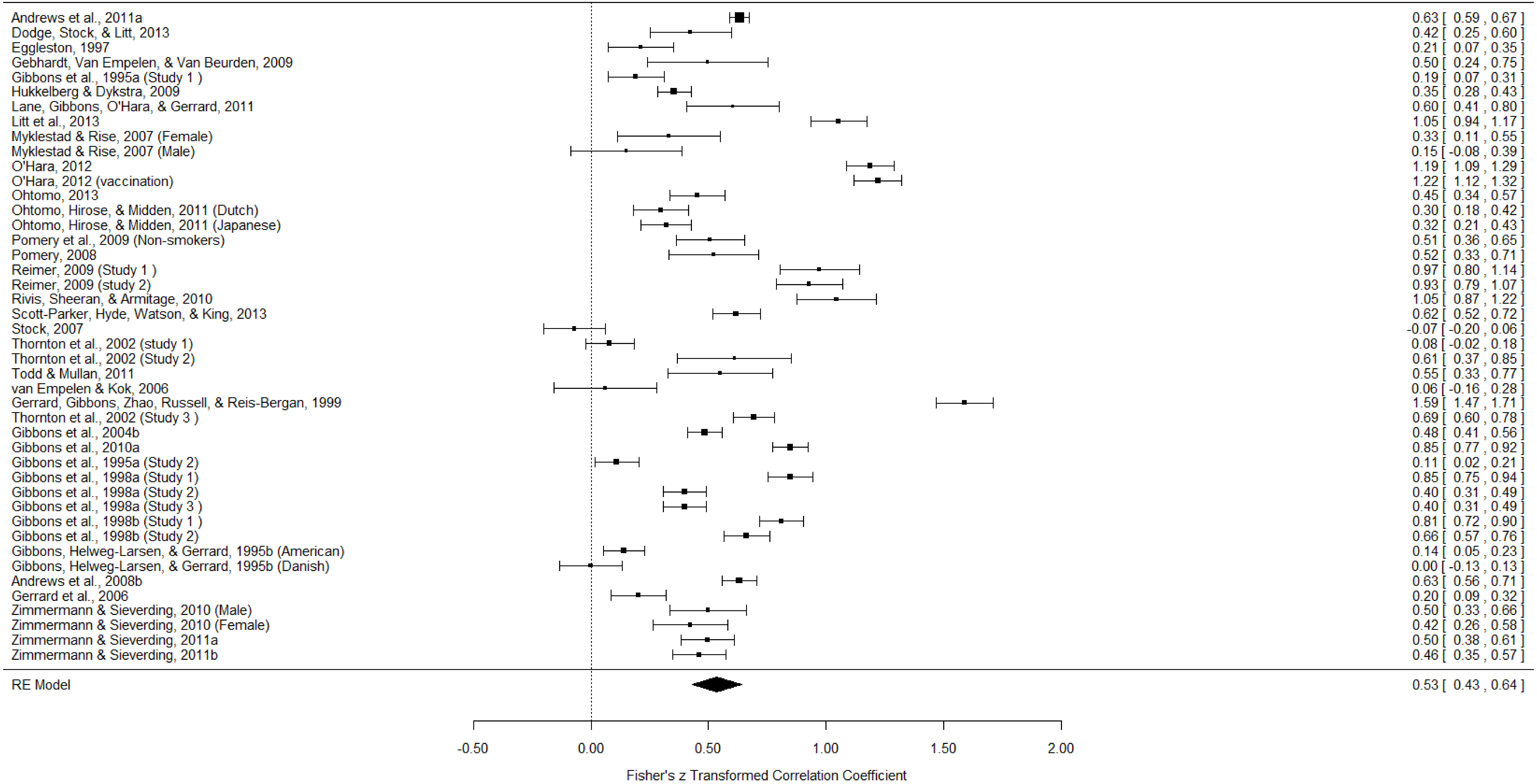
Gibbons, Gerrard, Lane, Mahler, & Kulik, 2005 (Study 2) 0.32 [0.15 , 0.49]
Hukkelberg & Dykstra, 2009 0.32 [0.25 , 0.39]
Lane, Gibbons, O'Hara, & Gerrard, 2011 0.34 [0.14 , 0.54]
Lane, Gibbons, O'Hara, & Gerrard, 2011 0.51 [0.24 , 0.78]
Litt & Stock, 2011 0.81 [0.67 , 0.95]
Litt, Stock, & Lewis, 2012 0.54 [0.43 , 0.64]
Matterne et al., 2011 0.22 [0.06 , 0.39]
Myklestad & Rise, 2007 (Female) 0.21 [0.00 , 0.43]
Myklestad & Rise, 2007 (Male) 0.19 [-0.04 , 0.43]
Peterson, 2013 0.37 [0.22 , 0.51]
Pomery, 2008 0.40 [0.21 , 0.59]
Rivis et al., 2011a (Younger adults) 0.40 [0.20 , 0.60]
Rivis et al., 2011a (Older adults) 0.53 [0.33 , 0.73]
Rivis, Sheeran, & Armitage, 2010 0.59 [0.42 , 0.76]
Scott-Parker, Hyde, Watson, & King, 2013 0.13 [0.03 , 0.23]
Spijkerman, van den Eijnden, & Engels, 2005 0.21 [0.17 , 0.25]
Stock, 2007 0.46 [0.33 , 0.59]
Stock, Litt, Arlt, Peterson, & Sommerville, 2013c 0.48 [0.40 , 0.57]
Thornton et al., 2002 (study 1) 0.24 [0.14 , 0.35]
Thornton et al., 2002 (Study 2) 0.61 [0.37 , 0.85]
Whitaker, Long, Petr¢czi, & Backhouse, 2013 0.40 [0.33 , 0.47]
RE Model 0.36 [0.30 , 0.43]
-0.20
0.00
0.20
0.40
0.60
0.80
1.00
Fisher's z Transformed Correlation Coefficient



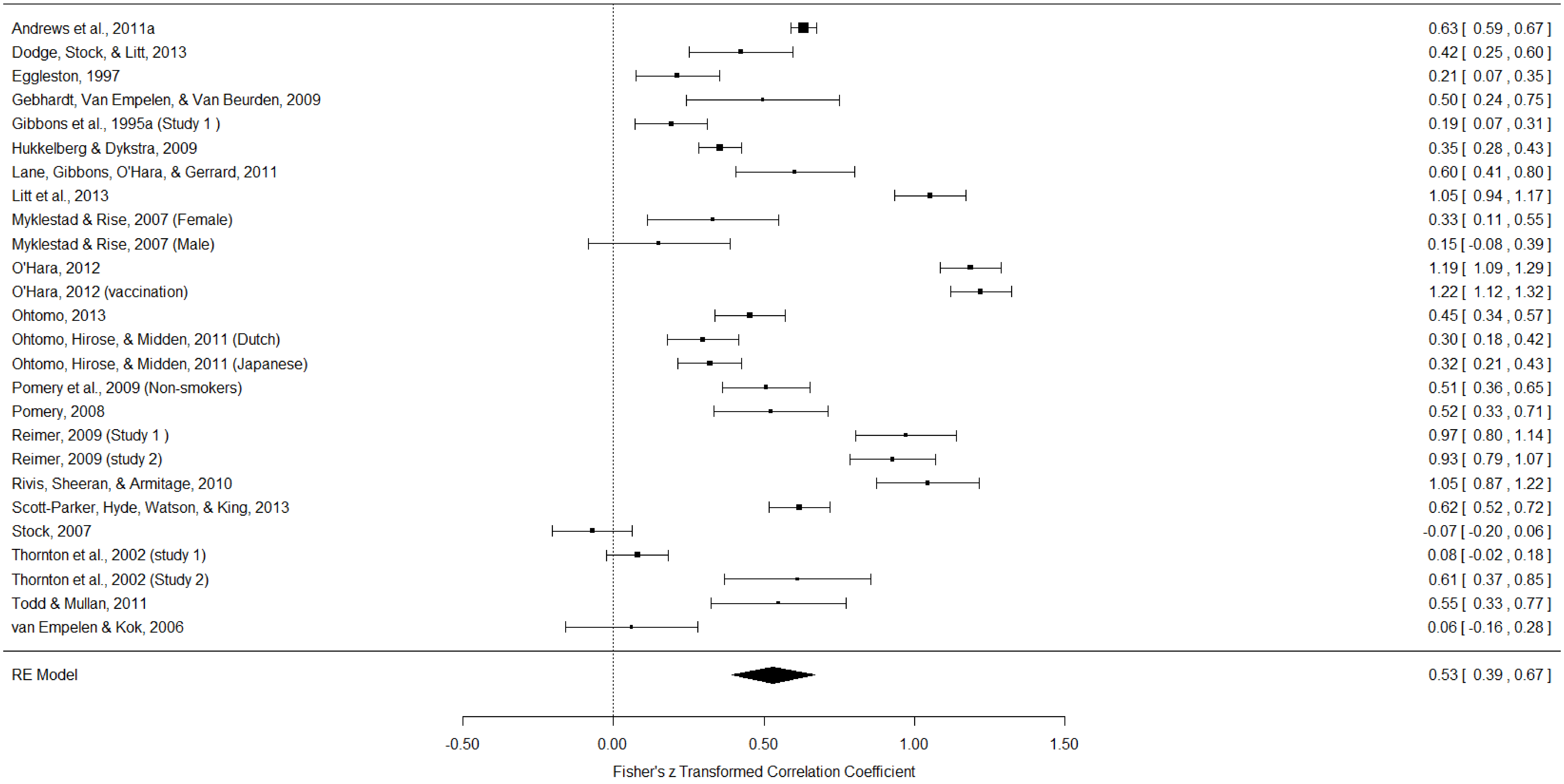
Dodge, Stock, & Litt, 2013 0.23 [0.06 , 0.41]
Eggleston, 1997 0.24 [0.11 , 0.38]
Gebhardt, Van Empelen, & Van Beurden, 2009 0.44 [0.16 , 0.71]
Hukkelberg & Dykstra, 2009 0.26 [0.18 , 0.33]
Litt & Stock, 2011 0.44 [0.29 , 0.58]
Litt et al., 2013 0.59 [0.47 , 0.71]
Litt, Stock, & Lewis, 2012 0.63 [0.53 , 0.74]
O'Hara, 2012 0.74 [0.64 , 0.84]
O'Hara, 2012 (vaccination) 0.33 [0.23 , 0.43]
Ohtomo, 2013 0.56 [0.44 , 0.67]
Ohtomo, Hirose, & Midden, 2011 (Dutch) 0.11 [-0.01 , 0.23]
Ohtomo, Hirose, & Midden, 2011 (Japanese) 0.20 [0.10 , 0.31]
Peterson, 2013 0.41 [0.27 , 0.55]
Pomery et al., 2009 (All participants) 0.72 [0.61 , 0.82]
Pomery et al., 2009 (Non-smokers) 0.27 [0.12 , 0.41]
Rivis, Sheeran, & Armitage, 2010 0.78 [0.60 , 0.95]
Scott-Parker, Hyde, Watson, & King, 2013 0.52 [0.42 , 0.62]
Stock, Gibbons, Peterson, & Gerrard, 2013b (Substance use) 0.85 [0.66 , 1.04]
Stock, Gibbons, Peterson, & Gerrard, 2013b (Sex) 0.05 [-0.14 , 0.24]
Stock, Litt, Arlt, Peterson, & Sommerville, 2013c 0.37 [0.29 , 0.45]
Todd & Mullan, 2011 0.44 [0.21 , 0.66]
van Empelen & Kok, 2006 0.26 [0.04 , 0.47]
Walsh & Stock, 2012 0.30 [0.14 , 0.46]
Whitaker, Long, Petróczi, & Backhouse, 2013 0.60 [0.52 , 0.67]
Gerrard, Gibbons, Zhao, Russell, & Reis-Bergan, 1999 1.07 [0.95 , 1.19]
Ouellette, Gerrard, Gibbons, & Reis-Bergan, 1999 0.32 [0.22 , 0.42]
Thornton et al., 2002 (Study 3) 0.74 [0.65 , 0.83]
Gibbons et al., 2010b (African American participants) 0.39 [0.31 , 0.46]
Gibbons et al., 2010b (European American participants) 0.78 [0.75 , 0.81]
Cleveland, Gibbons, Gerrard, Pomery, & Brody, 2005 0.15 [0.08 , 0.22]
Gerrard, Gibbons, Stock, Lune, & Cleveland, 2005 0.04 [-0.04 , 0.11]
Gibbons et al., 2004b 0.11 [0.04 , 0.18]
Gibbons et al., 2010a 0.29 [0.21 , 0.36]
Gibbons et al., 2012 (Substance use) 0.34 [0.26 , 0.42]
Gibbons et al., 2012 (Sex) 0.19 [0.11 , 0.27]
Houlihan et al., 2008 0.37 [0.29 , 0.44]
Pomery et al., 2005 0.66 [0.53 , 0.79]
Stock et al., 2013a 0.30 [0.23 , 0.38]
Stock, Gibbons, Walsh, & Gerrard, 2011 0.62 [0.37 , 0.87]
Gerrard, Gibbons, Vande Lune, Pexa, & Gano, 2002b (Cigarettes) 0.19 [0.06 , 0.32]
Gerrard, Gibbons, Vande Lune, Pexa, & Gano, 2002b (Alcohol) 0.34 [0.21 , 0.47]
Gerrard, Gibbons, Vande Lune, Pexa, & Gano, 2002b (Substance use) 0.35 [0.23 , 0.48]
Gerrard et al., 2002a 0.94 [0.83 , 1.05]
Gibbons et al., 1998a (Study 1) 0.73 [0.63 , 0.82]
Gibbons et al., 1998a (Study 2) 0.30 [0.21 , 0.39]
Gibbons et al., 1998a (Study 3) 0.31 [0.22 , 0.40]
Gibbons et al., 1998b (Study 1) 0.78 [0.68 , 0.87]
Gibbons et al., 1998b (Study 2) 0.55 [0.45 , 0.65]
Andrews et al., 2008b 0.44 [0.36 , 0.51]
Andrews, Hampson, & Peterson, 2011b 0.44 [0.29 , 0.58]
Gerrard et al., 2006 0.12 [0.00 , 0.24]
Dal Cin et al., 2009 0.46 [0.43 , 0.49]
Zimmermann & Sieverding, 2010 (Male) 0.41 [0.25 , 0.58]
Zimmermann & Sieverding, 2010 (Female) 0.50 [0.34 , 0.66]
Zimmermann & Sieverding, 2011a 0.51 [0.40 , 0.62]
Kalebi Maglica, 2011 (Cigarettes) 0.46 [0.35 , 0.57]
Kalebi Maglica, 2011 (Alcohol) 0.47 [0.37 , 0.58]
RE Model 0.44 [0.38 , 0.50]
-0.50
0.00
0.50
1.00
1.50
Fisher's z Transformed Correlation Coefficient



Dodge, Stock, & Litt, 2013 0.23 [0.06 , 0.41]
Eggleston, 1997 0.24 [0.11 , 0.38]
Gebhardt, Van Empelen, & Van Beurden, 2009 0.44 [0.16 , 0.71]
Hukkelberg & Dykstra, 2009 0.26 [0.18 , 0.33]
Litt & Stock, 2011 0.44 [0.29 , 0.58]
Litt et al., 2013 0.59 [0.47 , 0.71]
Litt, Stock, & Lewis, 2012 0.63 [0.53 , 0.74]
O'Hara, 2012 0.74 [0.64 , 0.84]
O'Hara, 2012 (vaccination) 0.33 [0.23 , 0.43]
Ohtomo, 2013 0.56 [0.44 , 0.67]
Ohtomo, Hirose, & Midden, 2011 (Dutch) 0.11 [-0.01 , 0.23]
Ohtomo, Hirose, & Midden, 2011 (Japanese) 0.20 [0.10 , 0.31]
Peterson, 2013 0.41 [0.27 , 0.55]
Pomery et al., 2009 (All participants) 0.72 [0.61 , 0.82]
Pomery et al., 2009 (Non-smokers) 0.27 [0.12 , 0.41]
Rivis, Sheeran, & Armitage, 2010 0.78 [0.60 , 0.95]
Scott-Parker, Hyde, Watson, & King, 2013 0.52 [0.42 , 0.62]
Stock, Gibbons, Peterson, & Gerrard, 2013b (Substance use) 0.85 [0.66 , 1.04]
Stock, Gibbons, Peterson, & Gerrard, 2013b (Sex) 0.05 [-0.14 , 0.24]
Stock, Litt, Arlt, Peterson, & Sommerville, 2013c 0.37 [0.29 , 0.45]
Todd & Mullan, 2011 0.44 [0.21 , 0.66]
van Empelen & Kok, 2006 0.26 [0.04 , 0.47]
Walsh & Stock, 2012 0.30 [0.14 , 0.46]
Whitaker, Long, Petróczi, & Backhouse, 2013 0.60 [0.52 , 0.67]
RE Model 0.43 [0.35 , 0.52]
-0.50
0.00
0.50
1.00
1.50
Fisher's z Transformed Correlation Coefficient



Andrews et al., 2011a 0.63 [0.59 , 0.67]
Dodge, Stock, & Litt, 2013 0.42 [0.25 , 0.60]
Eggleston, 1997 0.21 [0.07 , 0.35]
Gebhardt, Van Empelen, & Van Beurden, 2009 0.50 [0.24 , 0.75]
Gibbons et al., 1995a (Study 1) 0.19 [0.07 , 0.31]
Hukkelberg & Dykstra, 2009 0.35 [0.28 , 0.43]
Lane, Gibbons, O'Hara, & Gerrard, 2011 0.60 [0.41 , 0.80]
Litt et al., 2013 1.05 [0.94 , 1.17]
Myklestad & Rise, 2007 (Female) 0.33 [0.11 , 0.55]
Myklestad & Rise, 2007 (Male) 0.15 [-0.08 , 0.39]
O'Hara, 2012 1.19 [1.09 , 1.29]
O'Hara, 2012 (vaccination) 1.22 [1.12 , 1.32]
Ohtomo, 2013 0.45 [0.34 , 0.57]
Ohtomo, Hirose, & Midden, 2011 (Dutch) 0.30 [0.18 , 0.42]
Ohtomo, Hirose, & Midden, 2011 (Japanese) 0.32 [0.21 , 0.43]
Pomery et al., 2009 (Non-smokers) 0.51 [0.36 , 0.65]
Pomery, 2008 0.52 [0.33 , 0.71]
Reimer, 2009 (Study 1) 0.97 [0.80 , 1.14]
Reimer, 2009 (study 2) 0.93 [0.79 , 1.07]
Rivis, Sheeran, & Armitage, 2010 1.05 [0.87 , 1.22]
Scott-Parker, Hyde, Watson, & King, 2013 0.62 [0.52 , 0.72]
Stock, 2007 -0.07 [-0.20 , 0.06]
Thornton et al., 2002 (study 1) 0.08 [-0.02 , 0.18]
Thornton et al., 2002 (Study 2) 0.61 [0.37 , 0.85]
Todd & Mullan, 2011 0.55 [0.33 , 0.77]
van Empelen & Kok, 2006 0.06 [-0.16 , 0.28]
Gerrard, Gibbons, Zhao, Russell, & Reis-Bergan, 1999 1.59 [1.47 , 1.71]
Thornton et al., 2002 (Study 3) 0.69 [0.60 , 0.78]
Gibbons et al., 2004b 0.48 [0.41 , 0.56]
Gibbons et al., 2010a 0.85 [0.77 , 0.92]
Gibbons et al., 1995a (Study 2) 0.11 [0.02 , 0.21]
Gibbons et al., 1998a (Study 1) 0.85 [0.75 , 0.94]
Gibbons et al., 1998a (Study 2) 0.40 [0.31 , 0.49]
Gibbons et al., 1998a (Study 3) 0.40 [0.31 , 0.49]
Gibbons et al., 1998b (Study 1) 0.81 [0.72 , 0.90]
Gibbons et al., 1998b (Study 2) 0.66 [0.57 , 0.76]
Gibbons, Helweg-Larsen, & Gerrard, 1995b (American) 0.14 [0.05 , 0.23]
Gibbons, Helweg-Larsen, & Gerrard, 1995b (Danish) 0.00 [-0.13 , 0.13]
Andrews et al., 2008b 0.63 [0.56 , 0.71]
Gerrard et al., 2006 0.20 [0.09 , 0.32]
Zimmermann & Sieverding, 2010 (Male) 0.50 [0.33 , 0.66]
Zimmermann & Sieverding, 2010 (Female) 0.42 [0.26 , 0.58]
Zimmermann & Sieverding, 2011a 0.50 [0.38 , 0.61]
Zimmermann & Sieverding, 2011b 0.46 [0.35 , 0.57]
RE Model 0.53 [0.43 , 0.64]
-0.50
0.00
0.50
1.00
1.50
2.00
Fisher's z Transformed Correlation Coefficient



Andrews et al., 2011a 0.63 [0.59 , 0.67]
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Hukkelberg & Dykstra, 2009 0.35 [0.28 , 0.43]
Lane, Gibbons, O'Hara, & Gerrard, 2011 0.60 [0.41 , 0.80]
Litt et al., 2013 1.05 [0.94 , 1.17]
Myklestad & Rise, 2007 (Female) 0.33 [0.11 , 0.55]
Myklestad & Rise, 2007 (Male) 0.15 [-0.08 , 0.39]
O'Hara, 2012 1.19 [1.09 , 1.29]
O'Hara, 2012 (vaccination) 1.22 [1.12 , 1.32]
Ohtomo, 2013 0.45 [0.34 , 0.57]
Ohtomo, Hirose, & Midden, 2011 (Dutch) 0.30 [0.18 , 0.42]
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Pomery, 2008 0.52 [0.33 , 0.71]
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Scott-Parker, Hyde, Watson, & King, 2013 0.62 [0.52 , 0.72]
Stock, 2007 -0.07 [-0.20 , 0.06]
Thornton et al., 2002 (study 1) 0.08 [-0.02 , 0.18]
Thornton et al., 2002 (Study 2) 0.61 [0.37 , 0.85]
Todd & Mullan, 2011 0.55 [0.33 , 0.77]
van Empelen & Kok, 2006 0.06 [-0.16 , 0.28]
RE Model 0.53 [0.39 , 0.67]
-0.50
0.00
0.50
1.00
1.50
Fisher's z Transformed Correlation Coefficient

SUPPLEMENTARY FILE 7

Path Analysis Fit Statistics

Fit statistics for path analyses of the prototype willingness model with reasoned and heuristic pathways (path analysis Model 2) for overall dataset and each level of the behaviour and age category moderators (df=2)

	AIC	RMR	RMSEA	χ^2	p	N
Overall	409.77	0.012	0.10	393.76	<.001	18697
Alcohol	149.42	0.013	0.13	133.42	<.001	4031
Cigarette	27.98	0.004	0.04	11.98	.003	3769
Substance Use	263.26	0.026	0.19	247.26	<.001	3136
Sex	39.7	0.007	0.06	23.7	<.001	3467
Pre-adolescent	81.18	0.011	0.10	65.18	<.001	9866
Adolescent	97.21	0.008	0.08	81.20	<.001	3482
Adult	295.19	0.014	0.12	279.20	<.001	6700

Notes: AIC = Akaike information criterion, RMR=root mean square residual, RMSEA = Root mean square error of approximation, χ^2 = chi square, p = significance of the χ^2 statistic, N=sample size used to conduct the model, calculated from mean harmonic N. Fit statistics could not be calculated for Model 1 or Model 3 as these models are just-identified and have zero degrees of freedom.