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RESEARCH INTO PRACTICE

A Meta-analysis of the Effectiveness of Intervention Programs Designed to Support Autonomy

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Abstract The twofold purpose of the present study was, first, to determine whether training intervention programs designed to help people support the autonomy of others are effective and, second, to identify the set of conditions that allowed these interventions to be most effective. A meta-analysis of the findings from 19 studies with 20 effect sizes showed that the training programs were, overall, effective with a weighted effect size of 0.63. Moderator analyses of the overall effect size showed that the relatively more effective intervention programs were structured in ways that trained multiple elements of autonomy support and were presented in relatively brief (1–3 h) sessions in a laboratory training setting that focused on skill-based activities and utilized multiple types of media to deliver its content. Furthermore, relatively effective intervention programs were offered to teachers (rather than to other professionals), trainees (rather than to experienced professionals), and individuals with an autonomy (rather than a control) causality orientation. Though the small number of included studies warrants caution, results generally affirmed the effectiveness of autonomy-supportive training programs and identified the conditions under which future programs can be designed to be highly effective.

Keywords Autonomy · Autonomy support · Meta-analysis · Self-determination theory · Intervention · Training

According to self-determination theory (SDT; Ryan and Deci 2000), people function positively when others support their autonomy rather than control their behavior. Because the benefits from autonomy support have been found to be both widespread and predictive of important outcomes (discussed below), researchers and practitioners alike have asked whether or not people such as teachers, coaches, parents, physicians, counselors, workplace

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managers, and others can learn—be trained in—how to become more autonomy-supportive toward others. The twofold purpose of the present study was, first, to determine whether training intervention programs designed to help people support the autonomy of others are effective and, second, to identify the set of conditions that allowed these interventions to be most effective.

Autonomy and the Benefits of Autonomy Support

Autonomy is the inner endorsement of one's behavior; when autonomous, people perceive that their behavior emanates from the self and is self-authored (Ryan and Deci 2000). For example, students are autonomous when they pursue their interests, study to satisfy their curiosity, and volitionally engage themselves in schoolwork. In SDT, autonomy is conceptualized as an inherent psychological need that requires support from environmental conditions and interpersonal relationships for its satisfaction (Deci and Ryan 1985; Ryan and Deci 2000, 2002).

When people experience autonomy need satisfaction from nurturing environmental conditions, they function more positively and experience greater psychological well-being (Deci and Ryan 2008; Reeve *et al*. 2004a; Williams 2002). In educational settings, students who have their autonomy supported by teachers show educational and developmental benefits, including greater engagement, higher quality learning, a preference for optimal challenge, enhanced intrinsic motivation, enhanced well-being, and higher academic achievement (Guay *et al*. 2008; Reeve *et al*. 2004b; Vansteenkiste *et al*. 2004). Similar cause-and-effect benefits have been found in experimental studies for children and adolescents whose parents support their autonomy (Grolnick *et al.* 2002), for employees whose managers supported their autonomy (Hardré and Reeve 2009), and for patients whose physicians (Williams *et al*. 2006b) and dentists (Halvari and Halvari 2006) supported their autonomy. The general conclusion seems to be that people benefit when others support their autonomy and that they benefit in ways that are widespread and important to their lives and mental health.

What is Autonomy Support?

Autonomy support refers to what one person says and does to enhance another's internal perceived locus of causality, volition, and perceived choice during action (i.e., the subjective experience of autonomy; Reeve *et al*. 2003). It refers to the interpersonal sentiment and behavior one person provides to identify, nurture, and develop the other's inner motivational resources—such as the need for autonomy, intrinsic motivation, personal interests, intrinsic goals, and self-endorsed values (Reeve 2009). Cross-domain conceptual definitions of autonomy support appear in Table 1.

In the first article to operationally define autonomy support as a construct that could be manipulated within the context of an experiment (or intervention), Deci *et al*. (1994) used a laboratory procedure to vary the presence versus absence of three interpersonal conditions—provide meaningful rationales, acknowledge negative feelings, and use non-controlling language. Crucially, they found that none of the conditions by itself created an experience in which participants felt their autonomy was supported. Rather, it was only when all three conditions were provided together that participants felt their autonomy was supported. This three-condition operational definition of autonomy support was applied to a task in which

Table 1 Conceptual definitions of autonomy support across six different domains

Domain	Definition
Education (Reeve 2009)	Autonomy support is nurturing inner motivational resources, providing explanatory rationales, relying on non-controlling language, displaying patience to allow students the time they need for self-paced learning to occur, and acknowledging and accepting expressions of negative effect.
Parenting (Grolnick and Apostoleris 2002)	Autonomy support is valuing autonomy, encouraging children to solve their own problems, taking their perspectives, and minimizing the use of pressures and controls.
Coaching (Mageau and Vallerand 2003)	Autonomy support is providing choice within specific rules and limits, providing rationales for tasks and limits, acknowledging the other person's feelings and perspectives, providing opportunities for initiative taking and independent work, providing non-controlling competence feedback, avoiding controlling behaviors, and preventing ego involvement.
Organizations/work (Gagné and Deci 2005)	Autonomy support is taking employees' perspectives, providing greater choice, and encouraging self-initiation.
Health care (Williams *et al*. 2006a)	Autonomy support is acknowledging perspective, providing choice, responding to the other's initiations, providing relevant information, and minimizing control.
Psychotherapy (Ryan and Deci 2008)	Autonomy support is understanding and validating the other's internal frame of reference, respecting his or her experience, promoting choice through the clarification of values and goals, and facilitating growth through methods that emphasize ownership, personal responsibility and awareness.

participants worked on a very uninteresting activity. As experimental and intervention-based research was extended into naturally occurring applied settings (e.g., the classroom), researchers necessarily expanded the operational definition so that it applied equally well to supporting people's autonomy as they engaged in interesting and personally valued activities. In doing so, researchers added "offer choices" (Williams *et al*. 1999) and "nurture inner motivational resources" (Reeve *et al*. 2004b) as additional theory-based elements (or interpersonal conditions) of autonomy support. Another contemporary expansion has been to recognize the importance of taking the other person's perspective, as many researchers now integrate "acknowledge negative feelings," "acknowledge perspective," and "perspective taking," into a single supportive condition—namely, "acknowledge perspective and feelings" (e.g., Edmunds *et al*. 2008; Tessier *et al*. 2008). Operational definitions for all five interpersonal conditions appear in Table 2.

Research conducted prior to and concurrent with the wave of intervention studies reviewed in the present meta-analysis provide substantial empirical support for the validity of each interpersonal condition listed in Table 2. As for *provide meaningful rationales*, participants provided with a rationale that explained why task engagement was a personally beneficial thing to do self-reported greater perceived autonomy and task importance and showed greater task engagement than did participants who worked on the same task or lesson without an explanatory rationale (Assor *et al*. 2002; Jang 2008; Koestner *et al*. 1984; Reeve *et al*. 2002). As for *acknowledge negative feelings*, participants who had others acknowledge, accept, and even welcome their expressions of negative affect (e.g., "this is boring") self-reported greater perceived autonomy and showed greater engagement than did participants who had their expression of negative affect criticized or suppressed (Assor *et al*. 2002, 2005; Reeve and Jang 2006). As for *use non-controlling language*, participants exposed to flexible communications ("you may…") and non-evaluative comments self-

Table 2 Operational definition for each interpersonal condition of autonomy support

1. *Provide meaningful rationales*

Verbal explanations that help the other person understand why self-regulation of the activity would have personal utility.

2. *Acknowledge negative feelings*

Tension-alleviating acknowledgments that the request one is making of the other is in conflict with his or her personal inclinations and that his or her feelings of conflict are legitimate (yet not necessarily inconsistent with activity engagement).

3. *Use non-controlling language*

Communications that minimize pressure (absence of "shoulds," "musts," and "have tos") and convey a sense of choice and flexibility in the locution of behavior.

4. *Offer choices*

Provide information about options, encouragement of choice-making, and encouragement of the initiation of one's own action.

5. *Nurture inner motivational resources*

Vitalization of the other's interest, enjoyment, psychological need satisfaction (autonomy, competence, relatedness), or sense of challenge or curiosity during the engagement of a requested activity.

The operational definition for each of the first three interpersonal conditions is based on Deci *et al*. (1994); the operational definition of the fourth condition is based on Williams *et al*. (1999); and the operational definition of the fifth condition is based on Reeve *et al*. (2004b)

reported greater perceived autonomy and greater task engagement than did participants exposed to language that pushed and pressured them toward specific predetermined products, solutions, answers, and desired behaviors (Assor *et al*. 2005; Ryan 1982; Reeve and Jang 2006; Vansteenkiste *et al*. 2004). As for *offer choices*, participants offered choices among options and invitations to self-direct their own task engagements self-reported greater perceived autonomy and task engagement than did participants given assigned tasks (Assor *et al*. 2002; Cordova and Lepper 1996; Perry 1998; Reeve *et al*. 2003; Zuckerman *et al*. 1978). As for *nurture inner motivational resources*, participants showed greater constructive motivation and task engagement when others built their requested task engagements around their interests (Schraw and Lehman 2001), intrinsic motivation (Gottfried *et al*. 1994), autonomy (Reeve and Jang 2006), competence (Ryan and Grolnick 1986), relatedness (Furrer and Skinner 2003), sense of challenge (Clifford 1990), and intrinsic goals (Vansteenkiste *et al*. 2005).

Table 3 shows how each intervention examined in the present meta-analysis specifically operationally defined (and trained) autonomy support. Though different studies varied how they operationally defined autonomy support, all 19 studies included provide rationales. Most studies (16 out of 19) included acknowledge perspective or negative feelings. More than two thirds of the studies (14 out of 19) included provide choices. Most studies (16 out of 19) included nurture inner motivational resources (usually interest, competence, or relatedness). About two thirds of the studies (13 out of 19) included use non-controlling language. Importantly, most of the intervention studies (16 out of 19, or 84%) included at least four of these five elements of autonomy support within the design of the intervention.

An important point to make about the operational definition of autonomy support is that our review of the literature shows that the list of autonomy-supportive elements presented in Tables 2 and 3 is a comprehensive one, though we note two exceptions to this conclusion. First, some study-to-study variance exists within the operational definition of each element (e.g., "acknowledge perspective and feelings" is sometimes operationalized as

Table 3 Presence versus absence of various elements of autonomy support across different intervention studies

	Element of autonomy-supportive training intervention				
	Provide meaningful rationales	Acknowledge perspective and feelings	Offer choices	Nurture inner motivational resources	Use non-controlling language
Barch (2006)	Yes	Yes	No	Yes	Yes
Chatzisarantis and Hagger (2009)	Yes	Yes	Yes	No	Yes
Cheon and Moon (2010)	Yes	Yes	No	Yes	Yes
Collins (2001)	Yes	No	Yes	Yes	No
deCharms (1976)	Yes	Yes	Yes	Yes	No
Edmunds *et al*. (2008)	Yes	Yes	Yes	Yes	Yes
Froiland, under review	Yes	Yes	No	Yes	Yes
Hardré and Reeve (2009)	Yes	Yes	No	Yes	Yes
Moss (2009)	Yes	Yes	Yes	Yes	Yes
Reeve (1998)	Yes	Yes	Yes	Yes	Yes
Reeve *et al.* (2004b)	Yes	Yes	No	Yes	Yes
Tessier *et al*. (2008)	Yes	Yes	Yes	Yes	Yes
Weber-Gasparoni (2003)	Yes	Yes	Yes	Yes	Yes
Weber-Gasparoni, in preparation	Yes	Yes	Yes	Yes	Yes
Williams et al. (1999)					
Study 1	Yes	No	Yes	No	No
Study 2	Yes	No	Yes	No	No
Williams and Deci (1996)	Yes	Yes	Yes	Yes	No
Williams *et al*. (2002)	Yes	Yes	Yes	Yes	Yes
Williams *et al*. (2006b)	Yes	Yes	Yes	Yes	No
Number of studies including the element	19	16	14	16	13
Number of effect sizes calculated for the element	20	17	15	17	13

Yes = aspect was featured/included within the creation and implementation of the autonomy-supportive training intervention; *No* = aspect was absent

The number of studies including the element and the number of effect sizes calculated for the element are different because deCharms (1976) reported two independent effect sizes

"taking the other person's perspective" but other times as "acknowledging and accepting negative feelings"). Second, we found two possible additional autonomy-supportive behaviors that were not included in our investigation—namely, providing unconditional positive regard (Assor *et al*. 2004) and displaying patience so to allow time for self-paced learning to occur (Reeve 2009). While these two ways of relating to others may well be autonomy-supportive, we could not find an autonomy-supportive intervention study that included either one within its training procedures.

Intervention Studies and Their Effectiveness

People can learn to be significantly more autonomy-supportive toward others, and this has been shown to be true in empirical studies with pre-service teachers (Barch 2006; Reeve 1998), elementary school teachers (Collins 2001; deCharms 1976), middle school physical education teachers (Chatzisarantis and Hagger 2009; Tessier *et al*. 2008), high school teachers (Reeve *et al*. 2004b), college exercise instructors (Cheon and Moon 2010; Edmunds *et al*. 2008), coaches (Sullivan 2005), parents (Froiland, under review; Weber-Gasparoni, in preparation), physicians (Williams *et al*. 1999, 2002), counselors (Williams *et al*. 2006b), medical interns (Williams and Deci 1996), and company managers (Hardré and Reeve 2009). Some of these interventions, however, have worked better than have others. This is a potentially important observation because differences in how the autonomy-supportive intervention was designed and implemented might explain why one intervention program was more successful than was another. If this turns out to be the case, then we could learn not only more about the concept of autonomy support but, more practically, the optimal conditions for successful interventions.

For the 18 articles (reporting 19 intervention-based studies) included in the present meta-analysis, Table 4 lists the number and type of participants in each study, the type of training they received, the type of control group utilized, the dependent measure used to assess whether the intervention was successful or not, the effect size observed comparing participants in the experimental group versus participants in the control group, the composite reliability of the dependent measure, and eight distinct features of the experimental design—including (1) the target population's profession and (2) level of experience, (3) the setting in which the intervention took place, (4) the type of investigators who created and implemented the intervention, (5) the type of media used to deliver the intervention materials, (6) the focus of the training, (7) whether the intervention included a theory-based instructional session, and (8) the length of the training. Three studies also examined the causality orientations (autonomy versus control) of the participants, and we included this variable as well. Given this variance in target populations and experimental procedures, we examined the effect size results obtained in the moderator analysis to determine the effects that the different target populations and the various experimental procedures might have on how effective the interventions were.

Research Questions and Hypotheses

The present study pursued two research questions and was guided by two hypotheses. The first research question was whether intervention programs designed to help people support the autonomy of others are effective. Hypothesis 1 was that the autonomy-supportive training interventions would be effective in that participants in an experimental group who received the training would show greater post-training autonomy support than would participants in a control group who did not receive the training.

The second research question asked what set of conditions allowed the autonomy-supportive intervention programs to be relatively most effective. The moderator analyses were necessarily exploratory, however, as we could not offer a directional hypothesis as to which target populations would benefit relatively more from the interventions, or which method of delivery would be relatively more effective than another. The one exception was the target population characteristic of causality orientation, and we were able to offer a

Table 4 Training information of the intervention studies

Studies	Participants	Training	Control group	Dependent measure	*D*	Mean r_{yy}	1	2	3	4	5	6	7	8
Barch (2006)	91 pairs of pre-service teachers	A brief training using a four-slide PowerPoint presentation with embedded video clips modeling the autonomy-supportive behaviors	A four-slide PowerPoint which proposes supporting students' schemas	Raters' scoring of teachers' 10 instructional behaviors; students' subjective impressions of their teacher's motivating style	0.877	0.829	T	T	L	N	E	K	N	S
Chatzisarantis and Hagger (2009)	Ten high school PE teachers	Instruction, role play, and skill-based feedback on the autonomy-supportive behaviors for 3-day training with 3 h per session	Instruction, role play, and skill-based feedback on providing rationales only while providing neither choices nor acknowledging perspective and feelings.	Pupils' perceptions of teacher-provided autonomy support	1.559	0.89	T	E	R	Y		S		L
Cheon and Moon (2010)	One college PE instructor	Read extensive materials on how to support autonomy over a one semester period	Typical/usual teaching style	Students' perception of the teacher's motivating style using the Learning Climate Questionnaire	3.644	0.90	T	E	R	N	I	K	I	L
Collins (2001)	Eight elementary school female teachers	Workshops focusing on autonomy, competence, relatedness, problems in schools, teachers' roles, motivating styles, and creating meanings in classrooms	Participated in technology-rich authentic learning environment unrelated to autonomy support	Raters' scoring of teachers' autonomy-supportive style over four time intervals	1.55	0.72	T	E	R	N	B	S	N	L
deCharms (1976)	60 elementary school teachers	An intensive workshop and meetings once a month to focus on origin-pawn concept, evaluation of personal motives, achievement motivation and goal setting	Typical/usual teaching style	Perception of origin nature of the teacher-provided classroom climate	0.883 0.547	0.642	T	E	R	Y	B	S	I	L

Table 4 (continued)

Studies	Participants	Training	Control group	Dependent measure	*D*	Mean r_{yy}	1	2	3	4	5	6	7	8
Edmunds *et al.* (2008)	One college exercise instructor	Individualized tutoring on how to enact the full range of autonomy-supportive behaviors	Typical/usual teaching style	Students' perception of teachers' autonomy support using the Environmental Supportiveness Scale; raters' scoring of teacher's autonomy-supportive behavior	5.759	0.845	T	E	R	Y		S		
Froiland, under review	40 parents	Seven training sessions to explain and model autonomy-supportive style to help children set intrinsic learning goals	No trainings, just to fill out surveys	Parents' perception of how autonomy supportive they behaved toward their children	1.213	0.96	P	T	R	N	I	S	I	L
Hardré and Reeve (2009)	20 managers	A group-administered informational session, small group discussions, an independent study for a question-and-answer problem-solving session, and a training booklet on how to support employees' on-the-job autonomy; 2-week training with 1 h per week	A delayed-treatment control group with typical/usual managerial motivating style during the study	Raters' scoring of managers' self-reported motivating style during an episode of motivating an employee	1.482	0.87	M	E	R	Y	I	S	I	M
Moss (2009)	13 Pre-school teachers	90 min training session with PowerPoint presentation and introduction to a study-specific web site	A delayed-treatment control group with typical/usual teaching style during the study	Raters' scoring of teachers' autonomy-supportive instructional behaviors	0.094	0.779	T	E	R	N	E	S	I	M
Reeve (1998)	159 pre-service teachers	Participants read and worked with a six-page training booklets introducing motivational	Participants read and worked with a six-page training booklets introducing	Raters' scoring of participants' self-reported autonomy-supportive instructional behavior	1.291	0.88	T	T	L	Y	I	K	N	S

		concepts and autonomy-supportive strategies for 45 min	schemas and information-processing learning strategies for 45 min		long term 0.463									
Reeve *et al.* (2004b)	20 high school teachers	A 1-h informational session and independent study on a web site which focused on how to be autonomy supportive toward students	A delayed-treatment control group	Raters' scoring of teacher's autonomy-supportive instructional behaviors	1.94	0.779	T	E	R	Y	E	S	I	M
Tessier *et al.* (2008)	Five PE teachers (from 8th to 12th grades)	A seminar and eight-lesson teaching cycle which contained group work activities and an individualized guidance program teaching the basic tenets of self determination theory, empirical evidence, and the characteristics of an autonomy-supportive teacher	Typical/usual teaching style	Raters' scoring of teacher's autonomy-supportive instructional behaviors	0.885	0.82	T	E	R	Y	B	S	I	L
Weber-Gasparoni (2003)	86 moms	A 7-min videotaped oral health presentation showing an autonomy-supportive parenting style	Received the oral health information in a written form (brochure) that represented usual practice	Mothers' self-reported autonomy-supportive parenting behaviors	−0.289	0.68	P	T	R	N	E	K	N	S
Weber-Gasparoni, in preparation	223 moms	A 15-min videotaped oral health message facilitated by the self-determination theory of motivation showing autonomy-supportive parenting behavior	Received the oral health information in a written form (brochure) that represented usual practice	Mothers' self-reported autonomy-supportive parenting behaviors	0.543	0.725	P	T	R	N	E	K	N	S

Table 4 (continued)

Studies	Participants	Training	Control group	Dependent measure	*D*	Mean r_{yy}	1	2	3	4	5	6	7	8
Williams *et al.* (1999)	Study 1: one physician; Study 2: two physicians	Watching slideshow with a theme of offering choices	Watching a slideshow with a theme of disease and death caused by smoking	Adolescents' perceptions of physician-provided autonomy support	0.326 0.727	0.75 0.72	C	E	R	Y				
Williams and Deci (1996)	58 medical students	In groups to conduct a more patient-centered interview, elicit a more coherent story of the patient's experience, facilitate a helping relationship, greater awareness of one's own feelings and reactions	Typical/usual experience of a medical student	Self-reported autonomy support as one's approach to clinical interviewing	0.551	0.75	C	T	R	Y	B	S	I	L
Williams *et al.* (2002)	27 physicians	A 3-h training session, using patient-centered motivational interviewing to promote patients' autonomous motivation for smoking cessation	The physicians directed patients to quit without eliciting their perspectives.	Raters' scoring of physicians' autonomy-supportive behavior while providing patient care	1.574	0.81	C	E	R	Y	E		I	M
Williams *et al.* (2006b)	Counselors	Train to support patients in how to make a clear and autonomous decision regarding tobacco use	Patients received a booklet and a list of smoking cessation programs	Patients' perceptions of the practitioner's autonomy support	0.39	0.94	C	E	R	Y	I			

Target population's profession (*T* teacher, *C* clinician, *M* manager, *P* parent). Target population's level of experience (*E* experienced, *T* trainee). Training setting (*R* real setting, *L* lab). Type of investigator (*Y* SDT investigator, *N* non-SDT investigator). Type of media used (*E* electronic media, *I* instructional media, *B* both). Focus of the training (*S* skilled-based with discussion and practice, *K* knowledge-based with reading and watching). Presence of theory-based instruction (*I* instruction present, *N* no Instruction present). Length of training (*L* long, *M* medium, *S* Short)

directional hypothesis for this moderator variable. Specifically, hypothesis 2 was that participants in the experimental group who endorsed an autonomy causality orientation would benefit more from the training than would participants in the experimental group who endorsed a control causality orientation. This is so because any change in a person's interpersonal style toward others can be expected to occur only to the extent that the person accepts and internalizes that recommended change (Deci 2009), and people with an autonomy causality orientation have been shown to accept and internalize messages consistent with an autonomy-supportive style to a greater degree than have people with a control causality orientation (Reeve 1998).

Method

Literature search

To locate relevant studies, the first author performed an extensive search with ERIC, EBSCO computerized databases, APA PsycNET for PsycINFO, PsyArticle, PsyCRITQUES, and Dissertation Abstracts using variations and combinations of the following key words: autonomy support, autonomous support, autonomy supportive, self-determination, intrinsic motivation, intervention, training and experiment. We choose 1976 as the starting year because this was the year that the first published report on how to support autonomy in others appeared in the literature—namely, Richard deCharms' book *Enhancing motivation: Change in the classroom*. The first author also used manual and computerized searches of the *Journal of Educational Psychology*, *Contemporary Educational Psychology*, *Journal of Experimental Education*, and *Motivation and Emotion*, as well as a manual search of the hundreds of empirical studies listed at www.self-determinationtheory.org. The first author further examined the reference lists of review articles (e.g., Mageau and Vallerand 2003; Reeve 2009) and books (e.g., Grolnick 2003) for additional studies not identified in computer-based searches. Finally, e-mail requests to the self-determination theory list serve were used to collect unpublished studies, dissertations, and conference presentations. These search methods yielded 23 articles, which were reviewed to determine whether they could be included in the analysis by using the criteria described below.

Criteria for inclusion

The criteria for inclusion in the meta-analysis were (a) self-described (author-labeled) autonomy support training or intervention, (b) the intervention was delivered within the context of an experimental design (with an experimental group and a control group), and (c) the available data were sufficient to calculate an effect size. Because the intention was to assess the effects of autonomy-supportive interventions, studies reporting interventions to enhance only intrinsic motivation were excluded from the meta-analysis, as were studies aimed to measure and report only the positive effects of autonomy support, of which there are about 100. Based on the inclusion criteria, three of the collected studies were excluded because they focused only on the benefits of the autonomy-supportive intervention while they failed to assess the actual effectiveness of the intervention per se. The data from a fourth study were no longer available after contacting the original author. A fifth study did not report enough information to calculate an effect size. One study was published in a non-English-speaking journal, but we were able to obtain all the necessary information from the

author upon request. As a result, the final dataset included 18 articles including 19 independent studies with 20 effect sizes for the overall analysis and moderator analyses.[1]

Our criteria for inclusion in the meta-analysis were broad as our intention was to include the full range of studies conducted to date. Such broad inclusion criteria leave our analysis open to the possibility that a few relatively poorly designed studies (i.e., those with unusually small sample sizes or methodological shortcomings that might favor a positive result) might skew the result in a hypothesis-confirming way. To consider this possibility, we conducted a supplemental analysis with narrower inclusion criteria intended to include a set of only relatively well-designed intervention studies. Our narrow criteria included the following: (1) experimental studies with random assignment to the experimental and control conditions; (2) at least ten participants in the experimental group and ten participants in the control group; and (3) published in a peer-reviewed scholarly journal. These narrow criteria for inclusion resulted in a data set of five experiments with six effect sizes (i.e., deCharms 1976[2]; Hardré and Reeve 2009; Reeve 1998; Reeve *et al.* 2004b; Williams *et al*. 2002). The effect sizes obtained from these relatively rigorous experiments were used only in the overall analysis as we considered the number of included studies to be insufficient to perform moderator analyses. Furthermore, we treated this test not as a new hypothesis but, rather, as a supplemental and more stringent retest of hypothesis 1.

In addition, four of the 19 studies investigated participants' personality-based causality orientations, but one did not report enough information to obtain separate effect size calculations for autonomy-oriented and control-oriented individuals. Therefore, the final dataset to assess hypothesis 2 included three independent studies with three effect sizes.

Dependent measures

Supervisors' post-training autonomy support has been assessed in three different ways. The most common dependent measure has been to assess supervisors' post-training autonomy-supportive behaviors directly. Ten studies used this method. In all but two of these studies, trained raters observed supervisors during actual interactions with their supervisees and rated various categories of autonomy-supportive behavior (Barch 2006; Collins 2001; Edmunds *et al*. 2008; Moss 2009; Reeve *et al*. 2004b; Tessier *et al*. 2008; Williams and Deci 1996; Williams *et al*. 2002). Two studies (Hardré and Reeve 2009; Reeve 1998) had trained raters score participants' written description of an actual interaction they had with supervisees, so we used raters' autonomy-supportive scores on these written descriptions instead of raters' scores of actual behaviors.

The second dependent measure used to assess autonomy support has been to collect supervisors' self-reports of how autonomy-supportive they perceived themselves to be toward supervisees. Four studies used this method (Froiland, under review; Reeve 1998; Weber-Gasparoni 2003, in preparation), including self-reporting one's motivating style using the Problems in School questionnaire (Reeve 1998), self-reporting one's capacity to support their child's autonomous motivation (Froiland, under review), and self-reporting various autonomy-supportive behaviors on an experimenter-provided questionnaire (Weber-Gasparoni 2003, in preparation).

[1] The 18 articles included 19 independent studies because the Williams *et al*. (1999) investigation included two independent intervention studies. The 19 independent studies included 20 effect sizes because the deCharms (1976) investigation reported separate effect sizes for the seventh and eighth grade classes.

[2] The deCharms (1976) study was published as a book. However, deCharms published the key findings from the same research project in a scholarly journal; see deCharms (1972). The full citation appears in the references.

The third dependent measure used to assess autonomy support has been to collect supervisees' perceptions of how autonomy supportive their supervisor was. Eight studies used this method (Barch 2006; Chatzisarantis and Hagger 2009; Cheon and Moon 2010; deCharms 1976; Edmunds *et al*. 2008; Williams *et al*. 1999, 2006b). In all but two of these studies, supervisees reported their perceptions using the Learning Climate Questionnaire that was adapted for use in that particular domain. One study used the Origin Climate Questionnaire (the parent instrument to the LCQ; deCharms 1976), and a second study used the Perceived Environmental Supportiveness scale (Edmunds *et al*. 2008).

Total number of studies included

Using the broad criteria of inclusion, the meta-analysis included 19 studies taken from 11 published articles, one book, two dissertations, and four unpublished papers. Of these 19 studies, one published article reported two independent studies (i.e., Williams *et al*. 1999). Three studies assessed multiple dependent measures of autonomy support (Barch 2006; Edmunds *et al*. 2008; Reeve 1998). Although we included both published and unpublished studies, the possibility remains that we did not obtain all existing studies. Therefore, we conducted the file drawer analysis to estimate how the potentially missing studies might lower the obtained effect size.

Meta-analytic procedure

Coding process

The following variables from each of the 19 included studies were coded for the meta-analysis procedure: sample size, number of participants in the experimental group, number of participants in the control group, type of dependent measure, reliability of the dependent measure, mean difference of the dependent measure between the experimental and control groups, standard deviations of the dependent measure for both groups, and the statistical test reported (i.e., r, t, F, or d). To understand how different intervention programs did or did not help people become more autonomy-supportive, the following five participant characteristics were coded—gender, age, occupation, years of professional experience, and causality orientation—as were the following eight experimental procedures—elements of autonomy support included, type of training setting, type of investigator, type of media used, focus of the training, presence of theory-based instruction, length of training, and the time interval between the training and the assessment of the dependent measures.

Coding process for the predictor variables

The first author coded each article, while a College of Education doctoral student with familiarity with meta-analysis also independently coded each article. After both raters completed their independent scoring of all variables, they engaged in two separate half-day discussion sessions to discuss the coding process, obtain a uniform coding sheet, compare results, and discuss discrepancies. Among the 460 pieces of coding information that were scored, only 16 discrepancies emerged, yielding an initial coder agreement of 96.5%. When the two raters coded "type of instructor," they agreed that the definition of a SDT investigator was one who either had published at least one article on SDT prior to the intervention study or was included in the SDT faculty members' list on SDT web site. Similarly, when the two raters coded "length of training," they agreed to divide all studies

into three categories: short (10–45 min), medium (1–3 h), or long (7 weeks to an academic year) duration. An educational psychology professor with special expertise in self-determination theory served as a third coder to recheck the coding results from the first two raters and to make a final decision on each of the 16 discrepancies. This process in which two independent coders first code and discuss all studies while a third coder then resolves outstanding discrepancies has been shown to result in high reliability (Rosenthal 1987). Because consensus was reached on all coding decisions, there was no need to calculate a reliability (e.g., Cohen's kappa) for each study characteristic (i.e., agreement was 100%).

Coding process for the dependent variables

Dependent measures included both self-report and rater-scored assessments of the supervisor's motivating style. For the studies that utilized a self-reported measure, we coded the available reliability from each study, which was Cronbach's alpha coefficient for internal consistency. For the studies that utilized raters' scores, we coded the inter-rater reliability, expressed as a correlation coefficient. This distinction is important because estimates of reliability feature at least three types of measurement error that cause undercorrections and a downward bias in the meta-analysis (Hunter and Schmidt 2004)—namely, random response error, specific factor error, and transient error (Le *et al*. 2009, 2010). An alpha coefficient detects the extent of random response error, which comes from individual's randomness in behavior, and specific factor error, which comes from the measurement situation and person by item interactions, but not transient error, which is related to the time factor (Schmidt and Hunter 1999, 2003). Inter-rater reliability judgments detect all three types of measurement error and also idiosyncrasy in rater perception (e.g., halo error; Hunter and Schmidt 2004; Hoyt 2000).

Effect size calculations

To calculate the true mean effect size, which represents the true effects of the autonomy-supportive interventions, the researchers adopted the meta-analysis method in Hunter and Schmidt (2004) because this approach has been recommended following comparative analysis of the various meta-analytic approaches (Hall and Brannick 2002; Schulze 2004) and because it is the only procedure that corrects not only for sampling error but also for measurement error (Schmidt 2010). Moreover, the random effect method was preferred because it assumes that the population parameter may be different from study to study and allows for any possible value of SD_δ, rather than the fixed effect model which assumes homogeneity of effect parameters (Hedges and Vevea 1998; Hunter and Schmidt 2004) that could result both in a higher type I error and in narrower confidence intervals (Hunter and Schmidt 2000).

For the effect size from each study, we used Cohen's d (Cohen 1988) to estimate the training effect by dividing the difference between the autonomy-supportive experimental training group and the control group by their pooled within-group standard deviation, which was modified by Fisher: $d = \overline{X}e - \overline{X}c/\text{SDpooled}$; $\text{SDpooled} = [(Ne-1)\text{SD}e + (Nc-1)\text{SD}c]/[(Ne-1)+(Nc-1)]$. The reason we adapted this strategy is that the pooled within-group standard deviation has a smaller sampling error (Hunter and Schmidt 2004). In addition, for those studies reporting no information on effect size, the authors attempted to convert other statistics to effect sizes by using the following formulas (for t, F, and r, respectively): $d = \frac{2t}{\sqrt{N}}$; $d = \frac{2\sqrt{F}}{\sqrt{N}}$; $d = \sqrt{\frac{(N-2)}{N}} * \frac{2r}{\sqrt{1-r^2}}$;

and $r = \frac{bSx}{Sy}$ for equations with only a single predictor (Hunter and Schmidt 2004, p. 278).[3] Moreover, for some studies reporting neither effect size nor F or t ratios, the researchers calculated the effect size by using Fisher's modified formula (Fisher 1956) with the originally reported means and standard deviations for the experimental and control groups.

For the three studies that used multiple ratings of the supervisor's autonomy-supportive behavior, we used the reported composite score (e.g., Tessier *et al*. 2008) or calculated a composite score by equally weighting and averaging the reported indicators of supervisors' autonomy-supportive behavior.[4]

The effect size for each study was weighted by its sample size and individually corrected for artifacts. That is, we adjusted the mean weighted effect size for sampling errors by weighting the difference in sample sizes across studies, and we took into account the reliabilities of measures by correcting for r_{yy}. In addition, as recommended by Hunter and Schmidt (2004), we corrected each effect size for positive bias of d value by using the *D*-Value program in Schmidt and Le's (2005) software (i.e., *Hunter & Schmidt Meta-Analysis Program*). Furthermore, meta-analyses that utilize a relatively small number of studies (as in the present investigation) may be associated with second-order sampling errors while estimating means or standard deviations (Hunter and Schmidt 2004). We therefore adopted Hunter and Schmidt's (2004) recommendation to use the formula $\mathrm{Var}(\text{corrected } \overline{d}) = \mathrm{Var}(d)/k$. The square root of this value is the standard error of the mean corrected d which was used to calculate confidence intervals (i.e., 95% CI $= d \pm 1.96\sqrt{S^2_{\overline{d}}} = \pm 1.96\sqrt{\mathrm{Var}(d)/k}$). Thus, following these adjustments, we report the mean true effect size, true variance of effect size (S^2_δ), standard deviation of the mean true effect size, observed variance of the corrected effect size, percentage of variance in corrected effect size due to error variance, credibility interval (i.e., 80% credibility interval, 10 percentile and 90 percentile, $= d \pm 1.28\ \mathrm{SD}_\delta$), variance of mean corrected d as well as confidence intervals of mean corrected d for the overall meta-analysis.

Main effect analysis

To determine to what extent any one autonomy-supportive training intervention was effective requires specifying a consensus dependent measure of the intervention's effectiveness. For both overall main effect analyses (the first using the broad criteria of

[3] In one study (Williams and Deci 1996), we were unable to convert to an individual effect size because the results were reported as standardized beta coefficients with multiple predictors. Therefore, we relied on the point biserial correlation. For the causality orientation analysis in this same study, we coded the correlations between types of causality orientation and belief of autonomy-supportive care. Furthermore, both Reeve (1998) and Weber-Gasparoni (2003) had two experimental groups. For the purposes of the present meta-analysis, we used the data from only the autonomy support group and the control group, and we calculated effect sizes from the means and standard deviations for these two conditions. In Reeve (1998), both the immediate training effect and a longitudinal training effect were investigated; however, that study did not provide sufficient information on the longitudinal training effect to calculate that effect size (so only the immediate training effect was included in the present meta-analysis).

[4] Both Barch (2006) and Edmunds *et al*. (2008) reported separate results from students' self-report data and from raters' observation, while Reeve (1998) reported separate results from participants' self-report data and from raters' scoring of participants' autonomy-supportive behavior. For the "type of dependent measure" moderator analysis, these separate effect sizes are shown in Table 6. For the overall meta-analysis, we computed and used a single overall effect size for each study by averaging the two effect sizes into a single composite.

inclusion, the second using only the narrow criteria of inclusion), we combined the three different types of dependent measures into a single dependent measure.

Moderator analysis

The moderator analysis examined the effects of autonomy-supportive interventions across three different dependent measures, three different target population characteristics (profession, level of experience, and causality orientation), and seven different experimental procedures (elements of autonomy support, training setting, type of investigator, type of media used, focus of the training, presence of theory-based instruction, and length of training). To obtain the mean true effect sizes for each subcategory, we followed the same procedures as outlined above for the main effect analyses.[5] For each subcategory within each potential moderator variable, we report the subcategory's mean true effect size (d), the number of studies that used that subcategory (k), the true variance of effect size (S_δ^2), the variance of mean corrected d ($S_{\bar{d}}^2$), and the 95% confidence intervals for mean corrected d.

Following Hunter and Schmidt's (2004) recommendations, we determined the presence of any individual moderator variable by comparing four statistics: (a) differences in the true effect sizes among the subcategories; (b) variances of effect size across the subcategories relative to the variance of the effect size for the main effect analysis; (c) confidence interval overlap among the subcategories; and (d) the absence of zero in the subcategory's confidence interval. Thus, for a moderator to be considered present, the effect sizes among subcategories should be different, the variance for the subcategory effect sizes must be noticeably reduced when compared to the variance of the effect size from the main effect analysis, and the range of the subcategory's confidence interval needs to be noticeably different from the range of the other subcategories' confidence intervals.[6] As for an effect size to be 95% chance effective, the lower range of the subcategory's confidence interval must be >0.

Participants

We coded participants into the following mutually exclusive categories: 341 pre-service teachers (college students enrolled in a teacher certificate program), 13 preschool teachers, 68 elementary school teachers, 20 high school teachers, 2 college exercise instructors, 15 physical education teachers, 30 physicians, 58 second-year medical interns, 309 mothers, 40 parents, and 20 workplace managers. Each sample size calculation included participants in both the experimental and control (or delayed-treatment) groups. Thus, the total sample utilized to test hypothesis 1 included 916 participants taken from 19 studies with 20 effect sizes.

We coded participants for the subcategory meta-analysis for personality characteristics (causality orientation) into the following mutually exclusive categories: 106 pre-service teachers (Reeve 1998), 8 urban elementary school teachers (Collins 2001), and 72 second-year medical interns (Williams and Deci 1996). Thus, the total sample utilized to test hypothesis 2 included 186 participants taken from three studies with three effect sizes.

[5] That is, effect sizes were weighted by sample sizes, corrected individually for artifacts, adjusted for sampling errors by weighting sample sizes across studies, corrected for positive bias of d value and reliabilities of dependent measures, and we adopted the formula Var(mean corrected d)=Var(d)/K to obtain the standard error of mean corrected d and its confidence intervals.

[6] In comparing the confidence interval from one subcategory to the confidence interval of another subcategory, it is possible for a confidence interval to be the same as the effect size (i.e., when the standard error of the mean corrected d is 0). In this case, we checked if the effect size for the subcategory fell outside the middle range of the confidence interval for the other subcategories.

Results

Using the information displayed in Table 4, we conducted two sets of analyses. First, we tested the overall main effect analyses of the training's effectiveness. Second, we tested the series of moderator analyses.

Main effect analysis

For the overall meta-analysis (k=20; N=916), the mean true effect size was 0.632, the true variance of the effect size (S^2_δ) was 0.247 ($SD_\delta = 0.497$), while the observed variance of the corrected effect size (S^2_{dc}) was 0.247. The percentage variance in corrected effect size due to sampling error (S^2_e) was 33.1%. The 80% credibility interval (10th percentile and 90th percentile) ranged from −0.004 to 1.268, which means that for the whole populations, there exists an 80% chance that the effect sizes would fall in the range between −0.004 and 1.268. Adjusting for second-order sampling error, the variance of the mean observed effect size ($S^2_{\bar{d}}$) was 0.011, and the 95% confidence interval ranged from 0.431 to 0.833, which means that there exists a 95% chance that if any single training intervention was carried out, its true effect size would fall within the range between 0.431 and 0.833.

For the supplemental meta-analysis that included only those studies meeting the narrow criteria of inclusion (k=6; N=318), the mean true effect size was 1.332, the true variance of the effect size (S^2_δ) was 0.002 ($SD_\delta = 0.048$), while the observed variance of the corrected effect size (S^2_{dc}) was 0.115. The percentage variance in corrected effect size due to sampling error (S^2_e) was 33.6%. The 80% credibility interval (10th percentile and 90th percentile) ranged from 1.271 to 1.394. Adjusting for second-order sampling error, the variance of the mean observed effect size ($S^2_{\bar{d}}$) was 0.006, and the 95% confidence interval ranged from 1.176 to 1.488. Overall, the results from the studies using only the narrow criteria of inclusion validated the positive results from the studies using the broad criteria of inclusion.

Due to the concerns of publication bias and skewed distribution of the studies, we conducted the file drawer analysis. Results showed that adding about 30 missing studies with a zero effect size would reduce the overall effect size to 0.5, adding about 60 studies with zero effect size would reduce the overall effect size to 0.3, and adding about 227 studies with zero effect size would reduce the overall effect size to 0.1. However, it is unlikely that so many studies were lost. Hence, the current result from the meta-analysis seems to stand up well to the file drawer analysis.

Moderator effect analyses

We used the 75% rule in Hunter and Schmidt (2004) to decide (on a statistical basis) whether or not to conduct moderator analyses. If the percentage of sampling error variance divided by the corrected observed effect size variance (S^2_e / S^2_d) is larger than 75%, that means the residual variance could be explained by other artifacts and the true variance is 0 (Sagie 1993). Because the percentage variance of the overall effect analysis was 33%, which failed the 75% rule, it means that the studies are heterogeneous and that we are justified to continue to test for the presence of moderators.[7] To do so, we first tested the

[7] Even after dropping the large effect size of d=5.759 associated with the Edmunds *et al*. (2008) study—5.759 is the average of 9.67 and 1.85 from the first and third columns in Table 6, the corrected observed effect size variance (S^2_e / S^2_d) remained well below Hunter and Schmidt's (2004) 75% rule with a percentage of variance of 40%. Hence, we are justified to continue to test for moderators even after removing the Edmunds *et al*. outlier effect size.

type of dependent measure used. Second, we tested the three different target populations (profession, level of experience, and causality orientation). Finally, we tested the seven different experimental procedures (elements of autonomy support, training setting, type of investigator, type of media used, focus of the training, presence of theory-based instruction, and length of training). The data used to assess the importance of these moderator effects—mean true effect size (d), true variance of effect size (S^2_δ), variance of mean corrected d ($S^2_{\bar{d}}$), and 95% confidence interval of mean d—appear in Table 5.

Type of dependent measure

Regarding the three types of dependent measures, objective ratings of supervisors' autonomy-supportive behavior had a higher effect size than did either supervisors' self-report behavior or subordinates' ratings of their supervisors' autonomy-supportive style. However, the objective ratings subcategory also showed larger variance than the other two subcategories as well as larger variance than the overall meta-analysis. This means that the objective ratings subcategory had relatively more diverse results.

To help clarify this pattern of findings, the effect sizes for each study broken down by its dependent measure appear in Table 6. As can be seen from inspecting the ten effect sizes under "objective ratings of supervisors' autonomy-supportive behavior" listed in the first column, the large variance in the objective ratings subcategory was attributable to one very large effect size (d=9.67) involving the training of a single supervisor. Removing this potential outlier, the weighted effect size remained about the same (1.363 for k=9 versus 1.394 for k=10), while the true variance of the obtained effect size (S^2_δ) fell rather dramatically (0.306 for k=9 versus 0.813 for k=10). Removing this outlier therefore solved the variance problem, while the mean weighted effect size remained substantially greater than for the other two dependent measures. Thus, type of dependent measure did moderate the overall main effect analysis such that higher effect sizes were observed in studies using objective ratings of supervisors' autonomy-supportive behavior.

Profession

Training intervention studies were offered to teachers (k=11), parents (k=3), clinicians (k=5), and workplace managers (k=1). For the moderator analysis, we included only the subcategories of teachers, parents, and clinicians. Training teachers was most effective. Training parents and clinicians showed a similar effect size, and the confidence interval for clinicians falls within the confidence interval for parents. The confidence interval of trained parents, however, included zero (range=−0.066 to +1.064) and therefore implies the possibility that training parents to be autonomy-supportive might not be effective. Since the effect size associated with the teachers subcategory was higher than the other subcategories and also higher than the overall main analysis effect size (with reduced variance and largely non-overlapping confidence intervals as well), the moderator was present. Teachers profited from the autonomy-supportive training intervention to a greater degree than did parents and clinicians.

Level of experience

Training intervention studies were offered to inexperienced trainees (k=6) and to veteran professionals (k=14). As shown in Table 5, the effect size for inexperienced trainees was larger than was the effect size for experienced professionals. Large parts of the confidence

Table 5 Results from main effect and moderator effect analyses

Main effect analyses	D	K	S^2_δ	$S^2_{\bar{d}}$	95% Confidence interval
Overall meta-analysis	0.632	20	0.247	0.011	0.431–0.833
Overall meta-analysis using only narrow criteria of inclusion	1.332	6	0.002	0.006	1.176–1.488
Moderator effect analyses					
Dependent measures					
Objective ratings	1.394	10	0.813	0.069	0.878–1.970
Supervisors' self-report	0.556	4	0.126	0.042	0.156–0.956
Subordinates' ratings	0.655	9	0.169	0.016	0.409–0.902
Three different target populations					
Profession					
Teachers	1.161	11	0.241	0.019	0.888–1.433
Parents	0.499	3	0.202	0.083	−0.066–1.064
Clinicians	0.444	5	0.102	0.010	0.248–0.640
Managers	1.482	1			
Level of experience					
Experienced	0.524	14	0.244	0.015	0.283–0.765
Trainee	0.831	6	0.189	0.039	0.445–1.217
Causality orientation					
Autonomous-oriented	0.621	3	0	0	0.621
Control-oriented	0.365	3	0.059	0.019	0.096–0.634
Seven different experimental procedures					
Elements of autonomy support					
Provide rationales	0.632	20	0.247	0.011	0.431–0.833
Acknowledge perspective, feelings	0.640	17	0.230	0.012	0.429–0.851
Offer choices	0.553	15	0.218	0.012	0.334–0.772
Nurture motivational resources	0.625	17	0.200	0.010	0.428–0.828
Use of non-controlling language	0.943	13	0.375	0.026	0.629–1.257
Training setting					
Laboratory	1.157	2	0.010	0.021	0.873–1.441
Authentic setting	0.523	18	0.226	0.011	0.320–0.726
Type of investigator					
SDT investigator	0.616	13	0.254	0.017	0.362–0.870
Non-SDT investigator	0.679	7	0.221	0.027	0.356–1.002
Type of media used					
Instructional media	0.569	5	0.139	0.025	0.258–0.880
Electronic media	0.712	6	0.252	0.035	0.347–1.077
Both	0.796	5	0	0.013	0.571–1.021
Focus of the training					
Skill-based	1.071	11	0.345	0.027	0.752–1.390
Knowledge-based	0.829	5	0.271	0.049	0.397–1.261
Presence of theory-based instruction					
Instruction present	0.842	10	0.118	0.010	0.644–1.040
No instruction	0.828	5	0.217	0.052	0.382–1.274

Table 5 (continued)

Main effect analyses	*D*	*K*	S^2_δ	$S^2_{\bar{d}}$	95% Confidence interval
Length of training					
Long	0.965	8	0.052	0.008	0.790–1.140
Medium	1.498	4	0.096	0.208	0.605–2.391
Short	0.820	4	0.222	0.064	0.325–1.315

The reason why zero variance of the mean true effect size (S^2_δ) still has 95% CI is because CI is calculated based on the standard error of the mean corrected *d* ($\sqrt{S^2_{\bar{d}}}$); however, credibility interval is calculated based on the standard error of the mean true effect size (SD_δ).

intervals from the two subcategories did not overlap, and the variances of the mean effect size for both subcategories were smaller than the variance for the overall main effect analysis. Hence, level of experience did serve as a moderator of the overall main effect analysis such that the training offered to less experienced participants was particularly effective.

Causality orientation

Three intervention studies investigated participants' pre-intervention causality orientation to assess whether the training might be more effective for participants with an autonomy causality orientation than it might be for participants with a control causality orientation. As shown in Table 5, comparing the effect sizes, the interventions were relatively more effective for autonomous-oriented individuals. The effect size for autonomous-oriented individuals was at the upper range of the confidence interval for control-oriented individuals. Both groups had a variance of effect size that was notably smaller than the variance for the overall analysis. Thus, causality orientation did moderate the overall main effect analysis such that autonomy-oriented individuals benefited more from the training than did control-oriented individuals. Notably, however, training individuals with a control-oriented causality orientation to be autonomy-supportive was still effective (just relatively less so).

Elements of autonomy support

Different studies included different components of autonomy support within the delivery of the intervention. Among them, studies focusing on the use of non-controlling language had the highest effect size. Next were studies that focused on acknowledge perspective and feelings, provide rationales, and nurture motivational resources, while the effect size for studies focusing on offer choices was the lowest. The 95% confidence intervals of the effect sizes associated with elements focusing on acknowledging perspective and feelings, providing rationales, and nurturing motivational resources highly overlapped. The 95% confidence interval for the use of non-controlling language subcategory covered the upper range of the confidence intervals for the other three subcategories, while the confidence interval for offer choices covered the lower range. Elements of autonomy support (and the subcategory of use of non-controlling language in particular) only partially moderated the overall main effect analysis. One reason for these confusing findings is that the number of studies included for each element of autonomy support is not mutually exclusive as several studies included multiple elements of autonomy support.

Table 6 Weighted effect sizes of autonomy-supportive intervention (Cohen's *d*, corrected for sample size) on the dependent measures of supervisors' autonomy support

Study	n_e	n_c	Objective ratings of supervisors' autonomy-supportive behavior *d* (α)	Supervisors' self-report autonomy-supportive behavior *d* (α)	Subordinates ratings of supervisors' autonomy-supportive style *d* (α; *n* of subordinates)
Barch (2006)	91	91	0.74 (0.78)		1.02 (0.88; 182)
Chatzisarantis and Hagger (2009)	5	5			1.56 (0.89; 101)
Cheon and Moon (2010)	1	1			3.64 (0.90; 28)
Collins (2001)	4	4	1.55 (0.72)		
deCharms (1976)	32	28			0.88 (0.64; 40)
					0.55 (0.64; 52)
Edmunds *et al.* (2008)	1	1	9.67 (0.78)		1.85 (0.91; 56)
Froiland, under review	25	15		1.20 (0.96)	
Hardré and Reeve (2009)	10	10	1.48 (0.87)		
Moss (2009)	9	4	0.094 (0.78)		
Reeve (1998)	56	103	1.96 (0.87)	0.63 (0.89)	
Reeve *et al.* (2004b)	10	10	1.94 (0.78)		
Tessier *et al.* (2008)	2	3	0.89 (0.82)		
Weber-Gasparoni (2003)	30	56		−0.29 (0.68)	
Weber-Gasparoni, in preparation	153	70		0.54 (0.73)	
Williams *et al.* (1999)					
Study 1	1	1			0.33 (0.75; 154)
Study 2	2	2			0.73 (0.72; 246)
Williams and Deci (1996)	58	0	0.55 (0.75)		
Williams *et al.* (2002)	27	27	1.57 (0.81)		
Williams *et al.* (2006b)	714	292			0.39 (0.94; 1006)

d effect size, n_e number of participants in the experimental condition, n_c number of participants in the control condition

In Cheon and Moon (2010), Edmunds *et al.* (2008), Williams *et al.* (1999), and Williams *et al.* (2002), the same participants participated in both experiment and control groups; hence, the numbers in n_e and n_c are the same. In Williams *et al.* (2006b), n_e and n_c represent the number of patients (subordinates) because there was no information about the number of clinicians reported

Training setting

Some intervention studies took place in a laboratory setting (k=2), while other interventions took place in an authentic setting (k=18). As shown in Table 5, interventions carried out in

laboratory settings were more effective and had a smaller variance in effect size than did interventions carried out in authentic settings. Furthermore, there was no overlap in the confidence intervals of these two subcategories. Hence, training setting did moderate the overall main effect analysis such that the laboratory setting was particularly effective (high effect sizes) and produced highly consistent results (low variance).

Type of investigator

Regarding the possible superiority of an intervention implemented by a SDT investigator, the results show that the effect sizes for the two types of investigators were similar, the confidence intervals highly overlapped, and the variance in effect sizes for both subcategories were close to the variance for the overall analysis. Hence, type of investigator did not moderate the overall main effect.

Type of media used

Different intervention studies used different media to deliver the contents of the intervention to participants, such as reading materials (Cheon and Moon 2010; Froiland, under review; Hardré and Reeve 2009; Reeve 1998), a study-specific web site (Edmunds *et al*. 2008; Reeve *et al*. 2004b), PowerPoint slides (Barch 2006), a DVD presentation (Weber-Gasparoni 2003, in preparation), or a combination of various materials (Collins 2001; deCharms 1976; Tessier *et al*. 2008; Williams and Deci 1996). Results in Table 5 contrast studies that used reading-based instructional materials only (k=5), any type of electronic media (k=6), or both (k=5). Using both types of media had the highest effect size (with a true variance of 0), using electronic media only had the next highest effect size, while using reading materials only had the lowest effect size. Using both types of media had a narrow confidence interval that overlapped only the upper range of the confidence interval for using electronic media (and the confidence interval for instructional media only). This pattern of results suggests that the type of media used did somewhat moderate the overall main effect analysis such that studies that used both types of media were most effective and also that the electronic media subcategory was somewhat more effective than was the instructional materials only subcategory.

Focus of the training

Some intervention studies asked participants to read, watch, or listen in ways that were designed to enhance their knowledge about autonomy support and its practice (k=5), while other studies asked participants to engage themselves in skill-based activities (k=11). As shown in Table 5, both foci of training—knowledge-based and skill-based—were both important in helping people learn how to be more autonomy-supportive toward others, but skill-based training was more effective because its effect size is larger and because its confidence interval overlapped only the upper level of the confidence interval for knowledge-based training. Thus, focus of the training did moderate the overall main effect analysis.

Supplemental analyses showed that training programs with instructors teaching the material were effective (d=0.961, $S_\delta^2 = 0.583$; CI=0.531–1.391; deCharms 1976; Hardré and Reeve 2009; Moss 2009; Reeve *et al*. 2004b; Tessier *et al*. 2008; Williams and Deci 1996; Williams *et al*. 1999), as were training programs with only individual learning without an instructor (d=0.829, $S_\delta^2 = 0.271$; CI=0.397–1.261; Barch 2006; Cheon and

Moon 2010; Reeve 1998; Weber-Gasparoni 2003, in preparation). Furthermore, training programs that took place in the context of group discussions were effective (d=0.893, $S^2_\delta = 0$; Collins 2001; deCharms 1976; Hardré and Reeve 2009; Tessier *et al*. 2008; Williams and Deci 1996), as were training programs that took place in the context of individual learning (d=0.873, $S^2_\delta = 0.447$; CI=0.445–1.30; Barch 2006; Cheon and Moon 2010; Reeve 1998; Reeve *et al*. 2004b; Weber-Gasparoni 2003, in preparation; Williams *et al*. 1999).

Presence of theory-based instruction

Some interventions included the presence of a theory-based instructional period (i.e., outline of SDT and its assumptions and postulates; k=10) while others did not (k=5). Effect sizes for the two subcategories were similar, and the confidence intervals of the two subcategories overlapped fully. Hence, the presence of theory-based instruction did not moderate the overall main effect analysis as both subcategories were equally effective (though the theory-based instruction subcategory did show a narrower confidence interval and produced more consistent results).

Length of training

The length of training time ranged from 10 min (Barch 2006) to 1 year (deCharms 1976). As shown in Table 5, short (k=4), medium (k=4), and long (k=8) training lengths were all effective. For long training time (e.g., seven once-a-week meetings to an academic year), the studies were effective with variance of effect size close to zero, which implies that their results were consistent. For medium training time (e.g., 1–3 h), the studies were most effective with small variance of effect size. For short training time (e.g., 10–45 min), the studies were also effective but with a variance of mean effect size that was close to that in the overall analysis. The medium training duration subcategory produced a noticeably higher effect size with the majority of its confidence interval above the confidence interval associated with the long and short training subcategories. Hence, length of training time was a good moderator as a medium training duration was most effective.

Discussion

The result from the overall meta-analysis showed that intervention programs can effectively help people learn to support the autonomy of others. The mean weighted effect size was 0.63 (95% CI of 0.43–0.83). Using Cohen's rubric (Cohen 1988), the difference between training groups and control groups was a moderately large 0.63 standard deviation. This training effect was rather robust across a number of different target populations, across a number of different experimental designs, and across broad versus narrow criteria of inclusion. In addition, a number of moderator variables emerged to help clarify the two questions of (1) who benefits the most from autonomy-supportive training intervention programs and (2) why some intervention programs were relatively more effective than were others.

Who benefits the most from an autonomy-supportive intervention program?

Training teachers to become more autonomy-supportive was more effective than was training other types of professionals, though the intervention effect for clinicians and

workplace managers was still effective. For parents, however, the effect was diverse and unreliable. The relatively small and unreliable training effect for parents may have occurred because of the small number of studies that trained parents (k=3), because the parents studied had diverse backgrounds (e.g., education level, age, occupations or social economic status), because one's parenting style may be seen as more of a personal (rather than a professional) issue, or because parenting uniquely involves the most bidirectional (rather than unilateral) processes between supervisor and supervisee (Grolnick and Slowiaczek 1994; Pomerantz and Eaton 2001).

The training programs were more effective for inexperienced trainees than for experienced professionals. This finding implies that inexperienced trainees maybe more open to adopting new strategies, or that veteran professionals' preexisting knowledge and experiences might give rise to counterarguments to the training. A similar finding was observed for the causality orientation moderator variable. Participants with an autonomy-oriented causality orientation showed a greater training effect than did participants with a control-oriented causality orientation. It is likely that prior professional experience and a control causality orientation relatively interfered with (or competed against) the training effect in a process reflecting conceptual change such that inexperienced and autonomy-oriented individuals experienced little cognitive conflict and assimilated the training message into their existing ways of thinking about motivating others, while experienced and control-oriented individuals experienced at least some cognitive conflict and accommodated the training message in a more conditional way. Experienced and control-oriented individuals might also act in a relatively more defensive way to information about autonomy support (Hodgins and Knee 2002), one that would again create a sense of conflict with the training message.

Why are some autonomy-supportive intervention programs more effective than are others?

We tested seven different experimental procedures and found that four moderated the overall main effect analysis—namely, training setting, type of media, focus of the training, and length of training. Regarding training setting, studies conducted in a laboratory setting had relatively consistent and stronger effects, while the studies conducted in authentic settings such as schools had more diverse results. This is likely because the laboratory-based setting is more able to control nuisance effects, whereas authentic settings and field studies likely contain confounding variables and multiple sources of influence on a supervisor's motivating style that are above and beyond the training effect message (see Pelletier *et al*. 2002) such that training in authentic settings yields a larger error variance. That said, autonomy-supportive intervention programs carried out in authentic settings were nevertheless consistently effective (d=0.523, $S^2_\delta = 0.226$). The strong and highly consistent training effect for the laboratory setting (d=1.157, $S^2_\delta = 0.01$) suggests the potential potency that autonomy-supportive training programs can have when free of the confounding variables inherent in authentic settings.

For type of media used, we found that applying both instructional booklets and electronic media in the training program helped participants learn to support others' autonomy better than using either one of them alone. When programs utilized both types of media, the message from one media likely complemented the message from the other in a way that allowed participants a better opportunity to accommodate the training message.

Evidence to support focus of the training as a meaningful moderator variable also emerged, though results for focus of the training were not as clear-cut as were the results from the other three experimental procedure moderators. Specifically, a skill-based training

focus tended to be more effective than a content-based training focus, though the results from the skill-based training programs were more diverse. The conclusion seems to be that participants tended to benefit from both a skill-based and from a knowledge-based training focus.

For length of training, a longer duration did tend to produce a larger effect size, but training programs that ranged from an hour to 3 h were relatively most effective. In addition, both the long and medium subcategories produced highly consistent positive results. Still, carrying out the interventions for an efficient time period (and avoiding repetition of the message) produced the best training effect. Several of the medium-length training interventions included important supplemental activities that likely served as a booster effect to the original experimental manipulation, and these will be discussed in the next section.

Suggestions for the design and implementation of effective autonomy-supportive intervention programs

We recommend that practitioners interested in designing or delivering an autonomy-supportive intervention tailor their intervention according to three sets of suggestions. The first concerns what content to emphasize. The data summarized in Table 5 on the five elements of autonomy support suggest a possible content emphasis on "use non-controlling language" and a possible content de-emphasis on "offer choices," though it also suggests the need for future research to determine the essential and optimal elements underlying an autonomy-supportive motivating style. At present, the clearest recommendation is to include multiple and complementary elements of autonomy support within an intervention program. Additionally, a reliance on objective raters to assess the effectiveness of the intervention seems warranted, though self-report measures offered a valid supplement.

The second set of suggestions concerns the "how to" of the intervention's delivery. Effective programs tended to deliver the training in only one or a few sessions for a moderate duration of time (hours, not days or months) and to offer supplemental follow-up activities such as take-home informational booklets or manuals, a study-specific web site, a follow-up group meeting, or structured journaling activities (e.g., each day, try to implement an autonomy-supportive style, then record your reflections and students' reactions). In fact, almost all of the intervention programs included some version of a follow-up activity, blurring the distinction as to what constituted the study's length of training. Effective intervention programs also tended to deliver the autonomy-supportive message using both instructional booklets and electronic media, and they tended to focus on skill-based training rather than on knowledge-based training. The finding that autonomy-supportive training intervention programs were more effective in laboratory settings suggests that intervention programs implemented in authentic settings likely need to address the multiple sources of influence on a supervisor's motivating style to help practitioners cope with non-training-based influences that push and pull them toward a controlling motivating style (and away from an autonomy-supportive one, e.g., see Reeve 2009, pp. 163–166).

The third set of suggestions concerns addressing potential pre-training beliefs, expectations, and values that participants might have about effective motivating strategies. For experienced professionals and for individuals with a control-oriented causality orientation, it seems necessary to approach the training intervention as an exercise in conceptual change in which the training intervention program targets a sense of dissatisfaction with one's current motivating style. For instance, training programs can address the ineffectiveness of

both the controlling and a laissez-faire (permissive) styles before offering the autonomy-supportive style as a viable alternative approach to motivating and engaging students (e.g., see Reeve 2009, pp. 171–172).

Unit of analysis

In most autonomy-supportive training intervention programs, the unit of analysis is the individual supervisor—the teacher, parent, manager, coach, or clinician. The two exceptions were the cohort-based interventions from Chatzisarantis and Hagger (2009) and deCharms (1976). In practice, however, interventions are often carried out at a macro-level, such as at the level of the school, corporation, or hospital. A complementary line of research has investigated the question of how groups (e.g., teachers at the same school) accept or reject interventions, irrespective of its content or foci. For instance, Assor *et al*. (2009) and Felner *et al*. (2007) both showed that teachers were more accepting of interventions when they (a) were invited to become partners in the process, (b) were supported by the principal and other administrators, (c) believed that changes were needed, (d) believed they had the skills necessary to produce the needed change, and (e) received a continuing flow of support throughout the intervention's implementation (e.g., ongoing small mutual support groups).

While the macro-level of analysis of accepting and benefiting from a training intervention program is both interesting and informative, our basic question asked whether one particular type of intervention program (i.e., autonomy support) tended to work and, if so, under what conditions it was most effective. Still, we acknowledge that a macro-level of analysis adds importantly to the current research question.

Limitations

Two main limitations temper the conclusions that can be drawn from the present study. The first limitation concerns the shortage of available studies included in the meta-analysis. Our overall main effect analysis included only 19 studies and 20 effect sizes. The supplemental analysis using the narrow criteria of inclusion included only five studies with six effect sizes. Furthermore, the number of studies included in some subgroups within the moderator analyses were noticeably few (e.g., parents, k=3; causality orientations, k=3; laboratory settings, k=2). Until these findings can be confirmed by an additional number of studies, we recommend caution in interpreting the findings because a meta-analysis with a small number of sample studies is relatively less able to correct primary and secondary sampling errors and less able to reduce the effect size variance estimate, which leads to loose rather than to tight confidence interval estimates (Hunter and Schmidt 2004). Reflecting this limitation, an alternative and likely better way to test for moderators would be to conduct a hierarchical moderator analysis. However, there were simply too few studies in each cell to conduct a hierarchical moderator analysis.

The second limitation concerned the methodological quality of the included studies. Two included studies, for instance, relied on only a single teacher to provide instruction under different conditions, a methodological feature that limits any causal claim that might be drawn from the effectiveness of these particular autonomy-supportive training programs. Six of the 19 included studies were unpublished reports, a point worth emphasizing because it raises the question of whether studies with relatively weaker methodologies might have biased the findings in a hypothesis-confirming way. Recognizing this concern, we carried out the supplemental analysis with narrower and more methodologically rigorous criteria of

inclusion. The (supplemental) effect size obtained using only the strongest methodological studies reproduced and confirmed the overall effect size analysis using the full set of studies. The higher effect size in the supplemental analysis even suggests that the inclusion of the relatively weaker methodological studies likely suppressed, rather than exaggerated the study's overall main effect size finding. While the supplemental analysis supports the overall main effect size finding, the low number of included studies and the variable quality of their methodologies nevertheless warrants caution over the conclusions the present study can offer.

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