Effects of Treatment on Disruptive Behaviors: A Quantitative Synthesis of Single-Subject Researches Using the PEM Approach

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The present study uses the PEM approach to synthesize the effectiveness of treatment on disruptive behaviors and simultaneously tests whether the higher validity of the PEM approach than that of the PND approach is repeatable. A hand search of the *Journal of Applied Behavior Analysis* was conducted, and reference lists from reviewed articles were traced to locate relevant studies. Altogether, 106 single-subject studies, which produced 694 effect sizes, were analyzed. The grand mean of 106 averaged effect sizes was significant. Results demonstrated that the PEM approach was more congruent with the original authors' judgments than the PND approach. Important findings regarding the effectiveness of interventions on the disruptive behaviors are that the strategies of differential reinforcement and the token economy system along with multi-components intervention were highly effective.
Key words: PEM (percentage of data points exceeding the median of baseline phase); PND (percentage of non-overlapping data); Disruptive behavior; Quantitative synthesis (Meta-analysis) of single-subject research

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Meta-analysis provides a quantitative method to reach a certain conclusion by integrating relevant studies on a theoretical issue. Because the data of successive measurements over time in single-case experimental designs usually violate the assumptions of parametric statistics, especially that of homogeneity and independence of residuals, it is not appropriate to adopt methods used in conventional meta-analysis for between-group research. Mastropieri and Scruggs (1985-86) took a nonparametric approach, percentage of non-overlapping data (PND), to calculate the effect size for intra-subject research. Ma (2006) discussed the advantages and drawbacks of the PND and proposed an alternative method, the percentage of data points exceeding the median (PEM), to improve the shortcomings of the PND. Using original authors' judgment, i,e, the judgment of the author(s) of each located study, on the effectiveness of treatment as a validity criterion, the PEM approach had demonstrated a higher Spearman correlation with original authors judgment than the PND approach did. And this result was confirmed by Gao and Ma (2006).

Scruggs et al. (1986, p.262) suggested a criterion to evaluate the effectiveness of treatment according to the PND scores: (a) highly effective when the score is above .90, (b) moderately effective when the score is between .70 and .90, (c) mildly (or questionable) effective in cases with scores between .50 and .70, and lastly, (d) ineffective, when the score is below .50. However, during coding, it was difficult to differentiate between moderately and mildly or questionable in the visual judgment of the effectiveness of treatment based on the curve change in the baseline and treatment phases. Ma (2006) and Gao and Ma (2006) incorporated "mildly (or questionable) effective" into "not effective." Hence these categories of effectiveness were coded: (a) highly effective, which was coded as 2, with core higher than .90, (b) moderately effective (coded as 1) with score equal to or higher than .70 but lower than .90, and (c) questionable or not effective (coded as 0) with score lower than .70. In the present study the authors try to incorporate "mildly (or questionable) effective" into "moderately effective" to form three categories: (a) highly effective with score above .90 (coded as 2), (b) partially effective including moderately and mildly (or questionable) effective (coded as 1) with score equal or greater than .50 but less than .90, and (c) ineffective (coded as 0) score less than .50, and to examine whether the superiority of validity of PEM approach over PND approach still sustains.

Although some disruptive behaviors are not life threatening or excessively severe, they are considered to be problematic by participants' teachers, parents, caregivers and dentists since disruptive behaviors prevent participant participation in instructional activities, family routines, and high-quality dental treatment. In the present synthesis, disruptive behavior is defined as "An excessive behavior that can interfere with the general activities proceeding at the time."

Disruptive behavior is a common problem in educational settings. Scholars have noted that disruptive behavior is closely related to less academic engagement, low grades, and a poor performance on standardized tests (Bailey, Wolf, & Philips, 1970, p.223; Stage & Quiroz, 1997, p.333). Moreover, Ramp, Ulrich, and Dulaney (1971, p.235) indicated that many teachers have had to devise their classroom management techniques through experience, because public education has long lacked effective principles to aid teachers. Therefore, the development and implementation of effective and acceptable interventions for students who exhibit disruption in schools is an important educational problem (Wilkinson, 1997).

The present study uses the PEM approach to synthesize the effectiveness of treatment of disruptive behaviors and simultaneously tests whether the higher validity of the PEM approach than that of the PND approach is repeatable.

Method

Procedures for Locating Studies

Studies in this synthesis were acquired according to the following steps. A hand search of a major journal in the field, the *Journal of Applied Behavior Analysis*, was conducted. Descriptors included aggressive behavior; inappropriate behavior; noncompliant behavior; destructive behavior; disruptive behavior(s); off-task behavior; self-injurious behavior; self-stimulatory behavior; uncooperative behavior; and problem behavior. Then, reference lists from reviewed articles and bibliographies from individual research reports were examined. Studies including administration of medication were rejected (e.g., Blum, Mauk, McComas, & Mace, 1996). All studies that met the following criteria were selected for this synthesis:

1. The objective of the study was the reduction of disruptive behavior; those studies investigating training or instructional procedures were included only in cases identifying that the explicit purpose of the procedures was to decrease an excess behavior.
2. A single-subject research design was employed.
3. Baseline and treatment phases of reversal or multiple-baseline design were recorded using a time series graphic display for individual participants.

For studies meeting the above criteria, the PND and PEM procedures were employed to compute each effect size of baseline-treatment phases.

Procedures for Coding Each Study

Categorization of Disruptive Behaviors. The operational definition of disruptive behavior used in the present study was adopted form Thomas, Becker, and Armstrong (1968) who classified the disruptive behavior into five categories: (a) gross motor activities including fiddling, jerking, and out of seat; (b) non-verbal noise-making; (c) orienting including off-task; (d) verbalization including crying, inappropriate verbalization, and talk outs; and (d) verbal or physical aggression. All behaviors in each category were considered incompatible with good classroom learning.

Categorization of Treatment Procedures. Over the last few decades, numerous behaviorists have developed treatment techniques designed to reduce disruptive behaviors and have also developed training programs to teach caregivers in a variety of settings. The categorization of treatments is briefly described below.

1. Differential reinforcement of other appropriate behaviors: A procedure involving provision of positive

reinforcement contingent upon the absence of a disruptive behavior and the presence of desirable behaviors during a specified time interval (e.g. Stage et al., 1997). This category includes differential reinforcement of other behavior/behavior omission (DRO), differential reinforcement of alternative behavior (DRA), differential reinforcement of incompatible behavior (DRI), and differential reinforcement of low rates of response (DRL). The disruptive behaviors were ignored and appropriate behaviors were reinforced with tangible reinforcers, such as free time, an interesting activity, play-time, edible reinforcers, social reinforcers, or multiple reinforcers.

2. Token economy system: The system enables a child to earn points or tokens for his/her appropriate behaviors. Points or tokens can then be exchanged for a wide variety of activities, privileges, or priorities (e.g. Ayllon & Roberts, 1974).
3. Response cost: A procedure involving the withholding of previously given tokens, points, or their equivalents when a participant emits a disruptive behavior.
4. Token economy system plus response cost: tokens are taken back from participants for rule violation and participants can receive additional opportunities for regain tokens.
5. Punishment: Use a negative behavioral consequence to ameliorate disruptive behaviors, such as time out from interesting activities or a meal, over-correction, and nagging.
6. Providing preferential tasks: Revising instructional conditions to decrease disruptive behaviors, e.g. providing activity choice, choice of task sequence, interesting assignment, outside-reading, or decreasing difficulty of task.
7. Instruction or training: Teach communication, self-control, and other adaptive skills to guide the participant to eliminate disruptive behaviors. These instructional strategies include self-management training, social skill training, problem-solving training, functional communicative training, compliance training, cognitive-behavior training, behavior feedback, oral instruction and written instruction.
8. Multi-components intervention: Integrating two or more treatments into one treatment package, such as DRA and over-correction, DRO and over-correction, functional communication training plus token economy system, increased attention and timeout, social skill training and parent involvement, DRL plus functional communicative training plus timeout.

Original author's conclusion of overall effectiveness of treatment. Conclusions were assigned an outcome rating of 2 (effective), 1 (partially effective, including moderately and mildly or questionable effective), or 0 (ineffective).

Settings. Intervention settings were classified as a classroom; dental clinic room; institute (e.g., day-program at public residential facility); therapy room including room for experiment, therapy or training; home; and other places such as bus, library, fast-food restaurant, playground, and school hallway.

Interveners. This category includes school staff (including librarians, school bus drivers, teachers, and teaching assistants), psychology professionals (including clinical psychology graduate students, professional therapists, school psychologists, speech therapists, and research assistants), caregivers (including attendants, parents, and caregivers), dental staff (including dentists and dental nurses), and composite staff (including teachers and researchers, parents and clinicians, etc).

Participant classifications. Participants in the present study were classified as regular students (including those who perform in the average range on intelligence tests and do not participate in any remedial education program), students with attention deficit hyperactivity disorder, students with developmental or mental retardation, students with emotionally disturbed behavior, students with autism, students with behavior problems, students with brain damage, students with language delay, students with learning disability, pre-delinquent students, students with developmental or mental retardation and autism, students with developmental or mental retardation and behavior problems, and students with other diagnoses.

Participant age. Age was divided into six groups: Primary elementary school children (i.e., kindergarten to third grade or younger than 9 years old), upper elementary school children (fourth grade to sixth grade or 10 to 12 years old), junior high school (seventh grade to ninth grade or 13 to 15years old), senior high school students (tenth to twelfth grade or 16 to 18 years old), adult (over 18 years old), and composite (several grade levels combined).

Experimental design. Experimental designs were classified as reversal design, multiple-baseline design, reversal plus multiple-baseline design and other designs.

Computation of treatment outcomes

Treatment outcome of each pair of baseline-treatment phases was calculated by the PEM and PND methods. Steps in computing the PEM scores are described as follows (Ma, 2006): first, a horizontal median line is drawn in the baseline phase. This horizontal median line will hit the median point when the number of data points in the baseline phase is odd; and go between the two median points if the number of data points is even. Second, the median line stretches out horizontally to the treatment phase, and the percentage of data points of treatment phase above the median line may be calculated to obtain a PEM score. The percentage of data points of a treatment phase below the median line may be calculated if the undesired behavior is expected to decrease after the specific treatment is given. The null hypothesis of the PEM approach is that if the treatment has no effect, the data points in the treatment phase will fluctuate up and down around the median line. That is to say, the data points have a 50% probability of appearing above and 50% for appearing below the median line. The PEM score ranges from 0 to 1. The meaning of a PEM score is the same as an effect size. If there is more than one effect size in an article, they may be averaged to form a mean effect size for that article.

The PND is the percentage of data points in the treatment phase over the highest point of the distribution in the baseline phase (or below the lowest point of data points in the baseline phase if the undesirable behavior is expected to decrease after the intervention is introduced).

Treatment generalization and follow-up phases were not included in the present analysis.

Computation of orthogonal slope change and floor effect. The proportion of orthogonal slope change and that of floor effect of each pair of baseline-treatment phases were computed in order to examine whether orthogonal slope change or floor effect would influence the computations of the PND and PEM scores.

Reliability. The reliability of the coding procedure was established by a separate independent rater rating a random sample of 30% of total coding. Disagreement was resolved by discussion.

Results

Reliability

Inter-rater agreement was calculated on a random sample of 30% (n=32) total coding. Two doctoral students majoring in educational psychology served as raters for coding. One rater aided the first author of the present study in compilation of outcome ratings for the original authors' judgments, the PND scores, and the PEM scores. The agreement was 95.06% for the original authors' judgments, 84.77% for PND scores, and 88.48% for PEM scores. The second rater classified independent variables and dependent variables. Inter-rater agreement for all studies sampled was 93.01%. Disagreements were reassessed and resolved in discussion. If the rating was contradictory between the rater and the first author, the first author made the final decision.

Analysis of the Validity of the PND and PEM Approaches

A total of 106 single-subject studies on treatments of disruptive behavior were analyzed. Table 1 shows that both the PND scores and PEM scores significantly correlated with the original authors' judgments on treatment effectiveness. However, the PEM scores had a higher correlation coefficient with the original authors' judgments on treatment effects than the PND scores did.

Table 1. *Inter-correlation between original authors' Judgment, the PND Scores, and the PEM Scores*

Variable	PND	PEM
With pair as unit (n=694)		
Authors' Judgments	0.60**	0.68**
PND		0.71**
With article as unit (n=106)		
Authors' Judgments	0.52**	0.66**
PND		0.77**

Note. The correlation coefficient between PND and PEM scores are Pearson correlation coefficients while others are Spearman correlation coefficients.
** $p < .01$.

When the original authors judged an intervention as ineffective, the mean effect sizes by both measures were below 0.5. Both the mean PND score and the mean PEM score of the ineffective treatment confirmed the practical evaluation made by the original authors. However, in cases where the original authors' considered interventions to be only partially effective, the mean PND score was 0.342 and the mean PEM score was 0.645. The mean PEM score of partially effective interventions was more close to the original authors' practical evaluation than the mean PND score. The mean PEM score for effective interventions is higher than 0.9 while that of the PND is below 0.9. Results of this synthesis indicated that synthesis using the PEM approach is more congruent with the original authors' practical evaluations than the PND approach even when the category "mildly or questionable effective" was integrated with the category "moderately effective".

Table 2. *Mean Effect Sizes Categorized by Original Authors' Judgments (n=694)*

Original Authors' Judgments	N	Mean PND Score *(SD)*	Mean PEM Score *(SD)*	The criterion of Scruggs et al. (1986)
2 (effective)	507 (73.06%)	0.73 (0.35)	0.92 (0.21)	> .9
1 (partially effective)	37 (5.33%)	0.34 (0.40)	0.65 (0.32)	.5 .9
0 (ineffective)	150 (21.61%)	0.09 (0.21)	0.29 (0.36)	< .5

Proportion of orthogonal slope change and that of floor effect. When 694 effect sizes of each pair of baseline-treatment phases were analyzed, only 0.72% (n=5) of the pairs of baseline-treatment phases manifested orthogonal slope change. Orthogonal slope change was mostly near the zero level. However, 14.41% (n=100) of baseline phases had floor data points. These results indicate that the floor effect had a more seriously disturbing influence on the computation of effect sizes with the PND approach.

Influence of Interventions on Effectiveness

Overall Treatment Effectiveness. A lag-1 autocorrelation of residuals (i.e., $x-\bar{x}_{PND}$ and $x-\bar{x}_{PEM}$) analysis was conducted to determine whether the data set violated the basic assumption of independence. It resulted in significance, r (692) = .395, $p < .001$ for PND score and r (692) = .505, $p < .001$ for PEM score respectively. In addition, the number and variances of effect sizes of each independent variable were unequal, which may violate the basic assumption of homogeneity of variance. Hence, it is appropriate to use nonparametric statistics to analyze the effectiveness of treatments in this data set.

However, when the effect sizes of an article was averaged to represent the effect size of that article, the lag-1 autocorrelation of residuals of 106 averaged effect sizes from each article was not significant, r *(104)* = .022, $p > .05$ for PND score and r *(104)* = .038, $p > .05$ for PEM score respectively. Hence, a t-test was conducted to determine whether the overall treatment effectiveness of 106 averaged scores was significantly different from the null hypothesis.

The overall mean effect size of 106 averaged scores from each article was 0.64 (SD = 0.29) for the PND score and 0.84 (SD = 0.21) for the PEM score. The result of a t-test was significant, t_{105} = 22.82, p < .001 and t_{105} = 16.22, p < .001 for the PND score and the PEM score respectively. These results indicate that all interventions for all kinds of disruptive behaviors had a significant effect.

Effectiveness of Intervention. Table 3 shows that the strategies of differential reinforcement, the token economy system, and multi-components intervention were highly effective in the elimination of disruptive behaviors. A nonparametric statistical test using Kruskal-Wallis one-way analysis of variance by ranks (K-W ANOVA) reveals a significant difference between the mean ranks of different treatments, χ^2 (8, N = 613) = 34.15, p < .01, for PEM scores.

Table 3. *Results of Mean Effect Size, K-W ANOVAS, and Mann-Whitney U Tests by Intervention*

Intervention	N of effect sizes	Mean PND Score (SD)	Mean PEM Score (SD)
1 Differential reinforcement	136	0.72 (0.36)	0.90 (0.24)
2 Token economy system	98	0.67 (0.38)	0.90 (0.21)
3 Response cost	29	0.60 (0.38)	0.88 (0.30)
4 Token economy system plus response cost	12	0.65 (0.47)	0.90 (0.29)
5 Punishment	79	0.66 (0.40)	0.85 (0.31)
6 Providing preferential tasks	66	0.46 (0.44)	0.73 (0.38)
7 Instruction or training	141	0.56 (0.42)	0.76 (0.34)
8 Multi-components intervention	35	0.75 (0.40)	0.98 (0.06)
9 Other procedures	17	0.579 (0.33)	0.847 (0.26)
K-W ANOVA	613	χ^2 (8, N=613)=26.80**	χ^2 (8, N=613)=34.15**
Mann-Whitney U Test	—	1 > (6, 7) [a]; 2 > 6 [a] 8 > (2, 5, 6, 7, 9) [a]	(1, 2, 5) > (6, 7) [a] 8 > (2, 5, 6, 7, 9) [a]

Note. Through out the tables in the present study, the N (numbers) of effect sizes of PND scores are the same as that of the PEM scores; By the multiple post hoc comparisons of different variables using the Mann-Whitney U test, the numbers represent the serial number of each variable in the table. The numbers in the parentheses refer to the fact that there are no significant differences between the mean ranks of effect sizes of these variables by pair comparisons, and the mean ranks of those variables on the left side of “>” are significantly higher i.e., larger effect size, than that of those variables on the right

side.
[a] Significant at least at $p < .05$.
$^{**}p < .01$.

Effectiveness on different category of disruptive behaviors. As Table 4 shows, it was easier to eliminate the disruptive behaviors such as noise, orienting, and gross motor activities than to control composite of (multiple) disruptive behaviors, which covered about 72% of disruptive behaviors.

Table 4. Results of Mean Effect Size, K-W ANOVAS, and Mann-Whitney U Tests by Disruptive Behaviors

Behavior Class	N	Mean PND Score *(SD)*	Mean PEM Score *(SD)*
1 Aggression	46	0.62 (0.44)	0.88 (0.27)
2 Noise	19	0.93 (0.16)	0.98 (0.01)
3 Orienting	14	0.86 (0.25)	0.93 (0.27)
4 Gross motor activities	33	0.71 (0.32)	0.95 (0.14)
5 Verbalization	80	0.71 (0.35)	0.87 (0.26)
6 Composite	502	0.51 (0.43)	0.72 (0.39)
K-W ANOVA	694	χ^2 (5, N = 694) = 6.44***	χ^2 (5, N = 694) = 14.47***
Mann-Whitney U Test	—	2 > (1, 5,) [a] (2, 3, 4, 5) > 6 [a]	(1, 2, 3, 4, 5) > 6 [a]

Note.
[a]Significant at least at $p < .05$.
$^{***}p < .001$.

Influence of Study Characteristics on Effectiveness

Table 5. Mean Effect Size by Study Characteristics, K-W ANOVAS, and Mann-Whitney U Tests

	N	Mean PND score (SD)	Mean PEM score (SD)
		Experimental design	
1 Reversal design	395	0.53 (0.44)	0.71 (0.41)
2 Multiple-baseline design	133	0.61 (0.40)	0.88 (0.25)
3 Reversal plus multiple-baseline design	48	0.73 (0.39)	0.867 (0.31)
4 Other design	118	0.56 (0.41)	0.803 (0.30)
K-W ANOVA	694	χ^2 (3, N = 694) = 10.39**	χ^2 (3, N = 694) = 16.22**
Mann-Whitney U Test	—	3 > (1, 2, 4) [a]	(2, 3) > 1 [a]
		Intervener	
1 School staff	426	0.60 (0.41)	0.81 (0.32)
2 Psychology professional	223	0.51 (0.45)	0.65 (0.44)
3 Caregiver	13	0.71 (0.43)	0.79 (0.07)
4 Dental clinic staff	12	0.65 (0.41)	0.98 (0.05)
5 Composite staff	20	0.69 (0.34)	0.98 (0.09)
K-W ANOVA	694	χ^2 (4, N = 694) = 6.62	χ^2 (4, N = 694) = 26.45***
Mann-Whitney U Test	—	—	(1, 3, 4, 5) > 2 [a]
3 Composite	81	0.713 (0.34)	0.91 (0.20)

4 Sex not specified	78	0.54 (0.42)	0.80 (0.29)
K-W ANOVA	616	$\chi2$ (2, N = 616) = 9.02*	$\chi2$ (2, N = 616) = 8.03*
Mann-Whitney U Test	—	3 > (1, 2) a	3 > (1, 2) a
		Grade level	
1 Primary elementary	323	0.55 (0.43)	0.72 (0.41)
2 Secondary elementary	158	0.58 (0.42)	0.78 (0.35)
3 Junior high school	113	0.68 (0.41)	0.83 (0.32)
4 Senior high school	40	0.55 (0.40)	0.86 (0.28)
5 Composite	51	0.45 (0.45)	0.80 (0.28)
6 Adult	9	0.66 (0.41)	0.89 (0.33)
K-W ANOVA	694	χ^2 (5, N = 694) = 10.36	χ^2 (5, N = 694) = 9.06
		Diagnosis	
1 Regular education student	186	0.62 (0.38)	0.86 (0.25)
2 Students with attention deficit hyperactivity disorder	47	0.57 (0.43)	0.71 (0.42)
3 Students with developmental or mental retardation	149	0.54 (0.43)	0.76 (0.38)
4 Students with emotional disturbance	44	0.67 (0.38)	0.87 (0.24)
5 Student with autism	28	0.40 (0.48)	0.48 (0.50)
6 Students with behavior problems	37	0.62 (0.44)	0.82 (0.33)
7 Students with brain damage	14	0.50 (0.52)	0.62 (0.49)
8 Students with language delay	24	0.31 (0.45)	0.40 (0.49)
9 Student with learning disability	24	0.71 (0.38)	0.84 (0.34)
10 Pre-delinquent students	12	0.08 (0.26)	0.65 (0.40)
11 Students with developmental or mental retardation and autism	58	0.54 (0.44)	0.63 (0.43)
12 Students with developmental or mental retardation and behavior problems	19	0.80 (0.23)	0.96 (0.13)
13 Other diagnoses	52	0.60 (0.44)	0.85 (0.29)
K-W ANOVA	694	χ^2 (12, N = 694) = 38.88***	χ^2 (12, N = 694) = 47.10***
Mann-Whitney U Test	—	(1, 9, 12) > 5 [a];	(1, 2, 3, 4, 6, 12, 13) > (5, 8) [a];
		(1, 2, 3, 4, 6, 9, 11, 12, 13) > (8, 10) [a];	1 > 10 [a];
		12 > 3 [a],	(1, 3, 4, 6, 12 13) > 11 [a]
			(11, 9) > 8 [a];
			12 > (1, 3, 7, 10, 11) [a]

The results of the effect of different moderators (study characteristics) on the effect sizes of treatments are presented in Table 5:

Influence of experimental design. About 57% of the treatment phases used a reversal design (withdrawal design), 19.16% used a multiple baseline design; 6.92 % used a reversal plus multiple baseline design; and 17% used an AB or other designs. The difference of mean ranks of different experimental designs appeared to be statistically meaningful according to a test with K-W ANOVA. It demonstrates that using the multiple baseline design or the multiple baseline design plus the reversal design is more likely to produce greater effectiveness of treatment than using the reversal design alone.

Influence of intervener. The school staff was the major Among the interveners in 61.38% of interventions, psychology professionals in 32.13%, and caregivers in 1.87%. Dental clinic staff was involved as interveners in 1.73% of the studies. Composite staff was involved as interveners in about 2.88 % of the studies. In pair wise comparisons, the treatment effect by psychology professionals as interveners was significantly lower than that given by other classes of interveners, as measured by the PEM approach. Further research is needed to determine whether the degree of familiarity which the intervener(s) and the subject have with one another had moderated the treatment effect.

Influence of setting. It shows that 72.05% of interventions took place in classrooms; 13.83% in therapy rooms; 5.76% in institutes; and 2.88% in homes or in dental clinics. The overall difference of mean ranks of settings appeared to be statistically meaningful according to a K-W ANOVA. In pair wise comparisons, the treatment, which took place in a therapy room, produced a significantly lower effect than interventions, which took place in other types of settings for both the PND and PEM scores.

Influence of sex. A few of the studies did not provide the subjects' sex. This subcategory was not included in the statistical analysis. Therefore, there are only 2 degrees of freedom in the χ^2 of K-W ANOVA. Results of studies, which included composite sex, were associated with stronger outcomes than that of studies including only male or female participants. However, the sex difference in the effectiveness of treatment on disruptive behaviors was not significant when single sex was recruited to take part in the experiment.

Influence of Grade Level. No relation was observed between grade level and outcome effectiveness for either the PND or PEM scores.

Influence of diagnosis. A relation can be observed between diagnosis and outcome effectiveness. The effectiveness of treatment on the disruptive behaviors of the students with language delay and those with autism showed to be the weakest (effect sizes were below .5).

Discussion

The Validity of PND and PEM approach

A total of 106 single-subject research studies producing 694 effect sizes were included in the meta-analysis. With the original authors' judgment on the effectiveness of treatment on disruptive behaviors as the validity criterion, the present study has confirmed that the validity of the PEM approach is superior to that of the PND approach, even when the category "mildly or questionable effective" was integrated into the category "moderately effective". The most possible explanation for the difference between the PND approach and PEM approach is that the floor effect has a more seriously disturbing influence when using the PND method. Scholars have suggested that the crucial drawback of the PND method is *floor* or *ceiling* effects (Scruggs et al., 1987; Faith, Allison, & Gorman, 1997; Ma, 2006; Gao & Ma, 2006). When a baseline phase has floor or ceiling data points, the PND score will be zero, suggesting an ineffective treatment even if a specific intervention might be very effective.

When 694 effect sizes of each pair of baseline-treatment phases were analyzed, only 0.72% (n=5) of pairs of baseline-treatment phases manifested an orthogonal slope change. Hence, it imposes no threat to the validity of the PEM and PND approach. This result replicates the findings made by Ma (2006) and Gao and Ma (2006).

Other important findings over the effectiveness of interventions on the disruptive behaviors are that; (a) the overall grand mean effect size of 106 articles with each one having an averaged mean effect is significantly different from the null hypothesis of .5 for the PEM score; (b) the intervention strategies were effective on the elimination of disruptive behaviors, especially, the strategies of differential reinforcement, the token economy system, and the multi-components intervention were highly effective; (c) it was easier to eliminate those disruptive behaviors such as noise, orienting, and gross motor activities than to control composite of disruptive behaviors; (d) using the multiple baseline design or the multiple baseline design plus the reversal design is more likely to have a greater effectiveness of treatment than using the reversal design alone; (e) the treatment conducted by psychology professionals as interveners was significantly less effective than that carried out by other classes of interveners; (f) the treatment, which took place in a therapy room, produced a significantly less effect than interventions, which took place in other types of settings; (g) the sex difference in the effectiveness of treatment on disruptive behaviors was not significant when single sex was recruited to take part in experiments; (h) no relation was observed between a participant's age and outcome effectiveness; (i) treatment on the disruptive behaviors of the students with language delay and autism shown to be less effective than that of students with other kinds of diagnosis.

. The result that the treatments conducted by psychology professionals as interveners and the treatments implemented in a therapy room were least effective is contrary to the anticipation of the authors. Because the psychology professionals have expertise, therefore their intervention should be more effective than other kinds of agent. Whether the familiarity with the participant or the reinforcement history experienced with the participants having the impact on the effectiveness of intervention needs to be investigated in the future

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