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The impact of background music on adult listeners: A meta-analysis

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Abstract

Background music has been found to have beneficial, detrimental, or no effect on a variety of behavioral and psychological outcome measures. This article reports a meta-analysis that attempts to summarize the impact of background music. A global analysis shows a null effect, but a detailed examination of the studies that allow the calculation of effects sizes reveals that this null effect is most probably due to averaging out specific effects. In our analysis, the probability of detecting such specific effects was not very high as a result of the scarcity of studies that allowed the calculation of respective effect sizes. Nonetheless, we could identify several such cases: a comparison of studies that examined background music compared to no music indicates that background music disturbs the reading process, has some small detrimental effects on memory, but has a positive impact on emotional reactions and improves achievements in sports. A comparison of different types of background music reveals that the tempo of the music influences the tempo of activities that are performed while being exposed to background music. It is suggested that effort should be made to develop more specific theories about the impact of background music and to increase the methodological quality of relevant studies.

Keywords

background music, effects of music, healthy adults, meta-analysis, methodological problems

Background music permeates our daily lives. It is so ubiquitous that many people might not even be aware of it when driving, shopping, eating, reading, or working. How does it affect

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people who happen to listen to it? That music produces beneficial effects is a long-held assumption. In ancient Greece the philosopher Plato praised them in his *Politeia* (Rainbow, 1988). Nowadays, the general public might be especially aware of such potential benefits because of highly visible newspaper articles on, for instance, cows giving more milk when exposed to background music (Drösser, 1999). Usually, music is assumed to have a positive impact on performance and there is indeed evidence for this view in the research literature. For instance, Cockerton, Moore, and Norman (1997) found an increase in IQ scores for participants who were played (relaxing) music compared to those in a no-music condition. Adverse effects are also occasionally reported. In the early 1900s Jensen (1931) found that background music had detrimental effects on typewriting. Other potential effects of music cannot be easily categorized into positive or negative. For example, McElrea and Standing (1992) examined how fast participants drank water dependent on whether they listened to fast or slow music: fast music led to fast drinking. Yet looking more closely into the literature, effects are not always so clear. Therefore, to be able to make a solid statement about the impact of background music it is necessary to conduct a comprehensive overview of the studies on the topic. This is what Behne (1999) attempted to do in his pioneering study (published in German).

Behne (1999) analyzed 153 studies that examined the impact of background music on 'non-musical behavior' understood in a wide sense. Some examples are achievement on test scores and in school, behavior in the workplace and public places (e.g., airports, shopping malls, and banks), conduct during telephone calls, understanding of documentaries, reaction to commercials, driving a car, and playing sports. He did not include studies on the impact of foreground music, that is, the impact of focused listening to music, such as, for instance, when attending concerts, participating in music therapy, or watching video clips. He also excluded clinical studies and studies with physiological dependent measures. Behne did not differentiate between positive and negative effects and looked only at *p*-values. He found that about one third of all studies yielded non-significant results at an α of 5 percent, and another third yielded 'inconsistent results'. Moreover, he found that the proportion of non-significant results had increased over time. From this, he concluded that in general, background music has a negligible impact on everyday behavior and that this impact, if any, has even diminished over time because of habituation effects.

This conclusion has some plausibility but Behne's (1999) analysis can only give a first impression, because *p*-values do not necessarily correspond to effect sizes. For instance, small *p*-values may represent small effects because of very large sample sizes, whereas non-significant *p*-values might correspond to rather large effects that did not reach significance because of small samples. Behne (1999) acknowledged this problem but apparently did not want to discard a substantial number of studies only because they provided insufficient information for the calculation of effect sizes. However, in our view, the only way to make a sound judgment about the general impact of background music on behavior is to conduct a (real) meta-analysis based on effect sizes. This is the aim of the present article.

The current meta-analysis is not the first on the impact of music. Other meta-analyses investigated the impact of music therapy on medical and dental treatment or on behavior change and mostly detected large and positive average effects (Gold, Voracek, & Wigram, 2004; Kroger, Chapin, & Brotons, 1999; Rudin, Kiss, Wetz, & Sottile, 2007; Silverman, 2003; Standley, 1986, 1996; Whipple, 2004). Another meta-analysis found music to decrease stress-induced arousal (Pelletier, 2004), but this analysis also revealed that the effects were not unequivocal: they depended on age, type of stress, associated relaxation technique, musical preference, previous music experience, and type of intervention. A different meta-analysis that examined the therapeutic effects of music in clinical settings found only very small or even negligible effects (Evans, 2002). There were also meta-analyses on the non-therapeutic effects of music. However, these studies did not analyze the effects of background music but the effects of (actively) having been listening to music (Mozart effect) that yielded rather small effects (Chabris, 1999; Hetland, 2000a) and the effects of making music (Hetland, 2000b) that produced moderate effects.

A second look at some of the analyses that produced very large effects reveals that the average effect sizes reported may have been somewhat inflated by inclusion of invalid designs (designs without a control group, e.g., Gold et al., 2004), by giving small studies the same weight as large ones (e.g., Standley, 1996), or by using the same sample repeatedly in the analysis and therefore giving more weight to some studies than to others (e.g., Pelletier, 2004). But even if these deficiencies are taken into account, it seems safe to conclude that music used in a therapeutic context does have marked and beneficial effects. Can the same be said about (non-therapeutic) background music? Apart from Behne's (1999) study, this question has, to the best of our knowledge, only been addressed in one other systematic meta-analytic review by Garlin and Owen (2006) that examined the impact of background music on customer behavior. These authors found some rather small effects of background music on value returns (sales/purchases, intention to purchase or patronize, intention to recommend or return, and evaluation of products/service), behavior duration (actual time spent, perceived time spent), and affective response (mostly measurements of arousal and pleasure). Garlin and Owen also found that some moderator variables such as tempo and genre had an impact on the outcomes. However, because of the scarcity of studies, the number of effect sizes available for analyzing a given question was usually quite low, even though they frequently used several (dependent) effect sizes from a single study, which could have biased the results by unduly giving more weight to the studies that contributed more effect sizes.

In this article, we do not start from a specific area of application (such as customer behavior) but, following Behne (1999), first try to find out about global effects of background music before looking at more specific effects in different theoretically well-defined areas and contexts. We first clarify the methods we used and then report the results of two meta-analyses. In the first analysis, the effect of music as compared to no music is summarized and in the second, different kinds of music are compared in respect to their impact on different kinds of psychological measures. In each analysis, we also looked at potential alternative explanations for the results.

General method

Selection of studies

Similar to Behne's (1999) study, our analysis concentrated on the impact of background music on 'non-musical behavior'. Because it can be expected that the impact differs according to the age of the listeners, we only considered studies with adult participants. To collect relevant studies, we relied on a list of 130 studies provided to us by Behne and, in addition, conducted database searches in PsycInfo, PsycArticles, PsycLIT, Web of Sciences, The Cochrane Library and Academic Search Premier with the descriptor 'background music'. These databases covered all articles published before 2008. In addition, we also examined references from relevant articles to identify further studies. After excluding studies on the impact of music therapy and studies with children we ended up with a list of 189 articles that fulfilled our content criteria.

As already indicated by Behne (1999), not all studies allowed the calculation of effect sizes. Indeed a substantial number of the reports did not provide sufficient information so that in the end only 97 studies could be included for analysis. As a result of differences in design, 66 of these studies allowed the comparison of background music to no music and 71 allowed the comparison of the impact of different kinds of background music. These comparisons give answers to different research questions, and therefore we conducted two separate meta-analyses with 40 studies (out of the 97) used in both analyses.

Classification of effects

Obviously, whether background music influences behavior positively or negatively makes an important difference. Therefore, we classified the results into positive and negative outcomes whenever possible. In addition, we aimed to obtain more specific conclusions than whether background music has an impact on behavior (understood in a broad sense). Consequently, we classified the dependent variables used into three main categories: *mundane behavior*, *cognition* and *emotion*. A more fine-grained distinction would have yielded very few exemplars in each category because of the relatively few studies that would have resulted from such an approach (but see below).

Examples of mundane behavior are eating (e.g., the speed of eating and drinking depending on the speed of music, McElrea & Standing, 1992) and driving (e.g., the number of steering wheel movements depending on whether drivers listened to music or not, Konz & McDougal, 1968). The category cognition was divided into two subcategories: *judgment* and *achievement*. Examples for judgments are the assessment of one's own ability to sustain concentration, depending on the level of arousal induced by music (e.g., Smith & Morris, 1977) and the attitude toward vendors in a shopping mall (e.g., Dubé & Morin, 2001). In contrast, the number of correct responses in a reading test depending on the speed of music (e.g., Kallinen, 2002) and the results in a math test depending on the loudness of music were classified as achievements (e.g., Wolfe, 1983). The category emotion was used when nervousness and excitement in a job context were measured (e.g., Oldham, Cummings, Mischel, Schmidtke, & Zhou, 1995) and for emotional reactions when doing treadmill exercises (Brownley, McMurray, & Hackney, 1995). The numbers of studies that fell into the different categories are shown in Table 1.

Table 1. Numbers of studies that fell into the different categories of dependent variables. Note that several studies examined more than one dependent variable. Therefore, the total number of studies is less than the sum of studies that are classified into the different categories.

Dependent variable	Background music versus no music	Different kinds of background music
Total	$N = 66$	$N = 71$
Mundane behavior	$N = 22$	$N = 30$
Cognition (judgment)	$N = 13$	$N = 20$
Cognition (achievement)	$N = 43$	$N = 35$
Emotion	$N = 6$	$N = 8$

Calculation of effect sizes

All effect sizes used in the analyses reported below refer to the comparison of two group means (music vs. no music or one type of music vs. another type of music). Effect sizes can be calculated from raw scores, from the results of significance tests, and from other effect sizes, and can be expressed as standardized differences (*d* and *g*) and as the correlation (*r*) between group membership and values of the dependent variables (e.g., Rosenthal, 1994; Sedlmeier & Renkewitz, 2007). For the final analysis, we used correlations but for the intermediate steps we used those effect sizes that best suited the information available. In the majority of cases ($n = 61$ studies), means and sample standard deviations (for groups *a* and *b*) were available and allowed the calculation of *d*:

$$d = \frac{\bar{x}_a - \bar{x}_b}{s_{ab}} \quad \text{with} \quad s_{ab} = \sqrt{\frac{n_a s_a^2 + n_b s_b^2}{n_a + n_b}}$$

For the calculation of effect sizes, the design of studies makes a difference: in general, within-participants designs yield larger effect sizes than between-participants designs because of the usually positively correlated measurements (see Dunlap, Cortina, Vaslow, & Burke, 1996). For between-participants designs we calculated *r* as follows:

$$r = \sqrt{\frac{t^2}{t^2 + df}} \quad \text{and}$$

$$r = \sqrt{\frac{F}{F + df_{\text{error}}}}, \text{ for } F(1, df_{\text{error}})$$

Results of within-participants designs (t_{WD}) were made comparable to between-participants design results by using the correction proposed by Cohen (1988; see also Dunlap et al., 1996). If effect sizes were initially calculated as *d*, (for between-participants designs) or as corrected *d* (for within-participants designs) they were transformed into *r* for final analysis:[1]

$$r = \frac{d}{\sqrt{d^2 + \frac{1}{pq}}}$$

where *p* and *q* are the proportions of the sample sizes of the two groups of the total sample size. For instance, if in a between-participants design with groups A and B, $n_A = 20$ and $n_B = 30$, $p = .4$ and $q = .6$ (for within-participants designs: $p = q$).

The sign of *r* was determined as follows. If the dependent measure allowed differentiation between a positive and a negative outcome (e.g., higher test scores with music versus no music would be a positive outcome) then the correlation had a positive sign for a positive outcome and a negative sign for a negative outcome. If the values of the dependent variable could not be classified into positive and negative, a positive difference ('music' minus 'no music') was expressed in a positive correlation. The analyses that compared one type of music to another usually did not allow us to derive clear predictions; therefore in those analyses, only the absolute size of *r* was used. In every analysis, one sample yielded only one effect size. This means that for analyses of categories that were measured by more than one dependent variable, the mean of the effect sizes for all relevant dependent variables was used. In the meta-analyses, effect sizes were always weighted by sample sizes.

Comparability of studies and the search for moderator variables

A potential problem one has to deal with in all kinds of meta-analyses is whether the studies included are really comparable – in other words, whether they stem from the same population. In our analyses, we used two kinds of checks to examine this question. First we performed a graphical analysis, a so-called *funnel plot*. A funnel plot (e.g., Egger, Smith, Schneider, & Minder, 1997; Light & Pillemer, 1984) is a scattergram for the variables 'effect size' and 'sample size' that should give the impression of a funnel turned upside down if all results come from the same population and if there were no systematic selection processes. An (inverted) funnel shape is expected because the largest samples should give the best estimates of the population effect, whereas effect sizes calculated from small samples can vary widely through sampling error. If the effect sizes stem from different populations, or if only a subsample was selected (e.g., only the studies with significant outcomes), the scattergram should deviate markedly from a funnel shape.

A second, more precise way to analyze whether studies are comparable is psychometric meta-analysis (Hunter & Schmidt, 1990). The 'psychometric' comes from the analogy to the traditional test theory where the test score (e.g., in a personality test or an IQ test) is assumed to be the sum of the true score and an error component (Lord & Novick, 1968). Accordingly, the empirical variance, that is, the variance of the effect sizes in a meta-analysis (expressed in *r*) is the sum of the variance of the population effect sizes (ρ) plus an error variance:

$$\sigma_r^2 = \sigma_\rho^2 + \sigma_e^2.$$

If all effect sizes stem from one population, there should be no variance of the population effect sizes ($\sigma_\rho^2 = 0$) and the variance of the effect sizes found should be totally attributable to sampling error alone. If, however, the empirical variance is substantially larger than the error variance, this indicates that the effect sizes stem from several different populations and, therefore, should not be combined in a single meta-analysis.

If the above analyses indicate that the effect sizes stem from different populations, the next step is to search for those populations, that is, to search for systematic differences between groups of effect sizes. This is nothing but the search for *moderator variables*. If one has plausible candidates for such variables, the psychometric meta-analysis can be repeated for the subgroups built by the categories of the moderator variables. If, for the subgroups, the empirical variances can be strongly reduced or explained by error variances alone, this might indicate that 'true' population effects have been identified.

Global analysis

In a first step, all studies were analyzed using the methods and criteria described above. For all 97 studies, we determined whether background music was compared to no music or to other music or to both. Then we classified the dependent variable(s) into the type(s) of behavior examined in the respective studies and calculated global effect sizes, one per study (and kind of comparison, if applicable). Table 2 shows the results. For each study, column 3 indicates the conditions with which the background music condition was compared. There are three possible cases: comparison with a no-music condition (NM), with some different music condition (DM), or with both. The next column shows the classification for the dependent variables used: mundane behavior (MB), judgments (C(J)), achievement (C(A)), and emotional reactions (E). The fifth column gives the sample size(s) used. For between-participants studies that compared background music to both no music and some other music, the second sample size is smaller than the first because it only contained participants who had listened to music (and not those in the no-music condition). In the final column, the global effect sizes (*r*), possibly averaged over different kinds of dependent variables, are shown for the comparisons listed in column 3. The correlations are signed for the comparison between music and no music (a positive sign if music led to a more positive effect) and unsigned for the comparison between different kinds of music. The weighted mean (weighted by sample sizes) is $r = .03$ for music versus no music and $r = .17$ for the comparison between different music conditions. This first and global result gives a first impression that is consistent with Behne's (1999) findings. In the following, we will look at both kinds of analyses in more detail.

Does background music have a beneficial effect?

By using signed effect sizes, we can find out whether background music generally has a beneficial or a detrimental effect on nonmusical behavior as compared to no music. We already saw that the results of a global analysis indicate that there is no general effect of background music. Now we will take a closer look.

Detailed analysis

More detailed results are given separately for the different classes of dependent variables in Table 3. Shown are the number of studies (*N*), the total sample size summed up over all relevant studies (*n*), the minimum and maximum effect sizes (r_{min} and r_{max}), the unweighted averaged effect sizes, the standard deviation of effect sizes, and the weighted average of the effect sizes. Although the variation in effect sizes is considerable (from $r = -.57$ to $r = .96$), the weighted mean effect sizes are rather small also for the predefined subgroups: background music apparently has no general effect on cognition and only small effects on behavior and emotion. And the largest of these small effects ($r = .11$) was found for the smallest class of our dependent variables, emotion, where sampling error could have had a stronger biasing effect on the result of the meta-analysis.

Comparability of studies

If all the studies in our sample measured the same population effect, we could conclude that background music does not influence behavior at all. However, a null effect might also arise if there are different population effects that cancel each other out. Figure 1, a scatterplot of effect sizes versus sample sizes, shows the form of an (upside-down) funnel with large-sample effect sizes near 0 and a covariation of large effects with small sample sizes. Because large samples give more accurate estimates, the funnel plot lends some support to the result of the basic analysis: background music has no effect.

Table 2. Listing of studies, basic characteristics, sample size(s), and global effect size(s). Articles that contain more than one independent sample are listed repeatedly.

No.	Study	Type of comparison[a]	Dependent variable(s)[b]	Sample size(s)	*r*
1	Alpert, Alpert, & Maltz (2005)	DM	C(J), E	71	.19
2	Anshel & Marisi (1978)	NM/DM	MB	32/32	+.17/.19
3	Areni & Kim (1993)	DM	MB	16	.24
4	Bailey & Areni (2006)	DM	C(J)	64	.22
5	Balch, Bowman, & Mohler (1992)	DM	C(A)	80	.07
6	Balch, Bowman, & Mohler (1992)	DM	C(A)	40	.14
7	Balch, Bowman, & Mohler (1992)	DM	C(A)	40	.04
8	Becker, Chambliss, Marsh, & Montemayor (1995)	NM/DM	MB	20/20	−.02/.04
9	Beh & Hirst (1999)	NM/DM	C(A)	45/30	+.30/.24
10	Brownley, McMurray, & Hackney (1995)	NM/DM	MB, C(J), E	16/16	+.06/.30
11	Brünken, Plass, & Leutner (2004)	NM	C(A)	10	−.03
12	Brünken, Plass, & Leutner (2004)	NM	C(A)	10	−.05
13	Burton (1986)	NM	C(A)	64	.08
14	Caldwell & Hibbert (2002)	DM	MB, C(J)	62	.26
15	Caldwell & Riby (2007)	DM	C(A)	16	.20
16	Carlton & MacDonald (2004)	NM/DM	C(J)	60/40	+.09/.62
17	Cassidy & MacDonald (2007)	NM/DM	C(A)	30/20	−.34/.73
18	Cockerton, Moore, & Norman (1997)	NM	C(A)	30	+.27
19	Cohen, Paradis, & LeMura (2007)	NM	MB	25	+.08
20	Copeland & Franks (1991)	NM/DM	MB, C(J)	24/24	+.04/.05
21	Corhan & Gounard (1976)	DM	C(A)	12	.71*
22	Crawford & Strapp (1994)	NM/DM	C(A)	61/40	−.23/.39
23	Crust & Clough (2006)	NM/DM	MB	58/58	+.13/.13
24	Crust, Clough, & Robertson (2004)	NM/DM	C(A)	57/57	+.21/.09
25	Dalton, Behm, & Kibele (2007)	DM	MB, C(A)	12	.18
26	Darrow, Johnson, Agnew, Fuller, & Uchisaka (2006)	NM	C(A)	87	+.03
27	de Groot (2006)	NM	C(A)	36	+.27
28	Dubé & Morin (2001)	DM	C(J)	110	.29
29	Edworthy & Waring (2006)	NM/DM	MB, C(J), E	30/30	+.10/.09
30	El Sayed, Farrag, & Belk (2003)	DM	C(J)	64	.27
31	Eroglu, Machleit, & Chebat (2005)	DM	MB	347	.08
32	Etaugh & Ptasnik (1982)	NM	C(A)	40	−.39
33	Fendrick (1937)	NM	C(A)	123	−.23
34	Ferguson, Carbonneau, & Chambliss (1994)	NM/DM	MB	14/14	+.71/.01
35	Freeburne & Fleischer (1952)	NM/DM	C(A)	208/165	+.09/.05
36	Freeman & Neidt (1959)	DM	C(A)	187	.03
37	Furnham & Allass (1999)	NM/DM	C(A)	48/48	−.02/.23
38	Furnham & Bradley (1997)	NM	C(A)	20	−.17

Table 2. *(Continued)*

No.	Study	Type of comparison[a]	Dependent variable(s)[b]	Sample size(s)	*r*
39	Geringer & Nelson (1979)	NM	C(A)	80	+.18
40	Gfeller, Asmus, & Eckert (1991)	NM/DM	E	90/60	+.12/.22
41	Gladstones (1969)	NM	MB	25	–.04
42	Grube (1996)	NM	C(J)	24	–.09
43	Grube (1996)	NM	C(A)	24	+.08
44	Guéguen, Hélène, & Jacob (2004)	DM	MB	120	.56
45	Hartley & Williams (1977)	NM	C(A)	12	–.57
46	Henderson, Crews, & Barlow (1945)	NM/DM	C(A)	50/50	–.22/.27
47	Iwanaga & Ito (2002)	NM/DM	C(A), C(J)	35/23	–.05/.19
48	Jacob (2006)	DM	MB	93	.33
49	Jensen (1931)	NM/DM	MB, C(A)	50/50	–.38/.75
50	Kallinen (2002)	NM/DM	C(A)	60/40	–.12/.41
51	Kellaris, Cox, & Cox (1993)	NM/DM	C(A)	232/168	–.12/.16
52	Kellaris & Mantel (1994)	DM	C(J)	110	.05
53	Kellaris & Mantel (1996)	DM	C(J)	85	.18
54	Konz & McDougal (1968)	NM/DM	MB	24/24	+.02/.07
55	Li (2005)	DM	MB, C(A)	223	.15
56	Madsen (1987)	NM/DM	C(A)	150/100	–.02 /.05
57	Mammarella, Fairfield, & Cornoldi (2007)	NM	C(A)	24	+.39
58	Mantel & Kellaris (2003)	DM	C(J)	92	.04
59	Mayfield & Moss (1989)	NM/DM	C(A)	68/40	–.05/.48
60	McElrea & Standing (1992)	DM	MB	40	.67
61	Mikol & Denny (1955)	NM/DM	MB	48/32	–.09/.00
62	Milliman (1982)	NM/DM	MB	63/42	–.03/.44
63	Nethery (2002)	NM	MB, C(J)	13	+.50
64	Nittono (1997)	NM/DM	C(A)	24/24	–.13/.09
65	Nittono, Tsuda, Akai, & Nakajima (2000)	DM	MB	24	.21
66	North & Hargreaves (1999)	DM	MB, C(J)	96	.34
67	North, Hargreaves, & McKendrick (1999)	DM	MB	82	.49
68	North, MacKenzie, Law, & Hargreaves (2004)	NM/DM	C(A)	162/162	+.05/.22
69	North, Shilcock, & Hargreaves (2003)	NM/DM	MB	393/262	+.12/.33
70	North, Tarrant, & Hargreaves (2004)	DM	MB	572	.18
71	Oakes (2003)	DM	C(J), E	235	.16
72	Oakes & North (2006)	NM/DM	C(A), C(J)	114/76	–.18/.14
73	Oakes & North (2006)	NM/DM	C(A), E	202/162	–.04/.16
74	Oldham, Cummings, Mischel, Schmidtke, & Zhou (1995)	NM	MB, C(J), E	256	+.12
75	Parente (1976)	NM/DM	C(A)	30/20	–.10/.10
76	Park & Young (1986)	NM	C(A), C(J)	120	–.03

(Continued)

Table 2. *(Continued)*

No.	Study	Type of comparison[a]	Dependent variable(s)[b]	Sample size(s)	*r*
77	Pates, Karageorghis, Fryer, & Maynard (2003)	NM	MB, C(J)	3	+.88
78	Ramos (1993)	DM	MB	14	.32
79	Ransdell & Gilroy (2001)	NM	C(A)	45	−.27
80	Rau & Chen (2006)	NM/DM	MB, C(A)	50/40	+.32/.19
81	Rink (1975–1976)	NM/DM	C(A)	107/80	+.20/.03
82	Roballey, McGreevy, Rongo, Schwantes, Steger, Wininger, & Gardner (1985)	NM/DM	MB	11/11	+.33/.20
83	Sang, Billar, Golding, & Gresty (2003)	NM	MB	24	+.17
84	Schreiber (1988)	NM	C(A)	64	+.29
85	Shen & Chen (2006)	DM	C(A), C(J)	130	.35
86	Smith & Morris (1977)	NM/DM	C(A), C(J), E	60/60	−.10/.16
87	Smith & Curnow (1966)	DM	MB	1100	.02
88	Sogin (1988)	NM/DM	C(A)	96/72	+.09/.21
89	Spangenberg, Grohmann, & Sprott (2005)	DM	C(J), E	130	.25
90	Stout & Leckenby (1988)	NM	C(A)	50	−.02
91	Szabo, Small, & Leigh (1999)	NM/DM	MB	24/24	.00/.09
92	Tannenbaum (1956)	NM	C(J)	120	+.16
93	Turner, Fernandez, & Nelson (1996)	NM/DM	MB, C(A)	90/90	.00/.12
94	Wolf & Weiner (1972)	NM	C(A)	15	+.14
95	Wolfe (1983)	NM/DM	C(A)	200/150	+.12/.12
96	Woo & Kanachi (2005)	NM/DM	C(A)	21/21	−.15/.21
97	Zhu & Meyers-Levy (2005)	DM	C(A), C(J)	77	.19

[a]NM: no music, DM: different music.
[b]MB: mundane behavior, C(J): cognition (judgment), C(A): cognition (achievement), E: emotion.

Table 3. Descriptive statistics for the comparison between background music and no music.

	N	*n*	r_{min}	r_{max}	$\bar{r}$	SD	$\bar{r}_{\text{weighted}}$
Total	66	4501	−.57	.88	.04	.24	.03
Mundane behavior	22	1293	−.24	.96	.14	.26	.08
Cognition (judgment)	13	875	−.29	.83	.09	.32	.03
Cognition (achievement)	43	3104	−.57	.46	−.02	.22	−.01
Emotion	6	654	−.27	.25	.05	.19	.11

However, a more detailed analysis using psychometric meta-analysis gives a different picture (see Table 4). First, the difference between the empirical variance and the error variance for all studies (Total) reveals a substantial variance for the population effect, expressed in a standard

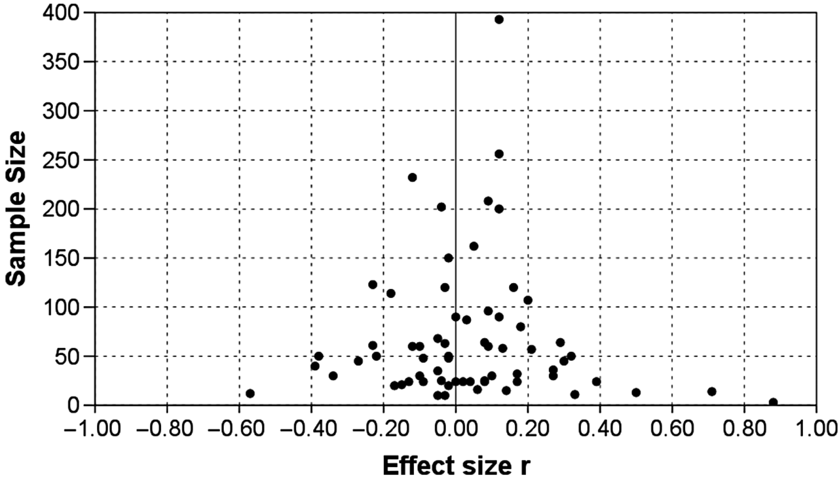

Figure 1. Funnel plot for the comparison between background music and no music.

deviation for the population effect of σ_ρ =.10. A separate analysis of our subgroups shows that neither of our two categories for cognition captured a single population effect: compared to the global analysis, the variance for the population effect even increased for achievement and did not decrease markedly for judgment. However, the separate analyses for emotion and especially mundane behavior diminish this variation of the population effect substantially. For the category emotion there is a strong reduction in population variance and for the category mundane behavior there is no difference between empirical and expected (error) variance.[2] Thus, it seems from our analysis that background music has a systematic, albeit small, impact on emotional and behavioral reactions.

Possible moderator variables

Apparently, our categorization of dependent measures did not lead to homogeneous subgroups of studies, with the exception of the category mundane behavior, and possibly emotion, although the latter conclusion is only tentative because of the small sample size. What could have caused the heterogeneity of results? In other words, what could be plausible moderator variables?

Table 4. Psychometric meta-analysis for the comparison between background music and no music.

Type of variance	Total	Mundane behavior	Cognition (judgment)	Cognition (achievement)	Emotion
σ_r^2	.0254	.0150	.0248	.0320	.0114
σ_e^2	.0149	.0171	.0151	.0140	.0090
σ_ρ^2	.0105	–.0021	.0097	.0180	.0024
σ_ρ	.10	.00	.10	.13	.05

One possible moderator variable mentioned by Behne (1999) is habituation over time: because music media are increasingly available everywhere, people get more and more used to background music and, therefore, its effect might have diminished over time. If this is true, we should find a negative correlation between year of publication and unsigned effect size. This correlation was, however, only $r = .01$ ($N = 66$ studies). The lowess curve (which makes visible any relationship between two variables, see Cleveland, 1985) in the scattergram of effect sizes versus year of publication (Figure 2) shows a slight negative trend until about 1970, but this trend might be due to the relatively few studies. In general, there is no systematic decline in the impact of background music over time.

To detect potential moderator variables it would be helpful to be able to rely on a general theory that makes precise predictions of the impact of background music on specific behavior. We are not aware of such a theory and therefore looked at the nature of the task and the context in which the studies were conducted. In our sample of studies these contexts and tasks were shopping, sports, job/work, watching commercials, driving, learning (with the help of movies), eating and drinking, cognitive tasks (such as reading, math or remembering), typing and the writing of essays. Unfortunately, the number of studies for the majority of these contexts and tasks was very small so that the respective conclusions would be rather unreliable. For all classifications with more than one study, consistent positive effects (better results with music) were found only for simple math tests ($N = 2$ studies, $\bar{r}_{\text{weighted}} = .12$, Wolf & Weiner, 1972; Wolfe, 1983). However, for some contexts and tasks, we could identify a sizable number of studies. These contexts and tasks were sports, advertisement, memory tasks and reading.

Sports. In 11 studies, the effect of background music on sports performance was examined. In these studies, participants had to ride a bicycle (Anshel & Marisi, 1978; Cohen, Paradis, & LeMura, 2007; Nethery, 2002; Szabo, Small, & Leigh, 1999), run (Becker, Chambliss, Marsh, & Montemayor, 1995; Brownley et al., 1995; Copeland & Franks, 1991; Edworthy & Waring,

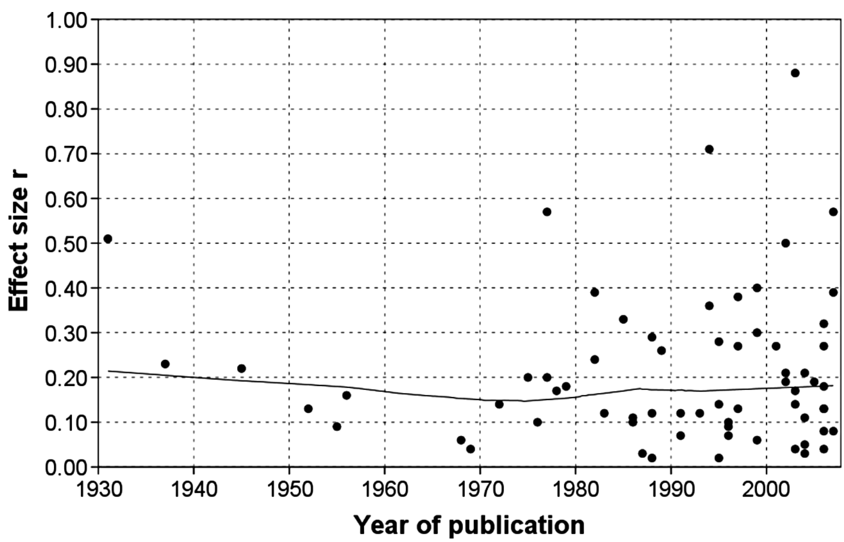

Figure 2. Lowess curve (with the tension parameter set to .9) illustrating the relationship between year of publication and (unsigned) effect sizes.

2006), lift weights (Crust & Clough, 2006), perform a karate exercise (Ferguson, Carbonneau, & Chambliss, 1994) or play basketball (Pates, Karageorghis, Fryer, & Maynard, 2003). Taken together, background music had a small but positive impact on sports performance ($\bar{r}_{\text{weighted}} = .15$, $N = 11$ studies, $n = 259$, $r_{\text{min}} = -.02$, $r_{\text{max}} = .88$). Table 5 shows that this effect seems to be genuine: The population variance decreases to 0 (see note 2 below), indicating that music might generally improve sports performance.

Advertisement. Seven studies examined the impact of background music on how well potential customers memorized the contents of advertisements (there were also other but quite different dependent measures used in these studies that did not allow any strong conclusions due to their idiosyncratic nature). Four of these studies used the radio as a medium (Kellaris, Cox, & Cox, 1993; North, MacKenzie, Law, & Hargreaves, 2004; Oakes & North, 2006, with two independent studies), two employed TV commercials (Park & Young, 1986; Stout & Leckenby, 1988) and one used mobile message advertisements (MMS) via a special kind of cell phone (Rau & Chen, 2006). Only for the latter could a substantial effect be found and the effect over all seven studies was slightly negative but negligibly small ($\bar{r}_{\text{weighted}} = -.05$, $N = 7$ studies, $n = 930$, $r_{\text{min}} = -.22$, $r_{\text{max}} = .46$). If the cell phone study is excluded, the effect does not change substantially ($\bar{r}_{\text{weighted}} = -.08$, $N = 6$ studies). The psychometric meta-analysis indicates that for the latter six studies, this slight negative effect might stem from one population (Table 5). If the cell phone study is included, the population variation increases remarkably (from $\sigma_\rho = .04$ without the study to $\Sigma_\rho = .14$ including the study), indicating that it might not be comparable to the other studies.

Other memory tasks. In addition to memorizing advertisements, a variety of other memory tasks (in different contexts) were examined in eight further studies (Cassidy & MacDonald, 2007; de Groot, 2006; Furnham & Allass, 1999; Furnham & Bradley, 1997; Iwanaga & Ito, 2002; Nittono, 1997; Smith & Morris, 1977; Woo & Kanachi, 2005). Participants had to perform these tasks with and without background music. It turned out that, consistent with the results for memory tests in an advertisement context, the weighted average effect size was slightly negative, with a very large variation in effect sizes ($\bar{r}_{\text{weighted}} = -.09$, $N = 8$ studies, $n = 274$, $r_{\text{min}} = -.57$, $r_{\text{max}} = .27$). Apparently, on average, background music slightly impaired memory processes. The psychometric meta-analysis confirms that the effects included were probably quite heterogeneous (Table 5).

Reading. Eight of the studies in our sample examined the effects of background music on reading performance (Etaugh & Ptasnik, 1982; Fendrick, 1937; Freeburne & Fleischer, 1952; Furnham & Allass, 1999; Furnham & Bradley, 1997; Henderson, Crews, & Barlow, 1945; Kallinen, 2002;

Table 5. Psychometric meta-analysis for the comparison between background music and no music for more specific areas.

Type of variance	Sports ($n = 11$)	Advertisements ($n = 6$)	Memory tasks ($n = 8$)	Reading ($n = 8$)
σ_r^2	.0361	.0085	.0482	.0140
σ_e^2	.0424	.0068	.0296	.0116
σ_ρ^2	−.0063	.0017	.0186	.0024
σ_ρ	.00	.04	.14	.05

Madsen, 1987). In all of the eight studies, the impact of music on text understanding was negative ($\bar{r}_{weighted}$ = –.11, N = 8 studies, n = 680, r_{min} = –.39, r_{max} = –.02).[3] The results of the psychometric meta-analysis in Table 5 indicate that the negative impact of music on reading might be a general effect.

Discussion

All the studies taken together yield a null effect: at first glance, background music does not seem to affect behavior. However, the results of the psychometric meta-analysis indicate that such a conclusion would be premature, because the studies are not really comparable. A distinction between subgroups divided along rather global categories (mundane behavior, cognition and emotion) already gives a more precise picture: there seems to be a slightly positive effect of background music on behavior and music seems to have a tendency to increase (positive) emotional experiences. If sports performance is singled out as a more specific kind of behavior, the positive effect is even slightly larger than the overall effect for behavior. The two categories initially used for cognition – achievement and judgment – were not helpful in explaining the results. It seems, however, that background music has a small but persistent negative effect on memory performance. Such a conclusion would be consistent with the results we found for three subcategories of cognitive tasks that all deal prominently with memory processes: memorizing advertisements, specific memory tasks and remembering texts read before.

Overall, the effects of background music in a non-clinical setting are generally not very large. However, if they are consistent, they can, because of the omnipresence of music in our lives, have a strong impact on many kinds of behavior. Our analysis might be interpreted as suggesting that this impact is tendentially positive for motoric behavior (e.g., sports) and emotional reactions, and negative for cognitive behavior (memory performance). To date, it is, however, far from clear how music might affect behavior of different sorts. If music unfolds its impact via arousal and mood, as the *arousal and mood hypothesis* (Thompson, Schellenberg, & Husain, 2001) suggests, one might indeed expect positive effects on emotional reactions (at least for liked music) and on sports performance (via arousal). One potential approach used for explaining the impact of background music on reading performance assumes that an increase in the activation of one brain hemisphere decreases the activation of the other hemisphere (Miller & Schyb, 1989). If background music activates the right hemisphere, tasks that need a highly activated left hemisphere, such as verbal tasks, could deteriorate. It might be worthwhile exploring potential antagonistic and supporting effects of music in connection with brain processes in more depth. Another candidate explanation for the negative impact of background music on memory processes might start with deliberations on the role of attentional limitations: listening to music while performing some cognitive task might distract attention from that task and therefore impair performance, especially in tasks (such as the reading task) that require conscious efforts (e.g. Treisman, 2006). For all theoretical considerations, it would be helpful to have a larger number of studies that examine specific effects (such as reading or different kinds of memory processes) in more detail.

Does the kind of background music make a difference?

When comparing different kinds of background music, there is often no unequivocal way to assign signs to effect sizes. Because different aspects of background music (e.g., speed, loudness, liking, familiarity, genre) are varied to different degrees in the available studies, there is also no clear standard of comparison, with the exception of loudness and tempo (see below). Therefore, only absolute effect sizes were used in this second analysis. This, of course, only allows us to draw conclusions about whether the type of music has an effect at all.

Detailed analysis

As already mentioned, the mean weighted effect size calculated from 71 studies that compare the effects of different kinds of background music is $r = .17$. This small effect is, however, probably an inflated figure because the use of absolute effect sizes means that the range of effect sizes is restricted by a minimum value of $r = 0$ (no negative effects). This means that, given some variation of effect sizes, the mean effect size *has* to be larger than 0. The fact that the weighted mean is not substantially larger than 0 indicates that the global effect size is close to 0. An inspection of the mean effect sizes for our subgroups shows similar results (Table 6).

Comparability of studies

The interpretation of the funnel plot in this case has to take into account that only absolute effects sizes are used in the analysis. If studies were comparable and if all effect sizes actually had the same sign, one would expect an inverted funnel shape in the scatterplot of effect size versus sample size. If the signs of the effects were mixed but studies were comparable, the funnel could be expected to be 'cut' in two pieces by the y-axis at $x = 0$ and part of the distribution of negative effect sizes 'mirrored' on the positive side of the x-axis. A 'half funnel', that is, a distribution of effect sizes with largest sample sizes for effects around 0, would indicate a zero effect in the population. The results shown in Figure 3 are most consistent with such an interpretation although the distribution of effect sizes is not very smooth, indicating that there might be different population effects.

A psychometric meta-analysis is not so useful in this case, because the range restriction means that the empirical variance is also restricted – that is, the calculated result will be smaller than the real variance. However, if the empirical (calculated) variance is then still larger than the (theoretical) error variance, this would be a strong indicator that studies are not comparable. Indeed, a comparison of variances shows the empirical variance to be substantially larger than the error variance for all studies taken together. An analysis of our subgroups reveals that this discrepancy still exists for mundane behavior and both kinds of cognition. In sum, there are strong indications that studies were not comparable, and that the categories we used do not explain the differences found.

Table 6. Descriptive statistics for the comparison of different kinds of background music.

	N	n	r_{min}	r_{max}	$\bar{r}$	SD	$\bar{r}_{\text{weighted}}$
Total	71	6821	.00	.75	.23	.18	.17
Mundane behavior	30	3570	.00	.67	.23	.19	.17
Cognition (judgment)	20	1595	.04	.62	.21	.14	.21
Cognition (achievement)	35	2605	.03	.81	.23	.19	.17
Emotion	8	764	.07	.35	.20	.11	.19

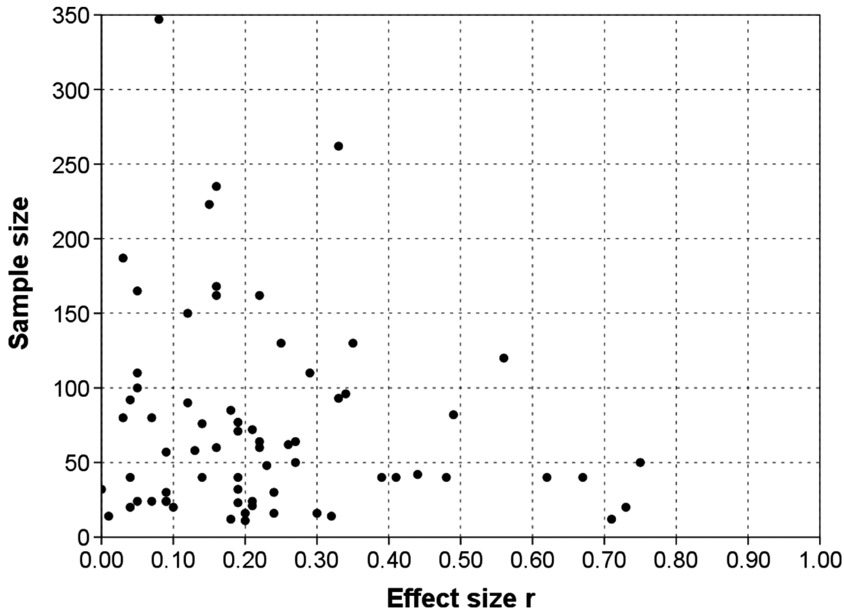

Figure 3. Funnel plot for the comparison of different kinds of background music. Two studies are not included in the plot (but are included in the calculations) because of the large sample sizes (n = 1100, r = .02, and n = 572, r = .18).

Possible moderator variables

The moderator variables mentioned above did not help in explaining the heterogeneity of studies. Therefore, we also looked at the peculiarities of music, such as loudness, preference, genre, tempo and familiarity. Sometimes it was not possible to assign a sign to the effects (e.g., if different genres were compared). In two cases it was possible: loudness and tempo.

Loudness. Eleven studies systematically manipulated loudness of music and in nine of these studies this manipulation was not confounded with a simultaneous variation of other factors (Beh & Hirst, 1999; Dalton, Behm, & Kibele, 2007; Edworthy & Waring, 2006; Guégen, Hélène, & Jacob, 2004; Rau & Chen, 2006; Smith & Curnow, 1966; Turner, Fernandez, & Nelson, 1996; Wolfe, 1983; Woo & Kanachi, 2005). For these studies, the effect size was negligible ($\bar{r}_{\text{weighted}}$ = .02, N = 9 studies, n = 1593, r_{min} = –.24, r_{min} = .56). This result might, however, be due to very large differences in the way loudness was manipulated, both in terms of increments (ranging from about 7 dB to about 42 dB) and situational context. The psychometric meta-analysis indicates that this mean effect does not stem from one population (σ_ρ = .14).

Tempo. We could identify 16 studies that systematically manipulated the tempo of background music (Balch, Bowman, & Mohler, 1992 (three studies); Brownley et al., 1995; Edworthy & Waring, 2006; El Sayed, Farrag, & Belk, 2003; Eroglu, Machleit, & Chebat, 2005; Kallinen, 2002; Mayfield & Moss, 1989; McElrea & Standing, 1992; Milliman, 1982; Nittono, Tsuda, Akai, & Nakajima, 2000; Oakes, 2003; Oakes & North, 2006; Roballey et al., 1985; Szabo et al., 1999). Once more, there was no overall effect of tempo ($\bar{r}_{weighted} = -.01$, $N = 16$ studies, $n = 1149$, $r_{min} = -.27$, $r_{max} = .67$). But again, this might be because of the heterogeneity of dependent variables and situational contexts. If just the impact of the tempo of music on motor behavior is considered, the results look quite different, though. There were eight studies that examined the impact the tempo of music had on the tempo of behavior (Caldwell & Hibbert, 2002; Edworthy & Waring, 2006; Kallinen, 2002; Mayfield & Moss, 1989; McElrea & Standing, 1992; Milliman, 1982; Nittono et al., 2000; and Roballey et al., 1985). The effect sizes ranged from $r = .13$ to $r = .67$ with a $\bar{r}_{weighted} = .40$. Apparently, the tempo of background music has a strong impact on how quickly behavior is performed: faster tempo consistently covaried with faster behavior. Psychometric meta-analyses tendentially support the importance of looking at specific dependent variables in this case: whereas for all studies with tempo as the independent variable the variation for the population effect size is rather large ($\sigma_\rho = .17$), the respective variation for tempo studies that measured the impact of tempo on motor behavior is remarkably smaller ($\sigma_\rho = .07$)

Discussion

Again, a cursory look at the data could yield the impression that it does not matter what kind of music is played as background music and, again, a closer look reveals that in fact the kind of music might be decisive in whether background music influences behavior. As a result of the small sample of studies that fell into different musical categories, we were able to find only one clear example where the characteristics of music made a strong difference: the tempo with which music is played and its effect on the tempo of behavior. This effect could be mediated via an arousal effect, which would be consistent with the arousal and mood hypothesis mentioned above (see also Schellenberg, Nakata, Hunter, & Tamoto, 2007). With a sufficiently large number of studies that address the impact of other moderator variables, a closer inspection might reveal similarly strong effects for some of them.

Conclusion

Background music is ubiquitous in private and public life. We listen to it at home, when driving our cars, on public transportation, in shopping malls, in the waiting rooms of doctors and in many workplaces. Numerous studies have been conducted on the effects of background music, but the methodological quality of those studies varies considerably, as we experienced during the analysis of candidate articles for our meta-analysis. Nevertheless, our results make it quite clear that there is no uniform effect of background music: sometimes it has a beneficial, sometimes a detrimental, and sometimes no effect on behavior, cognition and emotion. Therefore, in contrast to Behne's (1999) conclusion, the null effect found in our first global analysis cannot be interpreted as 'background music has no effect'. Rather, the psychometric meta-analysis indicates that there might be many different effects behind this global null effect and the detailed analyses identified several of them: listening to background music seems to interfere with reading and memory tasks but seems to have positive effects on emotions and especially motor behavior such as sports performance. Moreover, the tempo of background music strongly affects the tempo of behavior of different kinds. But even these findings might still be too global. Reading might be more disturbed by one kind of music than another (e.g., more by vocal than by instrumental music, Wipplinger, 2007, or more by jazz music than by classical music, Freeburne & Fleischer, 1952), and the effect of music tempo might be moderated by the kind of music played. It might also not be sufficient to focus on a special context. Summary studies that did so, such as, for instance, those in retail settings, marketing or advertising, could not identify uniform effects of background music (Bruner, 1990; Garlin & Owen, 2006; Oakes, 2007).

The only way out of this missing clarity about specific effects of background music is two-pronged: better theories and better methods. It is necessary to develop precise and testable theories that can make specific predictions about the impact of background music, taking into account the kind of music, the type of task and the context, as well as personal and social characteristics. For instance, Furnham and colleagues (Furnham & Allass, 1999; Furnham & Bradley, 1997) found a different impact of background music for extroverts and introverts, depending on task (reading vs. memory) and complexity of the music. However, there might also be some general effects attributable to background music that should be carefully examined: backgrond music could withdraw attention from the respective primary tasks, thereby worsening performance, especially in tasks that require conscious processing. In contrast, for the processing of largely automatic tasks, background music might have beneficial effects via the arousal it creates. The findings in the literature on attentional limitations, as well as the arousal and mood hypothesis referred to above might be good starting points for developing a comprehensive theory on the effects of background music.

In addition, to advance theoretically, it is also absolutely necessary to improve the methodological quality of studies on the impact of music. Authors should not stop at reporting 'significant' or 'non-significant' results but should calculate effect sizes themselves or at least report the information necessary to calculate the size of effects (e.g., precise test statistics and degrees of freedom). Otherwise, efforts to improve our understanding about the effects of music might go unnoticed by the scientific community because the results cannot be interpreted properly.

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Notes

1. For the calculation of correlative effect sizes from standardized differences it does not matter whether the latter are expressed as d or g, because the respective formulas take into account whether sample standard deviations (d) or estimates of the respective population values (g) are used (e.g., Rosenthal, 1994; Sedlmeier & Renkewitz, 2007).

   Here are two examples for the calculation of effect sizes. Assume that the impact of music tempo (fast vs. slow music) on money spent is examined and the following results are obtained. For the group with fast music ($n = 30$) the average amount spent is \$22.14 (SD = 4.56) and for the group with slow music ($n = 32$), this amount is \$27.33 (SD = 7.2). A significance test that tests the hypothesis that the fast-music group spends more gives $t(60) = -3.36$. Here are the calculations for r from t, d from means and SDs, and r from d (note that the negative sign for r in the first formula is derived from contextual information):

$$r = \sqrt{\frac{t^2}{t^2 + df}} = \sqrt{\frac{-3.36^2}{-3.36^2 + 60}} = -.40$$

$$d = \frac{\bar{x}_a - \bar{x}_b}{\sqrt{\frac{n_a s_a^2 + n_b s_b^2}{n_a + n_b}}} = \frac{22.14 - 27.33}{\sqrt{\frac{30 \cdot 4.56^2 + 32 \cdot 7{,}2^2}{30 + 32}}} = \frac{-5.19}{\sqrt{36.82}} = -0.86$$

$$r = \frac{d}{\sqrt{d^2 + \frac{1}{pq}}} = \frac{-0.86}{\sqrt{0.86^2 + \frac{1}{\frac{30}{62} \cdot \frac{32}{62}}}} = \frac{-0.86}{\sqrt{0.86^2 + 4{,}00}} = -.40$$

2. The negative population variance is probably due to the unreliability of the few effect sizes and can be treated as a variance of 0 (see Hunter & Schmidt, 1990, p. 109).
3. Freeburne and Fleischer (1952) also looked at reading speed and found that music made participants read faster as compared to the no-music condition. However, because none of the other studies measured reading speed, this effect was omitted from analysis.

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