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A Cluster-Randomized Controlled Trial to Increase Youth Ice Hockey Coaches' Beliefs and Use of Need-Supportive Styles

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Few educational programs to nurture coach need-supportive behaviors have been delivered by sport governing bodies (Evans et al., 2015). Consequently, the potential for such programs to meaningfully change coaches' interpersonal behaviors requires further investigation (Cushion et al., 2010). Grounded in self-determination theory, we hypothesized that participation in an educational program would increase youth ice hockey coaches' self-reported beliefs (e.g., effectiveness; Hypothesis 1) and application (Hypothesis 2) of need-supportive coaching styles. The study comprised 52 intervention coaches and 40 wait-list control group coaches enrolled in a 2-day regular education. Data were collected before the education with follow-up assessments 1½ and 3 weeks later. We used multigroup multilevel growth models to analyze the change trajectories of the outcomes. A significant group difference was shown for competence support, for which the intervention group exhibited a greater increase than the control group ($\Delta = 0.14$, $SE = 0.05$, $p = .004$). Further, the findings revealed significant increases in the intervention group's effectiveness (slope mean = 0.11, $p = .013$) and easy-to-implement beliefs (slope mean = 0.18, $p = .026$); both conditions significantly increased in autonomy support (intervention group: slope mean = 0.25, $p = .006$; control group: slope mean = 0.11, $p = .006$). We found no significant change in the normative beliefs or relatedness support in any condition. The study demonstrates the benefits of a self-determination theory-based coach intervention advocating the collaboration between researchers and sport governing bodies in designing, implementing, and evaluating such endeavors.

Keywords: intervention, formal, self-determination theory, motivating style, youth sport

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Dennis Bengtsson played a lead role in data curation and writing—original draft, a supporting role in conceptualization, and an equal role in formal analysis, investigation, and project administration. Andreas Stenling played a supporting role in formal analysis and software and an equal role in writing—review and editing. Jens Nygren played an equal role in writing—review and editing. Nikos Ntoumanis

continued

The capacity of coaches to cultivate a growth-oriented youth sport environment and enhance positive athlete experiences is recognized as a fundamental vocational competency (Beauchamp et al., 2023; A. L. Smith et al., 2010). This encompasses fostering positive interpersonal behaviors that bolster youth athletes' intrinsic motivation and commitment to the sport, emphasizing social connection, autonomy, and mastery of essential sporting skills (Castillo-Jiménez et al., 2022; Ntoumanis & Mallet, 2014; K. Smith et al., 2023). On the other hand, negative coaching behaviors (e.g., pressuring, controlling, and guilt-inducing language) can decrease youth athletes' intrinsic motivation and well-being (Bartholomew et al., 2009) and increase their risk for burnout (Li et al., 2013; Morales-Sánchez et al., 2020) and dropout (Castillo-Jiménez et al., 2022).

Until today, several interpersonal coach development programs (CDPs; Evans et al., 2015), focusing on knowledge acquisition and positive interpersonal coach behaviors, have been implemented and evaluated. Conversely, the literature on interpersonal CDPs is scattered, and there is a general lack of standardization regarding theoretical frameworks, research design, and evaluation criteria. However, a recent meta-analysis found that interpersonal CDPs can decrease youth athletes' anxiety and increase their self-esteem, enjoyment, team social cohesion, and perception of a more task-oriented coach-created motivational climate (Bengtsson et al., 2024). Nevertheless, each meta-analyzed pooled effect-size estimate was based on relatively few studies due to the many differing theoretical frameworks and outcome assessments used. This highlights the scarcity of uniform and rigorously evaluated interpersonal CDPs in youth sport (Bengtsson et al., 2024).

One of the theories informing both the content and delivery of interpersonal CDPs (Langan et al., 2015; Langdon et al., 2015; Lemelin et al., 2023; Mahoney et al., 2016; Ntoumanis et al., 2017; Pulido et al., 2017; Raabe et al., 2019; Reynders et al., 2019) is self-determination theory (SDT; Ryan & Deci, 2017). SDT postulates that youth athletes' autonomous motivation and personal development can be satisfied through their needs

for autonomy (e.g., feeling volitional), competence (e.g., feeling efficacious/able to meet challenges), and relatedness (e.g., feeling socially connected). Importantly, the coach can support these nutrients for autonomous motivation by acknowledging the athletes' perspectives (autonomy support), providing clear expectations and positive feedback (competence support), and showing personal interest (relatedness support; Ntoumanis et al., 2017). Provided that the coach is attuned to such positive interpersonal behaviors, experimental and longitudinal observational research show that several beneficial youth athlete outcomes can be reaped including psychological need satisfaction and enjoyment (De Mynck et al., 2017; Pulido et al., 2017), autonomous motivation, behavioral engagement (Lemelin et al., 2023; Reynders et al., 2019), goal motives, performance, and well-being (Fransen et al., 2018; A. L. Smith et al., 2010).

For example, an SDT-based randomized controlled trial (RCT) with 43 volunteering coaches successfully increased the intervention group's self-reported use of autonomy support at the posttest (12 weeks after baseline) and competence support on the follow-up assessment that was adopted another 4 months after the posttest (Reynders et al., 2019). Correspondingly, the intervention group athletes increased their self-reported autonomous motivation, engagement, and perception of the coaches' use of autonomy and competence support (Reynders et al., 2019). In another study, Langdon et al. (2015) tested whether their one-arm intervention could increase youth sport coaches' autonomy-, competence-, and relatedness-supportive styles and their athletes' need satisfaction and autonomous motivation. However, no significant effects were found for any outcome measurement (Langdon et al., 2015). Langan et al. (2015) used a cluster RCT and randomly allocated six youth sport coaches to an intervention or control group alongside their youth athletes. The coach outcomes, rated through a standardized observation tool, showed increased levels of need support in the intervention group. However, these findings were based on three coaches limiting the power and generalization of

played a supporting role in conceptualization and an equal role in writing–review and editing. Andreas Ivarsson played a lead role in funding acquisition and supervision, a supporting role in project administration, and an equal role in conceptualization, formal analysis, software, and

writing–review and editing.

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the results (Langan et al., 2015). Additionally, Mahoney et al. (2016) aimed to increase youth rowing coaches' autonomy-supportive behaviors while reducing their controlling behaviors. However, these hypothesized effects were not observed, and Mahoney et al. (2016) recommended incorporating role-playing and on-site tasks in future interventions to facilitate coaches' learning of need-supportive behaviors. Furthermore, Langan et al. (2015) suggested that future interventions should enable coaches to select which need-supportive strategies to train rather than imposing too many on them. Such acknowledgment of volition in the learning process can facilitate positive beliefs about the training (Aelterman et al., 2016) and continued use of positive interpersonal behaviors (Fishbach & Woolley, 2022).

SDT researchers also highlight that individuals' positive personal beliefs of need support can increase their adoption (Matosic et al., 2016). For instance, Reeve and Cheon (2016) implemented an autonomy-supportive intervention program to help physical education (PE) teachers support student autonomy. The assessment focused on the teachers' beliefs regarding the feasibility and practicality of autonomy support (easy-to-implement), its effectiveness in producing desirable results, and its acceptance among colleagues to motivate students (normative). They found that the intervention group's easy-to-implement and effectiveness beliefs of autonomy support increased compared with the control group. Additionally, the easy-to-implement beliefs mediated the effect of the intervention on increased future intentions, endorsement, and use of the autonomy-supportive style at follow-up. These findings suggest that with proper training, the autonomy-supportive style can be perceived as both easy and effective (Reeve & Cheon, 2016). Similar findings were shown in Aelterman et al.'s (2016) study where PE teachers increased their effectiveness and feasibility beliefs of autonomy and competence support after participating in an SDT-based intervention. Another recent RCT examined sport coaches' beliefs about the suitability of the autonomy-supportive style in practice. The intervention group did not differ significantly from the control group after 2 months, but differences were present 1 year later (Lemelin et al., 2023). However, the examination of coaches' perceived effectiveness, easy-to-implement, and normative beliefs regarding all need-supportive styles following an SDT-based

coach intervention remains unaddressed in the literature (Lemelin et al., 2023; Raabe et al., 2019; Reynders et al., 2019).

Furthermore, previous studies have not assessed the impact of a mandatory interpersonal CDP delivered by sport governing bodies nor have they utilized RCTs in this area (Bengtsson et al., 2024; Evans et al., 2015; Lefebvre et al., 2016; Lemelin et al., 2023; Raabe et al., 2019; Reynders et al., 2019). Expanding such scientific inquiries to larger scale settings can provide robust evidence on whether these programs effectively contribute to coaches' cultivation of positive interpersonal behaviors (Evans et al., 2015; Lacerenza et al., 2017). Despite the common practice of sport governing bodies using accredited educators in coach education programs (Cushion et al., 2019), there is a scarcity of peer-reviewed studies presenting summative outcomes from such interventions led by employed educators (Cushion et al., 2010; Wang et al., 2023).

The Present Study

Only a small percentage (approximately 1%) of coach education programs delivered by sport governing bodies are scientifically designed and evaluated as interpersonal CDPs (Lefebvre et al., 2016). Additionally, the literature shows mixed effects on coaches' adoption of need-supportive styles following SDT-based interventions (Langan et al., 2015; Langdon et al., 2015; Mahoney et al., 2016; Reynders et al., 2019), and little attention has been given to their impact on coaches' personal beliefs regarding need support (Lemelin et al., 2023; Matosic et al., 2016). Notably, these interventions recruited small samples of coaches and were not implemented within the regular coach education programs of sport governing bodies (Langan et al., 2015; Langdon et al., 2015; Lemelin et al., 2023; Mahoney et al., 2016; Reynders et al., 2019). Such limitations reduce the knowledge of whether larger scale interpersonal CDPs delivered in organizational settings can impact coaches' knowledge acquisition and positive interpersonal behaviors (Cushion et al., 2010; Lefebvre et al., 2016).

Therefore, this study aimed to evaluate a mandatory interpersonal CDP delivered by educators from the Swedish Ice Hockey Federation for coaches seeking formal certification in Sweden. Specifically, it assesses the effects of an SDT-based cluster RCT on youth ice

hockey coaches' self-reported effectiveness, easy-to-implement, and normative beliefs regarding need support, alongside their levels of autonomy, competence, and relatedness support. We hypothesize that the intervention group will show increased beliefs (Hypothesis 1) and greater application (Hypothesis 2) of the need-supportive styles compared with the control group over a 3-week training period.

Method

Participants

Ninety-two Swedish youth ice hockey coaches (89 men, three women) were enrolled in the regular first-level coach education (i.e., the accrediting education system within the Swedish Ice Hockey Federation). None of the coaches had any prior experience or training with the program. The coaches represented one of 32 ice hockey clubs of varying sizes throughout Sweden. They were on average 37.50 years old ($SD = 9.02$, range = 17–54) and had been engaged as an active coach or in a leadership position for about 2.41 years ($SD = 2.52$, range = 0–15) about 9.87 hr per week ($SD = 8.39$, range = 0–50). All the coaches had occupations (e.g., paramedic, salesman, IT developer, carpenter) alongside the coaching role. Most of them were former active players at varying levels (i.e., youth competitive and elite, adult professional) before coaching (85.9%) having active children of their own participating in the ice hockey club where they coached (73.9%). The coaches trained youth athletes of varying ages (i.e., 4–20 years) and were in most cases responsible for more than one team simultaneously. Coach baseline characteristics for the intervention and control groups can be found in Supplemental Table S1.

A summary statistics-based power analysis (Murayama et al., 2022) showed that with a multilevel model including one cross-level interaction (Condition \times Time), expecting a similar effect size as in Reynders et al. (2019), 80% power and a significance level of 0.05, we required a Level 2 sample size of at least 57 participants. In this multilevel model, time was nested within each coach at Level 1, and condition was a Level 2 predictor for the outcome variables. Given the previous experience of similar intervention studies in the research group

(e.g., Stenling & Tafvelin, 2016), we also assumed an approximate 30% dropout rate at follow-up, which required a sample size of approximately 90 coaches at baseline.

The study was approved in July 2022 (Dnr 2022-03235-01) and conformed to the recommendations of the Declaration of Helsinki. The coaches enrolled in the education were contacted by the first author and received written information about the study individually before the intervention and data collection. Written informed consent was obtained from all coaches and educators included in the study. Moreover, we notified the coaches that education participation would not be impacted by nonstudy participation.

Measures

Coaches' Beliefs of Need-Supportive Behaviors

Twelve items, based on the work of Reeve and Cheon (2016), were used to measure both the intervention and control group coaches' beliefs regarding need-supportive styles on all measurement occasions. Each subscale consists of four items: effectiveness belief (e.g., "this approach to coaching is effective in terms of motivating and engaging athletes"), easy-to-implement belief (e.g., "this approach to coaching is easy to do"), and normative belief (e.g., "this approach to coaching describes what most coaches do"). Each answer was given on a 7-point Likert scale ranging from 1 (*strongly disagree*) to 7 (*strongly agree*). Reeve and Cheon (2016) indicated adequate internal consistency for all the subscales in their SDT-based autonomy-supportive intervention program with PE teachers and supported the theoretical links between the intervention, beliefs of implementing the learned autonomy-supportive behaviors, and self-reported such behaviors. The composite reliability (ω) of the subscales was as follows: effectiveness belief = 0.87_{T1}, 0.92_{T2}, 0.89_{T3}; easy-to-implement belief = 0.86_{T1}, 0.89_{T2}, 0.89_{T3}; and normative belief = 0.86_{T1}, 0.88_{T2}, 0.90_{T3}.

Interpersonal Behaviors Questionnaire–Self

The *Interpersonal Behaviors Questionnaire–Self* (Rocchi et al., 2017) was used on all measurement occasions, in both groups, to assess the coaches' self-reported need-supportive styles toward their youth athletes. The predefined stem

from the measurement “when I am with my athletes, I ...” was followed by the 12 items. Examples include “give them the freedom to make their own choices” (autonomy support), “encourage them to improve their skills” (competence support), and “honestly enjoy spending time with them” (relatedness support). Answers were reported on a 7-point Likert scale, ranging from 1 (*do not agree at all*) to 7 (*completely agree*). Previous investigations have supported the psychometric properties (e.g., internal consistency, structural validity, convergent and discriminant validity) of the *Interpersonal Behaviors Questionnaire–Self* (Rocchi et al., 2017). In the present study, the composite reliability estimates (omega coefficient [ω]; McDonald, 1999) of the subscales were as follows: autonomy support = 0.87_{T1} , 0.91_{T2} , 0.86_{T3} ; competence support = 0.70_{T1} , 0.86_{T2} , 0.66_{T3} ; and relatedness support = 0.74_{T1} , 0.79_{T2} , 0.75_{T3} .

Study Design and Procedure

This study was designed as a cluster RCT and conformed to the extended Consolidated Standards of Reporting Trials 2010 statement for cluster RCTs (Campbell et al., 2012) and the Template for Intervention Description and Replication Checklist (Hoffmann et al., 2014). Data were collected from youth ice hockey coaches. We opted for the design to reduce the risk of spillover effects between intervention arms as the varying numbers of enrolled coaches belonged to the same clubs (Puffer et al., 2005). Moreover, it capitalized on preexisting team networks, which enabled coaches in the intervention group to acquire a joint understanding of the learning content and reflect upon how they could apply it in their team settings (Nonaka, 1994). The ice hockey clubs and coaches registered for the education were informed about the study and its protocol verbally and by email. It described that all the enrolled coaches were to be randomly allocated as intact club clusters to either an intervention or a wait-list control group. The control group was informed that they would receive the same education about 1 month after the intervention group. Adherence to the group allocation was not compulsory; hence, coaches who did not comply were not included in the study. At baseline, before the start of the education, each of the participating

coaches in both groups received their personalized links via email to an online-formatted questionnaire pack which included the informed consent forms to participate in the study. The intervention group received their questionnaire pack at the start of the morning session on the first education day before commencing the first module. The control group received their questionnaires through email at the same timepoint and returned them on the same day. This procedure was monitored by the coach educators and the first author. Subsequently, 1½ and 3 weeks after baseline and the education, both conditions received follow-up questionnaire packs. This timeframe was decided following the Swedish Ice Hockey Federation’s request concerning the control group’s need to receive the same coach education no longer than a month after study participation to coach their teams formally. No changes were made to the protocol after the intervention commenced.

Initially, 116 coaches were registered and randomized at club level. The represented clubs included varying numbers of participants (e.g., 2 vs. 14 registered coaches). To attain the most even number of participants possible within each condition, we created sample size-matched blocks of clubs within each delivery region before group allocation. Subsequently, the first author employed a simple randomization sequence to allocate the blocks to each condition (i.e., flipping a coin; Suresh, 2011). Owing to logistical constraints and requests from the sport governing body, all enrolled coaches received their allocation at least 1 week before the start of the education. After randomization, and before baseline, 13 coaches notified us that they could not adhere to their group allocation for various reasons (e.g., illness, convenience, absence at the course start) and were thus excluded from the study. This resulted in a total of 103 coaches who received the baseline survey package. Eleven coaches from the control group did not respond to the survey package and were thus excluded. This resulted in 52 participating coaches in the intervention group and 40 in the control group at baseline. Moreover, participants were included in our intention-to-treat analysis if they answered the questionnaires least at baseline. Hence, 92 coaches (89% rate) were included in this analysis across both groups. Moreover, coaches who answered all their received questionnaires from

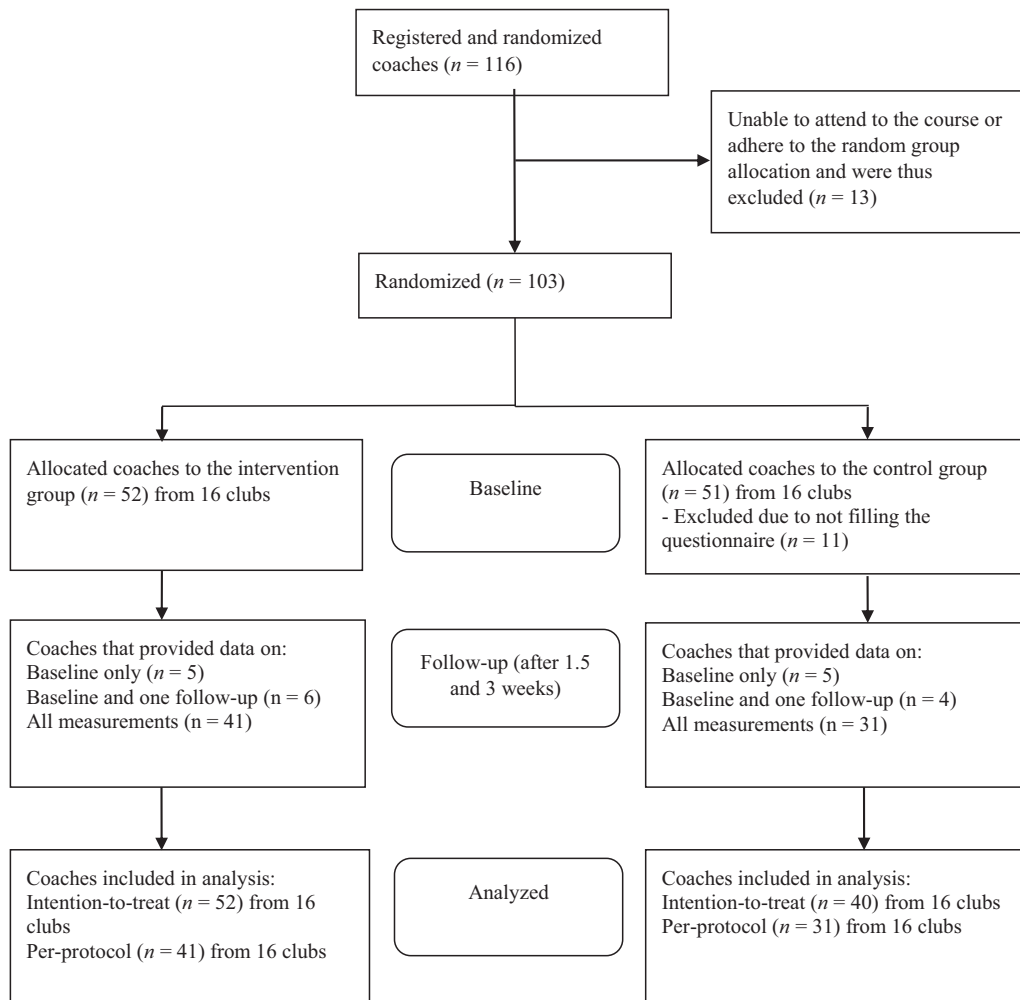
each timepoint were included in our per-protocol analysis. More information about retention between measurements in each group is presented in Figure 1. Both the intervention and control groups consisted of 16 club clusters each.

Setting

The interpersonal CDP component was set to train the intervention group in facilitating a positive growth-oriented youth sport environment through need-supportive behaviors. The interpersonal CDP was developed via collaboration between researchers (second and last authors)

and the Swedish Ice Hockey Federation. The program was delivered in Autumn 2022 in four locations throughout Sweden (i.e., north, south, east, and west). Three of the Swedish Ice Hockey Federation's employed coach educators delivered the interpersonal CDP in the four locations. One of the educators delivered the content on two occasions, the others on one each. On average, 13 coaches were trained in each region ($SD = 5.03$, range = 8–20). Before the interpersonal CDP, all the coach educators underwent training that spanned 2½ days on the content and the suggested mode of delivery. Their training was delivered by two experienced sport psychology practitioners

Figure 1
Intervention Flowchart



(not co-authors of this study), placed within the sport governing body. These practitioners held key roles in the Swedish Ice Hockey Federation's education system and were experienced with SDT and need-supportive behaviors. The coach educators' training considered the principles of need-supportive behaviors alongside how to (a) prepare and simulate different sport-based cases (see Module 3 in Table 1), (b) handle conflict and resolution within the group, and (c) deliver and facilitate discussions about the education content. During their training, the educators learned how to support the coaches' assimilation of the interpersonal CDP content by being responsive to their preferences and motivation for acquiring their subsequent learnings. After training, the coach educators also received digital briefings of the interpersonal CDP content and its modules and recordings of their education sessions.

The Interpersonal CDP

The interpersonal CDP proceeded for 2 consecutive days in ice hockey arenas and conference rooms within each delivery region including four separate delivery modules (see Table 1). The program started with an introduction informing about the values of the sport governing body and the facilitation of a positive and growth-oriented youth sport environment (Module 1). This was followed by reflective tasks concerning how the coaches wished to be perceived by their athletes and what behaviors they should perform to achieve those requirements (Module 2). In the third module, emphasis was put on sport enjoyment and the quality of motivation outlined by SDT. It included individual and group reflections on how to use need-supportive coaching to facilitate positive athlete outcomes. Subsequently, the coaches practiced these interpersonal behaviors in small groups via role-playing and during an on-ice session with approximately 25 youth ice hockey players. The fourth and last module was delivered on the second day. This part involved individual reflections and group discussions about how the learnings from the previous modules could be integrated into future coaching practices. The educators delivered all modules through PowerPoint and oral presentations, accompanied by handouts including guidelines for each slide (e.g., how to introduce each module, informational "cheat sheets," when to incorporate group discussions, and the practical

tasks). The intervention group received handouts for planning and executing the module tasks (e.g., the arrow model; Josefsson et al., 2020). In sum, the mode of delivery enabled the intervention group to identify need-supportive goals, express ideas and thoughts related to their behavioral intentions, and conduct practical tasks relative to the SDT-based principles.

Statistical Analyses

Descriptive statistics, intraclass correlation coefficients, and the main analyses for each primary outcome are presented in Table 2. Pearson's correlations for all measurement points on the primary study variables are presented in Supplemental Table S2. These analyses were performed using IBM SPSS Statistics for Windows Version 28 and Mplus Version 8.6 (Muthén & Muthén, 1998–2017). Moreover, we employed multilevel growth models with full-information maximum likelihood estimation to approximate potential changes and differences in the trajectories between the intervention and control group outcomes. The two-level model separates the within- (i.e., time nested in individuals) and between-person levels (i.e., interindividual differences). Time was a predictor of the outcomes at the within-person level, and the linear slope means and variances were estimated at the between-person level. To account for clustering at a third level (i.e., the club level), we adjusted the standard errors and goodness-of-fit testing using the "TYPE = COMPLEX" command (Muthén & Satorra, 1995). To examine the effects of the clustering adjustment, we also conducted unadjusted analyses for each model without considering the club level. All randomized coaches who participated at baseline were included in the intention-to-treat analyses. We also conducted per-protocol analyses to test for the sensitivity of the change in the trajectories using only coaches who provided data at all measurement points. Separate models were tested for self-reported beliefs regarding need support (Hypothesis 1) and the used need-supportive styles (Hypothesis 2). Assuming that data were missing at random, we used the full-information maximum likelihood estimation to provide unbiased estimates of the results based on the observed data and the accounted pattern of missingness (Enders, 2022). A significance level of $\alpha = .05$ was considered to indicate statistically significant results.

Table 1
Description of the Delivery Content

Intervention	Assignment	Target/goal	Reference
Module 1 (1 hr)		The Swedish Ice Hockey Federation’s vision of how to facilitate a youth sport context in which athletes can thrive and continue to enjoy their sport.	Swedish Ice Hockey Federation
Module 2 (1 hr)	The arrow model	Application of the arrow model as a pedagogical tool for self-reflection and the development of a behavioral action plan and goals.	Josefsson et al. (2020)
	Step 1: Valued direction	How the coach wish to be perceived by the athletes (e.g., creative, reliable, like to make decisions).	
	Step 2: Values-driven behaviors	Specify three observable behaviors that align with the valued direction (e.g., listen actively by asking questions to understand the athletes’ situation).	
	Step 3: Unwanted behaviors	Salient unwanted observable behaviors that conflicts with the value-driven behaviors (and in what situations).	
	Step 4: The way back	How to disrupt the unwanted behaviors in favor of the value-driven ones. The participants made lists of strategies and then discussed them in groups (e.g., help from colleagues to disrupt “bad” behaviors).	
Module 3 (2 hr)	Motivation	SDT perspective on the outcomes affiliated with the quality of motivation (regulations), facilitation of self-determined motivation through internalization, and the basic psychological needs including need support.	Cerasoli et al. (2014), Li et al. (2013), Ng et al. (2012), and Ryan and Deci (2017)
	AS	Acknowledge the athletes’ perspective (e.g., encourage their input and be receptive to their reactions to the activities). Offer a rationale (e.g., why a practice is done and in a certain way). Provide choice (e.g., athletes volitionally choose exercise when feasible). Recognize and accept feelings (e.g., validate and be receptive to positive and negative emotions). Informational and noncontrolling language (e.g., inviting—you can/might want to).	Lindwall et al. (2019)

(table continues)

Table 1 (*continued*)

Intervention	Assignment	Target/goal	Reference
Module 4 (1 hr)	CS	Clarify expectations and goals (e.g., communicate the objectives of the exercises and offer challenges adapted to the athletes' level). Informative feedback (e.g., encourage effort and include instructions for improvement where needed). Encourage questions (e.g., support athletes' performance-related reflections).	Lindwall et al. (2019)
	Role play in pairs: combining AS and CS	Be structured (e.g., goals, rules, feedback) with autonomy support (e.g., offering rationale, acknowledging athletes' choice and volition).	Lindwall et al. (2019)
	RS	Show understanding and consideration (e.g., invite to dialogue and ask how players feel). Be inclusive (e.g., make everyone feel like a part of the team and be receptive to anyone who seems to be outside the group). Listen actively (e.g., being receptive to the athletes' perceptions of the exercises without judgement). Use FunMaps to clarify athletes' perspectives of the determinants (fun factors) that make youth sport fun.	Lindwall et al. (2019)
	Fun and enjoyment Ranking fun factors	Ranking ten different factors from 1 to 10 (e.g., trying your best, training camps, support from teammates, winning, competition, when a coach treats players with respect, being active). The coaches received corrected results from the study of the youth athletes followed by group discussions. The coaches learned that athletes thrive when they, for example, can be active and compete, experience team cohesion, and encourage coaching.	Visek et al. (2015) Visek et al. (2015)
	Coach behaviors—case	Reconnect with previous modules including self-reflections and group discussions of how to facilitate enjoyment and need satisfaction via the coach-valued direction and behaviors listed in the arrow model and whether these aligned with a need-supportive style.	Josefsson et al. (2020), Lindwall et al. (2019) and Visek et al. (2015)

Note. SDT = self-determination theory; AS = autonomy support; CS = competence support; RS = relatedness support.

Table 2
Descriptive Data and Multilevel Analyses of the Intervention Effects

Outcome variable	Condition	ICC	Descriptive			Multilevel growth model			
			Baseline	Time 2	Time 3	Linear slope mean (<i>SE</i>) ^a	Linear slope variance (<i>SE</i>)	Δ difference (<i>SE</i>) ^b	95% CI
			<i>M</i> (<i>SD</i> , <i>n</i>)	<i>M</i> (<i>SD</i> , <i>n</i>)	<i>M</i> (<i>SD</i> , <i>n</i>)				
Beliefs about the need-supportive behaviors ^c									
Effectiveness belief	Intervention	0.40	5.89 ± 0.83 (52)	6.06 ± 0.85 (44)	6.14 ± 0.82 (44)	0.11 (0.04)*	0.04 (0.05)	0.02 (0.06)	[-0.11, 0.14]
	Control	0.77	5.67 ± 0.94 (40)	5.84 ± 1.03 (32)	5.86 ± 0.94 (34)	0.09 (0.05)	0.02 (0.01)		
Easy-to-implement belief	Intervention	0.34	4.83 ± 0.98 (52)	5.11 ± 1.05 (44)	5.17 ± 1.09 (44)	0.18 (0.08)*	0.00 (0.09)	0.05 (0.11)	[-0.17, 0.27]
	Control	0.58	4.85 ± 1.27 (40)	5.05 ± 1.48 (32)	5.09 ± 1.46 (34)	0.13 (0.08)	0.02 (0.03)		
Normative belief	Intervention	0.41	4.31 ± 0.85 (52)	4.52 ± 1.08 (44)	4.55 ± 1.11 (44)	0.12 (0.09)	0.02 (0.08)	-0.04 (0.14)	[-0.32, 0.24]
	Control	0.44	4.44 ± 1.27 (40)	4.47 ± 1.18 (32)	4.72 ± 1.30 (34)	0.16 (0.12)	0.07 (0.10)		
Need-supportive styles ^c									
Autonomy support	Intervention	0.26	5.30 ± 1.16 (52)	5.49 ± 1.06 (44)	5.78 ± 0.89 (44)	0.25 (0.09)**	0.01 (0.13)	0.14 (0.10)	[-0.06, 0.34]
	Control	0.68	5.23 ± 0.94 (40)	5.45 ± 0.94 (32)	5.44 ± 0.88 (34)	0.11 (0.04)**	0.06 (0.04)		
Competence support	Intervention	0.37	6.16 ± 0.68 (52)	6.34 ± 0.67 (44)	6.48 ± 0.52 (44)	0.16 (0.05)***	0.01 (0.06)	0.14 (0.05)**	[0.05, 0.24]
	Control	0.78	6.11 ± 0.82 (40)	6.08 ± 0.84 (32)	6.08 ± 0.73 (34)	0.01 (0.03)	0.01 (0.02)		
Relatedness support	Intervention	0.55	6.16 ± 0.69 (52)	6.13 ± 0.67 (44)	6.17 ± 0.65 (44)	-0.03 (0.04)	0.01 (0.04)	-0.08 (0.07)	[-0.20, 0.05]
	Control	0.78	5.90 ± 0.90 (40)	5.91 ± 0.94 (32)	5.92 ± 0.86 (34)	0.05 (0.06)	0.01 (0.01)		

Note. ICC = intraclass correlation coefficients; *SE* = standard error; CI = confidence interval.

^aSlope mean change over time in each condition. ^bSlope mean differences over time between the two conditions. ^c“Type complex” adjustment in the intention-to-treat analysis.

* $p < 0.05$. ** $p < 0.01$. *** $p < 0.001$.

Fidelity Assessment

We also added a fidelity assessment to investigate whether the intervention modules were delivered as intended. After the intervention, each coach educator received a self-report checklist including five questions asking whether each module was delivered as intended. Each question was followed by a free-text response prompting the educators to reflect on their previous yes or no answer. They were also asked to explain if and what deviations were made from the content of the delivery protocol in any of the modules.

Transparency and Openness

This study conforms to the Journal Article Reporting Standards for Quantitative Research in Psychology including the extension for experimental manipulation (Appelbaum et al., 2018). Its protocol, design, and analysis were not preregistered, and the materials, methods, and data used are available upon request from the corresponding author.

Results

Change From Baseline to Follow-Up

The results from the multilevel growth models are presented in Table 2. In the adjusted intention-to-treat analysis, only the intervention group reported a statistically significant increase in the effectiveness and easy-to-implement beliefs of the need-supportive styles. However, no statistically significant differences were found between the two conditions' change trajectories of these outcomes (see Table 2). Regarding the normative beliefs, no statistically significant effects were observed in or between any condition. The unadjusted intention-to-treat and adjusted per-protocol models showed that the intervention group only significantly increased their easy-to-implement beliefs. However, it was not different from the control group's change trajectory (see Supplemental Tables S3 and S4).

Considering the use of need support, only the intervention group reported a statistically significant increase in competence support that significantly differed from the change trajectory in the control group ($\Delta = 0.14$, $SE = 0.05$, $p = .004$).

Moreover, the intervention and control groups exhibited a statistically significant parallel increase in their linear slope means of autonomy support. Thus, despite the plateau in the control group, and the increasing mean values of the intervention group between the second and third timepoints, no statistically significant difference was found between these trajectories concerning the two conditions (see Table 2). Additionally, no condition showed statistically significant changes in relatedness support over time. The findings regarding Hypothesis 2 were equivalent in the unadjusted and adjusted intention-to-treat and adjusted per-protocol analyses. However, the control group showed no statistically significant changes in autonomy support in both the unadjusted intention-to-treat and adjusted per-protocol analyses (see Supplemental Tables S3 and S4),¹ which differed from the findings of the adjusted intention-to-treat analysis.

Intervention Fidelity

Results from the self-report checklist show that the interpersonal CDP was largely delivered as intended (see Supplemental Table S6). Nevertheless, one educator reported that there was too little time to immerse in some parts of the education considering Module 1. No other qualitative comments regarding protocol adherence were given.

Discussion

Situated within a sport governing body's regular coach education, we designed this study to test the effects of an SDT-based intervention on youth ice hockey coaches' self-reported effectiveness, easy-to-implement, and normative beliefs of need-supportive behaviors, and their use of such behaviors over a 3-week training period. While significant group differences were found in competence support, suggesting a discernible effect attributed to the interpersonal CDP, our findings showed no support for Hypothesis 1 and only partial support for Hypothesis 2. Notably, although the intervention group demonstrated increased easy-to-implement and effectiveness beliefs, alongside heightened use of autonomy

¹ To test for potential nonlinearity in the slopes, we used latent basis growth models for each outcome, which showed no statistically significant effects (see Supplemental Table S5).

support, these changes did not significantly differ from those observed in the control group. Surprisingly, the control group also showed a significant increase in their autonomy support use. These results are further unpacked in the following paragraphs.

The Coaches' Changed Beliefs (Hypothesis 1)

One joint understanding to explain the “why” of need support usage among socializing agents is to investigate their beliefs about such interpersonal behaviors (Aelterman et al., 2016; Matosic et al., 2016; Reeve & Cheon, 2016). Even though Hypothesis 1 was not supported, our findings reveal that the intervention group's self-reported effectiveness and easy-to-implement beliefs increased over 3 weeks. This finding corresponds with previous results on PE teachers who also exhibited a change in such beliefs shortly after participation in an SDT-based intervention (Aelterman et al., 2016). Hence, changing individuals' positive beliefs about a theoretical construct can increase their behavioral salience (,). However, during delivery, our intervention group was informed about the benefits of using need support to motivate athletes. In this sense, the intervention group's resulting effectiveness and easy-to-implement beliefs may be contingent on these statements and the proximity of their interpersonal CDP participation (Reeve & Cheon, 2016). In contrast with previous intervention research (Aelterman et al., 2016), we investigated the coaches' self-reported effectiveness and easy-to-implement beliefs regarding need support. This may have shrouded their varying beliefs about each need-supportive style as they represent different behaviors and skills (Lindwall et al., 2019; Matosic et al., 2016). For example, Aelterman et al. (2016) found that their intervention increased the PE teachers' feasibility and effectiveness beliefs regarding autonomy, but not competence support. Thus, a richer understanding can be attained by assessing the beliefs of each need-supportive style separately. Practically, ordinating an intervention group more time to exercise need support may facilitate such personal beliefs (Lemelin et al., 2023) and thus study findings that are more apt to the coaches' real-world experiences (Matosic et al., 2016; Ntoumanis et al., 2017).

Like previous intervention research (Reeve & Cheon, 2016), our intervention group did not

increase their self-reported normative beliefs of need support. Coaches' perceptions of the conventional ways to lead and communicate in their sport setting relate to individual and collective beliefs (M. Carroll & Allen, 2021; Matosic et al., 2016). Facilitating a joint understanding in the coaching staff of how to apply the education content in practice can favor positive beliefs and collective use (Nonaka, 1994). We acknowledged this by allowing the coaches in the intervention group to remain in their preexisting club clusters. However, our findings concerning normative beliefs suggest that need-supportive coaching may not be perceived as conventional within coaches' club settings (Reeve & Cheon, 2016). Coaches may instead view other behaviors, such as verbal abuse and punitive measures like benching players, as more normative for motivating their athletes, which has deep historical roots in ice hockey (LoGuercio, 2022). Thus, changing predominant descriptive norms that influence coaches' attitudes and behaviors may pose significant challenges (Reeve & Cheon, 2016). Future research should investigate coaches' normative beliefs regarding each need-supportive (and thwarting) coaching style to determine which is perceived as most conventional (M. Carroll & Allen, 2021).

The Coaches' Changed Need Support (Hypothesis 2)

Like previous interventions with PE teachers (Aelterman et al., 2016) and youth sport coaches (Langan et al., 2015; Reynders et al., 2019), our findings indicate that the intervention group increased their self-reported use of competence support to motivate their athletes. Facilitating these interpersonal behaviors through coach intervention can satisfy the athletes' need for competence (Pulido et al., 2017), thereby potentially improving their performance—an outcome often regarded as a benchmark of success in competitive sports (Fransen et al., 2018). The need for competence is also highlighted as a stronger antecedent of youths' self-determined motivation compared with autonomy and relatedness (Ntoumanis, 2001). However, in contrast with previous SDT-based interventions (Reynders et al., 2019), we found no statistically significant differences in the coaches' self-reported autonomy support use. This may be attributed to

the observed increase in both our conditions. Nonetheless, our findings indicate that while the control group stagnated after the second time-point, the intervention group increased their autonomy support use throughout all measurements (see Table 2). These findings align with previous research indicating that SDT-based interventions can facilitate coaches' use of autonomy support (Langan et al., 2015; Reynders et al., 2019). Such results hold relevance for athletes' perception of their coaches as autonomy supportive, as well as their behavioral engagement and autonomous motivation (Lemelin et al., 2023; Reynders et al., 2019), and can mitigate the risk of burnout (Langan et al., 2015).

Importantly, a coach who provides clear instructions and optimal challenges for skill mastery (competence support), without giving a rationale for the task and acknowledging the athletes' perspectives (autonomy support), omits the synergetic effect this combination has on athletes' autonomous motivation and behavioral persistence (cf. Jang et al., 2010). Our intervention addressed this by guiding coaches to role play communication of competence support within an autonomy-supportive framework (e.g., offering choices between alternatives). Additionally, the intervention group selected competence- and autonomy-supportive behaviors from a provided sample to apply while coaching a group of youth ice hockey players during on-ice sessions. As highlighted by previous SDT-based research (Langan et al., 2015; Mahoney et al., 2016), this delivery strategy acknowledged the coaches' self-governance when choosing which need-supportive behaviors to implement. Such behavioral skills training is also proven to facilitate target behaviors more effectively than merely providing general knowledge of the construct (Albarracín et al., 2024). Based on our study results, these sessions enhanced the intervention group's practical skills in delivering clear instructions and positive feedback to athletes in a competence-supportive manner. In this sense, competence support may have been perceived as the most effective for training and best aligned with the coaching strategies previously utilized by the intervention group (Ntoumanis et al., 2017; Reynders et al., 2019). Our findings underscore the benefits of exposing coaches to tasks that closely mirror their real-world practices. However, it is important to note that training sessions conducted only once,

without subsequent booster sessions, may not sufficiently cater to the implementation of trained behaviors over time (Stenling & Tafvelin, 2016). In contrast, Reynders et al. (2019) enabled their intervention group to apply the learned autonomy- and competence-supportive behaviors between several sessions, followed by reflective tasks of the experiences in the next workshop. This delivery strategy, contrasting with ours, could have influenced their intervention group to understand and adopt the need-supportive styles more extensively (Reynders et al., 2019).

Furthermore, our intervention group did not increase their self-reported relatedness support. Notably, it remained relatively stable in both conditions. This aligns with the findings of Langdon et al. (2015), who did not observe significant increases in the intervention group's use of relatedness support. In contrast, Langan et al. (2015) observed that their intervention group significantly increased their relatedness support use compared with the control group. Even though these results are based on a few coaches, they signal the relevance of SDT-based interventions to provide coaches with training on relatedness support. Previous research also shows that relatedness support can facilitate competence support, suggesting a synergy between the two (Haerens et al., 2013). Unfortunately, this combination of need-supportive styles was not assessed in our nor previous SDT-based coach interventions (Langan et al., 2015; Langdon et al., 2015; Lemelin et al., 2023; Pulido et al., 2017; Reynders et al., 2019), posing a research gap. Future SDT-based coach interventions could incorporate tasks designed to prompt coaches' responsiveness to athletes' reactions when delivering optimal challenges with clear objectives (cf. Lemelin et al., 2023) and rigorously evaluate their application of these behaviors.

Limitations and Future Research

Despite its contribution to the SDT-based coach intervention literature, our study is accompanied by limitations that require consideration. All our data were based on subjective self-reports from the participating coaches. Therefore, it cannot be assured that the study results are free from biases, such as common method bias (e.g., social desirability; Podsakoff et al., 2003). As the self-reported use of need support may diverge from an interpersonal approach that is meaningful to the

recipient (Ntoumanis et al., 2017), behavioral observations could be employed in future research to more adequately ascertain whether an intervention sufficiently facilitates such positive coach communication (Langan et al., 2015; Langdon et al., 2015). Moreover, team sport athlete self-reports can inform whether they perceive their coaches as supportive or thwarting toward the whole team or only a few athletes.

Moreover, our coaches' awareness of their group allocation before the intervention may have increased the risk of detection bias. However, potential spillover effects between coaches from the same club could be monitored via the cluster randomization procedure. Another central limitation of the findings is that our study was conducted over 3 weeks between the baseline and last follow-up measurement. The need-supportive styles are not merely occasional behaviors but interpersonal skills that require nourishment to improve (K. Smith et al., 2023). Thus, longer intervention delivery and time between measurements (with follow-up workshops to "boost" knowledge acquisition and the usage of learnings) may have provided greater increases in the intervention group (e.g., Reynders et al., 2019). Yet, this was not feasible in this study because the control group needed to attend the same education to formally coach in their clubs during the season. Future research should examine the long-term effects of sport governing bodies' education programs on coaches' sustained behavior change.

Our fidelity measure revealed that one educator could not fully deliver the intervention protocol according to the plan (Module 1), referring to time restraints. Importantly, this limitation may influence the dose of an intervention (C. Carroll et al., 2007). Moreover, our employed educators received the same training, resources, and guidelines to ensure a need-supportive instructing approach and uniform delivery in each region. Nonetheless, educators may vary in their used pedagogy and previous experiences of delivering coach education which, in turn, can relate to their trained coaches' understanding and use of the learnings (Wang et al., 2023). Hence, investigating the quality of delivery by observing the educators' interactions with the coaches would have been beneficial (C. Carroll et al., 2007). Furthermore, assessments (e.g., interviews) of an intervention group's responsiveness to the delivery content and the perceived interactions with the educators (e.g., Aelterman et al., 2016) can supplement the

quantitative findings. Future research can consider these aspects of delivery to highlight potential moderators that relate to the intervention outcomes (C. Carroll et al., 2007).

Practical Implications

Encouraging coaches to reflect on the interpersonal behaviors they aim to adopt in coaching practice appears effective in promoting need-supportive behaviors (cf. Josefsson et al., 2020; Meeûs et al., 2010). This factoring of intrinsic motivation based on conscious choices for change can benefit behavioral persistence (Fishbach & Woolley, 2022). Furthermore, future SDT-based coach interventions could integrate on-field tactical and skills-based sessions with guidance on how to provide a rationale for the practices (autonomy support), convey clear instructions concerning their execution and purpose (competence support), and be responsive to athletes' reactions and behaviors (relatedness support). This may facilitate coaches' perceived relevance and use of the need-supportive styles in their real-world practice (Ryan & Deci, 2017; Wang et al., 2023). Additionally, future interpersonal CDPs can consider using self-monitoring or peer-monitoring forms for ongoing feedback during the intervention.

Conclusion

This study provides insights into the impact of an SDT-based educational intervention on the personal beliefs and application of need-supportive styles among youth ice hockey coaches. It also highlights the effect of a mandatory interpersonal CDP on coaches' self-reported behavior change, contributing to the literature. The findings confirm our hypothesis that the intervention group showed a significant increase in the use of competence support compared with the control group. These results underscore the relevance of collaborative efforts between researchers and sport governing bodies to integrate SDT-based strategies into regular coach education programs.

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