

The Early Start Denver Model



Hannah Waddington, Lauren van Noorden, and Jessica Tupou

The Early Start Denver Model (ESDM) is an early intervention approach for children with, or suspected of having, autism spectrum disorder (ASD) between the ages of 12 and 60 months (Rogers & Dawson, 2010). The ESDM is implemented by trained therapists, parents, and educators throughout a child’s day in the context of play and daily routines. It is one of the most well-researched early intervention approaches for young children with ASD (Rogers & Dawson, 2010; Waddington et al., 2016) and the list of certified ESDM therapists includes individuals from more than 30 countries (University of California, Davis, MIND Institute, 2019).

The ESDM is classified as a naturalistic developmental behavioral intervention (NDBI; Schreibman et al., 2015). NDBIs are a comparatively new intervention approach, which incorporate behavioral and developmental techniques and are generally delivered in the child’s day-to-day environment. Recent meta-analyses have found that NDBIs are amongst the most promising approaches for young children with ASD, and can result in improvements in social communication, language, play skills, social engagement, and cognition (Tiede & Walton, 2019; Sandbank et al., 2020). Unlike many other NDBIs, the ESDM is comprehensive, meaning that it targets the “core deficits” of ASD including difficulties with language, cognition, play, and social skills (Odom et al., 2010). Indeed, the ESDM supports all areas of a child’s development.

H. Waddington (✉) · L. van Noorden · J. Tupou
Victoria University of Wellington, Wellington, New Zealand
e-mail: hannah.waddington@vau.ac.nz

Theoretical Basis of ESDM

The ESDM is based upon several previous intervention models and theoretical conceptions of the difficulties experienced by individuals with ASD (Rogers & Dawson, 2010). These include: (a) the Denver model, (b) Pivotal Response Treatment, (c) Rogers and Pennington's Model of Interpersonal Development, and (d) the Social Motivation Hypothesis.

The Denver Model

The ESDM incorporates many features of the original Denver model (also called the Playschool model), which was developed in the 1980s for young children with ASD and other types of developmental disabilities (Rogers et al., 1986). Features of this model include the use of positive adult affect (e.g. smiling and laughing with the child) and fun “sensory social routines” (e.g., peekaboo, chase, and hide and seek) to target a wide range of developmental skills. Skills are targeted during play routines as the developers believe that “play is the primary vehicle for communicative, cognitive, and social/emotional development” in all children (Rogers et al., 1986, p. 136). Other features of the Denver model include altering the classroom structure and routines to optimize the child's ability to attend to the therapist and to transition easily between activities.

Pivotal Response Treatment (PRT)

The ESDM also includes many aspects of PRT, a naturalistic behavioral intervention for children with ASD (Koegel & Egel, 1979). The developers of PRT propose that targeting “pivotal skills” including initiations, self-management, response to multiple cues, and empathy will lead to generalized gains in other areas, such as social skills, communication and a reduction of problem behavior (Koegel et al., 2016). PRT is based on the theory of learned helplessness. Children with ASD are hypothesized to experience more “failures” with social communication and interaction than their peers without ASD, which may cause them to be less motivated to interact socially in future (Koegel et al., 2016). Therefore, PRT and the ESDM incorporate procedures to increase child motivation such as a child choice, task variation, and using direct and natural reinforcers (Rogers & Dawson, 2010).

Rogers and Pennington’s Model of Interpersonal Development

Rogers and Pennington (1991) hypothesized that many of the difficulties experienced by individuals with ASD are due to early impairments in imitation. These impairments are thought to disrupt the bodily synchrony and emotional coordination between the infant and the caregiver and affect the “infant’s awareness and use of intentional communication” (Rogers & Dawson, 2010, p. 16). Thus, the ESDM places emphasis on relationship building and sensitive and responsive adult-child interactions. Imitation and social communication are also key intervention targets.

The Social Motivation Hypothesis

This hypothesis suggests the reward pathways in the brains of children with ASD are not sufficiently activated during social interaction (Dawson et al., 2012). These differences in brain wiring are thought to cause individuals with ASD to be less motivated by social interaction than their peers without ASD. Thus, the ESDM includes strategies to explicitly promote the sharing of positive affect and to increase the child’s desire to engage socially with a play partner (Rogers & Dawson, 2010). This includes adult use of positive affect and modelling of positive social interaction.

Core Features of the ESDM

There are several features which are inherent to the ESDM, regardless of delivery format. These include: (a) teaching through joint activity routines, (b) adherence to the ESDM fidelity scale, (c) use of the ESDM curriculum checklist, and (d) progress monitoring.

Joint Activity Routines

In ESDM, teaching takes place during “joint activity routines” (JARs) which are cooperative, often play-based, activities in which two (or more) partners work together to achieve the same goal (Rogers & Dawson, 2010). Each JAR has four parts:

1. The set-up, in which the first play act is established.
2. The theme, in which the child and adult jointly participate in a play act.
3. Elaboration, in which variations are added to the play.
4. The closing, in which the activity ends and the child transitions to another activity.

If a child has chosen crayons and paper, for example, the set-up phase might involve placing the paper on the table, selecting crayons, and the adult waiting to see what the child does. The theme could include the adult and child taking turns drawing large circles on the paper, and elaborations might be drawing with different materials such as colored pencils, and drawing lines, dots, or scribbles. The adult or child initiate the closing when the child is no longer interested, the play has become repetitive, or the adult cannot think of any new elaborations. Sensory social routines are a specific type of JAR in which the adult and child focus on each other rather than objects. This could include activities such as tickles, chasing games, songs, and peekaboo. Objects which the adult controls, such as bubbles and balloons, can be used to facilitate sensory social routines.

Teaching Fidelity Rating System

The ESDM teaching fidelity rating system (referred to herein as the ESDM fidelity scale) is a 13-item scale used to measure the accuracy of an individual's implementation of ESDM techniques (Rogers & Dawson, 2010). Each technique is rated on a 5-point Likert-type scale, where a score of 1 represents a "poor or unacceptable" use of the specified technique and a score of 5 represents "the best possible example" of the technique. An individual is deemed to have "achieved fidelity" when they score 80% or higher on the measure and have scores of 4 or 5 on all 13 items.

Table 1 includes a brief description of high-quality implementation of each of these 13 techniques. As ESDM is an NDBI, the techniques used in this model have been drawn from a variety of different theoretical underpinnings. For example, items B and C (behavioral teaching and instructional techniques) are foundational techniques from applied behavior analysis (Condillac & Baker, 2017), while items H and I (positive affect and sensitivity and responsivity) are fundamental aspects of relationship-focused interventions (Schreibman et al., 2015).

Curriculum Checklist

The ESDM curriculum checklist is used to set developmentally appropriate treatment targets (Rogers & Dawson, 2010). It includes the following domains: receptive and expressive communication, joint attention, imitation, social skills, play skills, motor skills, behavior, and daily living skills. Of these domains, communication, imitation, social skills, and play skills, are viewed as the most important (Talbot et al., 2016). The curriculum checklist has four levels, which correspond to skills which typically develop between 12 and 18 months (Level 1), 18 and 24 months (Level 2), 24 and 36 months (Level 3), and 36 and 48 months (Level 4). For example, the first skill at Level 1 in the receptive communication domain is "*localizes to sounds by turning toward sound source*" and we would expect most

Table 1 Brief descriptions of high-quality implementation of the ESDM fidelity items (Rogers & Dawson, 2010)

Item	Description
A. Management of attention	The child attends to the adult and the materials through the activity. The adult and child are positioned well in relation to each other, there are few distractions, and the pacing and timing of the activity is appropriate.
B. Behavioral teaching	Learning opportunities occur every 10–20 s, the structure of these opportunities is evident (clear antecedents and reinforcement), and the number of repetitions is appropriate.
C. Instructional techniques	The adult appropriately uses instructional techniques including shaping, fading, prompting, and chaining, to occasion and teach new behaviors.
D. Modulation of affect and arousal	The adult ensures that the child is optimally able to participate in learning through appropriate choices of activity and modulating his/her own tone of voice and activity level in relation to the child.
E. Management of unwanted behavior	The adult skillfully manages challenging behavior by understanding the function and eliciting a more appropriate behavior.
F. Dyadic engagement	The adult and child share control of the activity. Turn taking occurs throughout the activity, and the child shows engagement through gaze, communication, and smiles.
G. Optimizing motivation	The adult ensures that the child is motivated for the activity by providing choices, interspersing new learning and mastered skills, managing reinforcers, and ending the activity at the appropriate time.
H. Positive affect	The adult shows genuine positive affect throughout the activity.
I. Sensitivity and responsivity	The adult is attuned to the child and responds appropriately to all communicative and affective cues.
J. Multiple and varied communication	The adult creates opportunities for multiple types of child communication, including requesting, protesting, asking for help, naming, greeting, and finishing.
K. Appropriate language	The adult’s language is appropriate for the child’s language level. The adult generally uses slightly more language than the child.
L. Joint activity structure	The activity includes a clear set-up, theme, elaboration, and closing phase.
M. Transitions	The adult closes an activity at the appropriate time and the child chooses the next activity.

children under the age of 12 months to be able to do this. The final skill at Level 4 in the receptive domain is “*follows three-part unrelated instructions*”, which is a skill we would expect to see in a 48-month old child.

The curriculum checklist is administered prior to the start of treatment. Depending on the delivery approach, a therapist may implement the checklist directly with the child or may support a teacher or a parent to do so. The curriculum checklist is administered naturalistically within JARs. The individual implementing the assessment engages the child in a motivating activity and notes any skills that the child consistently shows with a P(pass)/+ on the checklist. If the assessor probes for a skill several times, and the child does not show that behavior, the assessor will mark an F(fail)/– on the checklist. Any skills which a child shows inconsistently are marked as P/F or +/-.

Setting Objectives

The results of the curriculum checklist are used to select treatment targets. Therapists consult with parents and/or teachers to select two or three goals per domain which the child could be reasonably expected to master within 12 weeks. These goals are collaboratively selected from the skills which the child showed inconsistently during the curriculum checklist, or the first few skills which the child did not show at all. The goals are then formulated into clear learning objectives which include (a) a statement of the antecedent stimulus, or cue for the target skills; (b) an observable, measurable description of the behavior; (c) the criteria for mastery of the skill, and (d) the criteria for generalization of the skill. For example, if a child's goal was "looks to partner when name is called", then her learning objective could be as follows (Rogers & Dawson, 2010, p. 77):

1. Antecedent stimulus—"When [child] is not looking and an adult calls his/her name from across the room..."
2. Observable, measurable description—"...[child] will orient towards the adult and make eye contact..."
3. Mastery criterion—"... three times in a 20-minute period..."
4. Generalization criterion—"... at home and in the clinic."

Progress Monitoring

To monitor child progress, each goal is separated into a series of progressively more difficult learning steps. The easiest learning step represents the child's level of skill prior to teaching the goal, while the final learning step indicates mastery and generalization of the target skill. The following example applies to the same goal of "looking to partner when name is called."

1. [Child] will turn to adult when name is called from 1 m away with a partial physical prompt. *Note: the child should already be able to do this.*
2. [Child] will independently turn to adult when name is called from 1 m away.
3. [Child] will independently turn to adult when name is called from the other side of the room.
4. [Child] will independently turn and make eye contact with the adult when name is called from the other side of the room.
5. [Child] will independently turn and make eye contact with the adult when name is called from the other side of the room at home and in the clinic. *Note: this includes generalization criteria.*

Therapists and teachers take data about children's progress on their learning steps for each goal approximately every 15 min. Once a child has consistently demonstrated the ability to perform the skill at a certain learning step, the next step is targeted. Parents are not expected to take such a rigorous approach to data

collection, however, they are encouraged to take data on child behaviors and learning in a more manageable and appropriate way, such as using ABC charts to identify the functions of difficult child behaviors.

There is no “one size fits all” approach to early intervention for children with ASD. Sometimes children do not make progress towards their goals during standard implementation of ESDM. If a child has not made measurable progress within 3–5 days for an intensive program (20+ h per week), or 1–2 weeks during a lower intensity program then aspects of the teaching may need to be altered (Rogers & Dawson, 2010). In such cases, the therapist consults the ESDM decision tree (Rogers & Dawson, 2010, p. 131). The decision tree allows therapists to manipulate three key intervention variables in order to promote child learning. These are increasing the reinforcement, increasing the structure and number of learning opportunities, and incorporating the use of visual supports.

Review of the Literature

There have been at least three reviews evaluating the effectiveness of the ESDM (Baril & Humphreys, 2017; Ryberg, 2015; Waddington et al., 2016). These reviews have generally concluded that ESDM is a promising intervention approach for young children with ASD, but that more research is needed to determine its effectiveness, particularly when implemented at a lower intensity and within the community. There do not appear to be any published reviews which have evaluated ESDM since 2016. Thus, this narrative review will focus on the more recent ESDM research and the evidence for ESDM when delivered: (a) 1:1 by trained/certified ESDM therapists, (b) 1:1 by trained parents, and (c) in a group setting by educators or trained/certified therapists. We will also discuss the difference between these three delivery methods.

Therapist-Implemented 1:1 Intervention

The ESDM is often delivered by a multidisciplinary team, which can include special educators, psychologists, speech language therapists, occupational therapists, and behavior analysts (Rogers & Dawson, 2010). Regardless of background, therapists follow a consistent process to become certified in the ESDM, which is administered through the UC Davis MIND Institute (n.d.). In order to enter this training, one must be experienced in working with young children with ASD and hold a degree in a relevant professional area. The training process involves an online introductory course, a 3-day advanced workshop, and submission of training materials for certification. In order to become certified, therapists must demonstrate that they can implement the ESDM techniques with 80% or greater fidelity in two 30-min videos

with different young children with ASD. Most professionals increase their use of ESDM techniques during the therapist training process (Vismara et al., 2013b).

ESDM therapy sessions often last between 1 and 2 h (Rogers & Dawson, 2010). The session will generally begin with some kind of greeting activity, such as a “hello song” with actions. The child will then choose the first activity. If this is a JAR with objects, often the child will next be offered a choice between two sensory social activities. The session continues in this fashion, with the therapist and child jointly engaging in play with and without toys. There will often be a snack break, which provides the child with an opportunity to request favorite foods, share with the adult, and practice daily living skills. The session ends with a “goodbye song” or a similar activity, to signal to the child that the play has finished.

ESDM therapy has traditionally been implemented intensively, that is, for 15 or more hours per week over an extended period of time (Dawson et al., 2010; Rogers et al., 2019a). Some researchers have found that early intervention for children with ASD is more effective when it is implemented for many hours per week (Klintwall et al., 2015). However, families in many countries are unable to access or afford this level of intervention, due to a lack of government funding and/or limited availability of suitably trained professionals (Kasilingam et al., 2019). In such cases, ESDM may be implemented at a lower intensity. To date, at least two studies have evaluated relatively intensive implementation of ESDM (15+ h per week for 2 years; Dawson et al., 2010; Rogers et al., 2019a), at least one has evaluated moderately intensive ESDM (12 h per week for 1 year; Geoffray et al., 2019) and eight have evaluated low-intensity ESDM (≤ 8 h per week for 8 weeks to 15 months; Colombi et al., 2018; Contaldo et al., 2019; Devescovi et al., 2016; Holzinger et al., 2019; Lin et al., 2020; Tupou et al., 2020; Waddington et al., 2019a; Xu et al., 2018). The research related to intensive/moderate ESDM therapy, and low-intensity ESDM therapy will be discussed separately.

Intensive/Moderate 1:1 ESDM Therapy

Table 2 provides details of the participants, intervention characteristics, and design for all ESDM studies published since 2010. Of the three studies evaluating intensive/moderate 1:1 ESDM therapy, two appear to have taken place primarily in the home (Dawson et al., 2010; Rogers et al., 2019a), while a third took place in a community clinic (Geoffray et al., 2019). The Dawson et al. (2010) and Rogers et al. (2019a) studies both also included a parent-implemented ESDM component (see pp. 12–16 for more details of parent implemented ESDM). In total, 98 children between the ages of 14 and 50 months with a clinical diagnosis of ASD participated in these studies. The Geoffray et al. (2019) study had a one group pre-posttest design, while Dawson et al. (2010) and Rogers et al. (2019a) studies were both RCTs.

Table 3 summarizes child and parent outcomes following these interventions. The three moderate/intensive ESDM studies had conflicting results for almost all outcomes. For most outcomes including adaptive behavior, socialization, and cognition, at least one study reported positive results, and a least one study reported no

Table 2 Participant, intervention, and design characteristics of ESDM studies published since 2010

Study	N TX, CT	Dx	Age-months	Setting	Implementer	Delivery	Prof. hours/week	Duration	Design
1. Dawson et al. (2010) ^a	24, 24	ASD	18–30	Home	Clinician; parent	1:1	15	2 years	RCT
2. Rogers et al. (2012a) ^a	49, 49	Susp.	14–24	Research lab	Parent	1:1	1	12 weeks	RCT
3. Vismara et al. (2012)	9, N/A	ASD	16–36	Distance	Parent	1:1	1	12 weeks	Multiple baseline participants
4. Eapen et al. (2013)	26, N/A	ASD	36–58	Preschool	Therapist	Group + 1:1	16–21	10 months	One group pre-post
5. Vismara et al. (2013a, b)	8, N/A	ASD	18–45	Distance	Parent	1:1	1.5	12 weeks	Multiple baseline participants
6. Fulton et al. (2014)	38	ASD	38–63	Preschool	Therapist	Group + 1:1	16–21	~12 months	One group pre-post
7. Vivanti et al. (2014) ^a	27, 30	ASD	<60	Preschool	Educator	Group	15–25	12 months	Multiple group comparison
8. Colombi et al. (2016)	22, 70	ASD	18–48	Comm. clinic	Clinician	1:1	~6	6 months	Multiple group comparison
9. Devescovi et al. (2016)	21, N/A	Susp.	20–36	Comm. clinic	Clinician	1:1	3	~15 months	One group pre-post
10. Vismara et al. (2016)	14, 10	ASD	18–48	Distance	Parent	1:1	1.5	12 weeks	RCT
11. Vivanti et al. (2018)	44, N/A	ASD	15–32	Preschool	Educator	Group	15+	~10 months	RCT—inclusive vs. autism-specific
12. Xu et al. (2018)	16, 20	ASD	24–60	Not Specified	Clinician	1:1	5	8 weeks	RCT
13. Zhou et al. (2018)	23, 20	ASD	18–30	Not Specified	Parent	1:1	1.5	26 weeks	Multiple group comparison

(continued)

Table 2 (continued)

Study	N TX, CT	Dx	Age- months	Setting	Implementer	Delivery	Prof. hours/ week	Duration	Design
14. Contaldo et al. (2019)	32, N/A	ASD	18–39	Not Specified	Clinician	Group + 1:1	~4	1 year	One group pre-post
15. Geoffray et al. (2019)	19, N/A	ASD	18–50	Home; clinic; preschool	Clinician	1:1	12	10 months	One group pre-post
16. Holzinger et al. (2019)	7, 6	ASD	34–54	Home; clinic; preschool	Clinician	1:1	~4.6	12 months	Multiple group comparison
17. Rogers et al. (2019a)	55, 63	ASD	14–29	Home; Clinic	Clinician; parent	1:1	Coach = 1 Therapy ~ 15	27 months	Multisite RCT
18. Rogers et al. (2019b)	45, N/A	Susp/ ASD	12–30	Clinic; home	Parent	1:1	1.5–3	12 weeks	RCT—basic vs. enhanced coaching
19. Waddington et al. (2019b)	5, N/A	Susp/ ASD	23–59	Home	Parent	1:1	1	12	Multiple probe participants
20. Waddington et al. (2019a)	4, N/A	ASD	27–51	Home	Clinician	1:1	3	12 weeks	Multiple probe participants
21. Lin et al. (2020)	16, N/A	ASD	25–46	Comm. clinic	Clinician	1:1	~8	6 months	One group pre-post
22. Tupou et al. (2020)	3, N/A	ASD	52–57	Preschool	Clinician	1:1	3	8–10 weeks	Multiple probe participants

ASD clinical diagnosis of ASD; *Susp.* suspected of having ASD, no official diagnosis; *TX* treatment; *CT* control; *Comm* Community; *RCT* randomized controlled trial

^a Indicates that follow-up studies or further analyses were conducted with this sample

Table 3 Child and parent outcomes following ESDM intervention

Note: Positive—significantly better than comparison at follow-up (RCT; multiple group comparison); significant improvements pre to post (one group pre- post-test; RCTs without a control group); clear improvements from baseline to intervention for all participants (multiple baseline/multiple probe). Mixed—significantly better improvements than the control group on some measures/aspects of this outcome and not others; significant pre-post improvements on some measures/as of this outcome and not others; clear improvements from baseline to intervention for some participants but not for others (Multiple baseline/probe). No Effect—no significant differences between intervention and comparison; no significant change from pre- to post-test; no clear change from baseline to intervention for any participants. Negative—significantly worse than comparison at follow-up, significant deterioration from pre- to post-test, significant deterioration from baseline to intervention

^aIn this study the intervention group received P-ESDM++ and the comparison group received P-ESDM

Study	ASD severity	Adaptive behavior	Socialization	Engagement/ Joint attention	Language	Cognition	Motor skills	Imitation	Parent fidelity	Other
1. Dawson et al. (2010)	Mixed	Positive	No effect	N/A	Positive	Positive	Mixed	N/A	N/A	
2. Rogers et al. (2012a, b)	No effect	No effect	No effect	No effect	No effect	No effect	N/A	No effect	No effect	Working alliance with therapist-positive
3. Vismara et al. (2012)	N/A	No effect	N/A	Positive	Positive	N/A	N/A	N/A	Positive	
4. Eapen et al. (2013)	Positive	No effect	No effect	N/A	Mixed	Positive	Mixed	N/A	N/A	
5. Vismara et al. (2013a)	N/A	N/A	N/A	Mixed	Mixed	N/A	N/A	N/A	Mixed	
6. Fulton et al. (2014)	No effect	No effect	No effect	N/A	Mixed	Positive	No effect	N/A	N/A	Maladaptive Behavior- Mixed
7. Vivanti et al. (2014)	No effect	No effect	No effect	N/A	Mixed	Positive	No effect	N/A	N/A	
8. Colombi et al. (2016)	N/A	Mixed	Mixed	N/A	N/A	Positive	N/A	N/A	N/A	
9. Devescovi et al. (2016)	No effect	N/A	N/A	N/A	Positive	Mixed	N/A	N/A	N/A	
10. Vismara et al. (2016)	N/A	N/A	N/A	No effect	No effect	N/A	N/A	No effect	Mixed	
11. Vivanti et al. (2018)	Mixed	Positive	Positive	N/A	Positive	Mixed	N/A	Positive	N/A	Parent stress-Positive
12. Xu et al. (2018)	Positive	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	
13. Zhou et al. (2018)	Mixed	N/A	N/A	N/A	Positive	N/A	Positive	N/A	N/A	Parent stress-inconclusive
14. Contaldo et al. (2019)	Positive	Positive	Positive	N/A	Positive	Positive	Positive	N/A	N/A	Play- Positive
15. Geoffray et al. (2019)	N/A	No effect	Positive	N/A	Mixed	Positive	No effect	N/A	N/A	
16. Holzinger et al. (2019)	Positive	No effect	Positive	N/A	Mixed	No effect	No effect	N/A	N/A	
17. Rogers et al. (2019a)	No effect	No effect	N/A	N/A	Mixed	No effect	N/A	N/A	N/A	
18. Rogers et al. (2019b)	No effect	No effect	N/A	N/A	No effect	No effect	N/A	N/A	Mixed	
19. Waddington et al. (2019b)	N/A	N/A	N/A	Mixed	Mixed	N/A	N/A	Mixed	Mixed	
20. Waddington et al. (2019a)	N/A	N/A	N/A	Positive	Positive	N/A	N/A	Positive	N/A	
21. Lin et al. (2020)	Mixed	N/A	N/A	N/A	Positive	Positive	No effect	N/A	N/A	
22. Tupou et al. (2020)	N/A	N/A	N/A	Positive	Mixed	N/A	N/A	Mixed	N/A	

treatment effect. The findings for language were positive (Dawson et al., 2010) or mixed (Rogers et al., 2019a; Geoffray et al., 2019), while the findings for motor skills and ASD severity were either mixed, or showed no effect of treatment. In the original (Dawson et al., 2010) study of “intensive” ESDM (there was an improvement of 1SD in terms of IQ points after 2 years). This improvement represents average early learning composite score of 78.6 or just above “mild ID”. For the most recent (Rogers et al., 2019a, b) “intensive” ESDM study there were no significant differences between the ESDM and control groups in terms of developmental quotient. One of the main differences between these studies and the early studies of traditional EIBI is that the control group receive a lot more and higher quality services.

The one study evaluating moderate intensity ESDM (Geoffray et al., 2019) had a weak design. Thus, limited conclusions can be drawn about the effectiveness of this delivery approach. While the designs of the Dawson et al. (2010) and Rogers et al. (2019a) studies were strong, these interventions appear to have been delivered or coordinated by university-based researchers, which means that little is known about the effectiveness of intensive ESDM when implemented by community practitioners. Further, Dawson and Rogers developed the ESDM, so this research should be replicated by independent investigators. Finally, the results of the original intensive ESDM research were more positive (Dawson et al., 2010) than the replication in 2019 (Rogers et al., 2019a). The authors suggest that this may be because the children in the control group in the 2019 study were receiving higher quality and more intensive intervention than those in the original research (Rogers et al., 2019a). This highlights the importance of selecting appropriate, comparable control groups.

Low-Intensity 1:1 ESDM Therapy

Low-intensity ESDM appears to have been evaluated in more countries than any other ESDM delivery approach. These countries include Austria (Holzinger et al., 2019), China (Xu et al., 2018), Italy (Contaldo et al., 2019; Devescovi et al., 2016), New Zealand (Tupou et al., 2020; Waddington et al., 2019a), and Taiwan (Lin et al., 2020). In contrast, intensive ESDM has only been evaluated in the United States (Dawson et al., 2010; Rogers et al., 2019a). One-hundred-and-twenty-one children with, or suspected of having, ASD between the ages of 18 and 60 months have participated in these low-intensity studies (see Table 2). This research has mostly taken place in community clinics, although a couple of studies have been at least partially delivered in the home (Holzinger et al., 2019; Waddington et al., 2019a) and/or in a preschool (Holzinger et al., 2019; Tupou et al., 2020). Tupou et al. (2020) delivered the intervention for the fewest hours per week and over the shortest period, while Devescovi et al. (2016) delivered the intervention for the most hours per week and the longest period. Contaldo et al. (2019) were the only researchers to evaluate

group ESDM in addition to 1:1 low-intensity therapy (see pp. 16–20 for more details of group ESDM).

Again, the studies evaluating low-intensity ESDM have generally found conflicting results (see Table 3). Most studies found positive results for socialization, engagement/joint attention, cognition, language, and reduction in ASD symptom severity following treatment. Conversely, most studies found mixed results or no effect for adaptive behavior and motor skills, while there was an even split of positive and mixed results for imitation. The one study which evaluated play reported positive results (Contaldo et al., 2019).

The low-intensity ESDM research has been conducted by researchers who did not develop the ESDM and has generally been implemented in community settings. However, many of these studies had small sample sizes, which means that their results are not necessarily generalizable to other individuals with ASD (Holzinger et al., 2019; Tupou et al., 2020; Waddington et al., 2019a). Further, several studies did not include a control group, so it is unclear whether the child improvements during intervention were greater than would be expected if they had not received treatment (Contaldo et al., 2019; Devescovi et al., 2016; Lin et al., 2020). Finally, a couple of studies did not measure therapist fidelity (Contaldo et al., 2019; Devescovi et al., 2016). Indeed, Devescovi et al. (2016) explicitly stated that the therapists only reached fidelity (80% or above correct implementation) after the study was completed. Thus, any child improvements in this study cannot be necessarily be attributed to correct therapist use of the ESDM techniques.

Parent-Implemented Intervention

Involving parents in their child's early intervention is considered best practice by the literature (National Research Council, 2001; Wallace & Rogers, 2010). The importance of this parental involvement is emphasized in all ESDM delivery approaches, however the parent-implemented ESDM (P-ESDM) positions the parents as the primary interventionist (Rogers & Dawson, 2010). Parents are natural intervention agents for their children, as they are able to embed teaching and learning opportunities in every-day routines and play (Nevill et al., 2018; Oono et al., 2013). Typically developing young children spend around 70 h per week engaged in everyday activities with their caregivers (Vismara & Rogers, 2018). Thus, supporting parents to implement interventions at home with their children with ASD may make intensive intervention (15+ h per week) feasible (Tomeny et al., 2019). Parent-implemented therapy may also help to promote generalization of skills from clinic to everyday environments and create more learning opportunities across the day compared to a clinic only intervention approach (Rogers et al., 2012a).

Parent Coaching Procedures

Many of the initial P-ESDM studies used a training approach that emphasized the transfer of knowledge from the therapist to the parent (e.g. Rogers et al., 2012b; Vismara et al., 2012, 2013a). This training approach aligns with an “expert model” approach to teaching (Brookman-Fraze, 2004). In this approach, the therapists used strategies such as direct instruction, suggestions and feedback, modelling, and self-instructional materials to help parents to reach fidelity in the use of the ESDM strategies. In comparison, most recent P-ESDM studies now use a coaching approach (Hanft et al., 2004). This involves an equal and reciprocal relationship between the coach and the parent, rather than viewing the trainer as an expert (Vismara & Rogers, 2018). Key principles of this coaching approach include “collaboration, active listening, self-reflection, and contextual and non-judgmental feedback” (Vismara et al., 2016, p. 5). Rogers et al. (2019b) also included motivational interviewing strategies and multi-modal teaching in an “enhanced” P-ESDM++ delivery approach.

Most P-ESDM programs last for 12-weeks with one weekly session of 1–1.5 h (Rogers & Vismara, 2015). The content of the P-ESDM is drawn from the ESDM parent manual (Rogers et al., 2012a), and the coaching process is outlined in the ESDM parent coaching manual (Rogers & Vismara, 2015). P-ESDM generally begins with an initial meeting to set the expectation of a collaborative partnership and to discuss parent goals for their child, followed by an ESDM curriculum assessment (see p. 5). Typically, fewer goals are written for parent implemented ESDM than therapist implemented ESDM, around 12–14 objectives, and these are written in parent friendly language.

After these initial meetings and goal setting meetings, the P-ESDM coaching sessions begin. Each session contains:

- A greeting and check-in, including a quick update on the previous week.
- A chance for the parent to practice and reflect on the skill from the previous week.
- A discussion of the topic for the week—selected by the parent.
- One or two opportunities for the parent to practice and reflect on the focus technique.
- A closing, in which the parent selects goals for the week.

The P-ESDM Coaching Fidelity Rating Tool is a 14-item scale used to measure the accuracy of the therapist’s implementation of the coaching techniques (Rogers & Vismara, 2015). Each item is rated on a 4-point Likert-type scale, where a score of 1 represents “absent or poor example of the specified practice”, and a score of 4 represents “a competent example of this teaching technique” Schreiber et al., (2015). Fidelity of implementation is achieved when a therapist achieves a mean total score of 80% across several consecutive activities, with no individual item scores under 2. The first six items on the P-ESDM fidelity scale relate to the structure of the session (as outlined above). The final eight items relate to the coaching

characteristics, including a collaborative approach, reflective practices, non-judgmental approach (using descriptive rather than evaluative language), conversational and reciprocal interactions, ethical conduct, organized and well-managed session, managing parental implementation and motivation, and collecting data.

Studies Evaluating P-ESDM

At least seven studies evaluating the P-ESDM have been published since 2010. These studies included 152 children with or ‘at risk for’ ASD in treatment conditions, aged between 12 and 59 months. The two studies by Rogers et al. (2012b) and Rogers et al. (2019b) were conducted in a university research clinic, although the latter also included home visits for one of their treatment conditions. Waddington et al.’s (2019b) research was conducted solely in the children’s homes, and the studies by Vismara et al. (2013a) and Vismara et al. (2012, 2016) delivered the P-ESDM via telehealth to families living in communities with minimal ASD intervention services available. Each of these studies was low-intensity, with 1–3 h per week of parent coaching. Each study used a 12-week parent coaching design, except Zhou et al. (2018) who ran a 26-week program on the basis that 12-weeks may not be long enough to see significant changes in children’s scores on standardized measures. Three studies were RCTs (Rogers et al., 2012b, 2019b; Vismara et al., 2016), one used a multiple group comparison design (Zhou et al., 2018), and all other studies used a single case multiple baseline design (Vismara et al., 2012, 2013a; Waddington et al., 2019b).

Table 3 indicates that the impact of P-ESDM on parent use of the ESDM techniques is predominately mixed as some, but not all, parents reach acceptable levels of fidelity of implementation (Vismara et al., 2013a, 2016; Rogers et al., 2019b; Waddington et al., 2019b). Rogers et al. (2012b) also found that parents in the P-ESDM condition did not improve in their techniques more than parents in a community comparison condition. One study did not report on parent use of the techniques (Zhou et al., 2018), and one study found positive effects of the P-ESDM on parent use of the ESDM strategies, with all parents reaching fidelity within 6 weeks (Vismara et al., 2012). Two studies have also reported positive impacts of the P-ESDM on parental stress levels (Rogers et al., 2012b; Zhou et al., 2018). Rogers et al. (2019b) compared a more traditional P-ESDM approach with an enhanced “P-ESDM++” approach. They found that both groups of parents made improvements in their ESDM fidelity, but parents in the P-ESDM++ condition made significantly more progress. Due to the confounding of all three enhancements however, it is impossible to know which variable or which combination contributed to parent improvement.

Regarding child outcomes, as outlined in Table 3, Vismara et al. (2012) and Zhou et al. (2018) found positive outcomes across all child development measures used. In contrast, Vismara et al. (2016) and Rogers et al. (2012b) found no significant

impact of the P-ESDM on any child outcome measures. All other P-ESDM studies have had mixed results, with increases in only some areas of development, and/or for only some children (Rogers et al., 2019b; Vismara et al., 2013a, b; Waddington et al., 2019b). In Rogers et al. (2019b) there were no group differences in child development over time but higher individual parent fidelity scores were associated with greater child improvements on the PATH CC (a proximal measure adapted from the ESDM curriculum checklist). However, maturation effects for the children cannot be ruled out without a true control condition. The use of a proximal measure to assess child progress is a useful addition to the literature, as it appears to be more sensitive to child change than standardized measures such as the ADOS and Mullen.

Group-Based Intervention (G-ESDM)

There are several potential benefits associated with group-based delivery of the ESDM. First, it is likely to be more efficient than 1:1 delivery as intervention can be delivered to multiple children at the same time (Eapen et al., 2013). The group environment may also provide learning opportunities that are not present in a 1:1 setting, such as participating in group routines (Vivanti et al., 2017) and learning tacit social rules (Capes et al., 2019). Further, the presence of other children may provide opportunities for children to practice newly learned skills and behaviors with their peers (Koegel et al., 2001; Vivanti et al., 2017). Learning and practicing new skills in a group setting may also help to prepare children for the school environment where learning is typically group-based (Leaf et al., 2018). Also, parents may not be required to be physically present during group-based intervention so this may help to ease the time burden that families often face when accessing early intervention for their child (Capes et al., 2019; Vivanti et al., 2017).

The provision for group delivery of the ESDM can be traced back to the program's foundations in the Denver Model (Rogers et al., 1986). The ESDM manual (Rogers & Dawson, 2010) encourages group delivery with an entire chapter focused on group-based ESDM, and multiple curriculum checklist items related to the child's interaction with peers and participation in group activities/routines. Additionally, a specific manual for group delivery of the ESDM (G-ESDM; Vivanti et al., 2017) was published in 2017 by researchers from La Trobe University in Melbourne, Australia. The G-ESDM manual is designed to be used alongside the original ESDM manual and provides detailed information on: (a) targeting child learning goals within small and large group activities, (b) organizing classroom layout, (c) managing daily schedules and routines, (d) staff roles and responsibilities, and (e) encouraging and managing peer interactions. It also includes additional fidelity measures specific to delivery in a group setting.

The G-ESDM utilizes the same principles and strategies as traditional ESDM but there are key differences. First, with G-ESDM children typically have 16 learning

objectives per 12-week cycle, compared to the 18–27 objectives used in traditional ESDM therapy. G-ESDM objectives may also include skills or behaviors that are not drawn from the curriculum checklist but are considered important in the group environment. For example, a child may need to learn to find and then approach an adult to ask for help. Finally, teaching opportunities may be delivered less frequently in G-ESDM (Vivanti et al., 2017).

Structure

The G-ESDM can be implemented in any group environment, including both ASD-specific and inclusive settings, with a recommended maximum adult-child ratio of 1:4 (Vivanti et al., 2017). Teaching is delivered via a mixture of 1:1, small group and large group activities within naturalistic classrooms where children have free access to a wide range of toys and activities. However, the classroom environment and daily schedule are carefully arranged to allow for individual children's interests and learning needs. For example, for a child who is interested in dinosaurs, teachers may add dinosaur stamps to the drawing table, to encourage the child into that activity and create an opportunity to target fine motor skills. Activities are also planned so that multiple learning objectives can be targeted for different children involved in the activity (Vivanti et al., 2017). For example, in a small group book activity, a teacher may target imitation of facial expressions for one child, taking turns with a peer for a second child, and pointing to share for another. The layout of the G-ESDM classroom is also carefully planned so that unnecessary distractions are minimized and children can easily transition between areas. Activity centers are set up throughout the classroom with materials arranged so that children can clearly see the purpose of each space. For example, books and comfortable cushions may be arranged in a book corner to show children that the area is for reading books. Staff roles and responsibilities are also clearly defined and managed throughout the day so that in any given activity, the child knows which adult he/she should be attending to.

Studies Evaluating G-ESDM

The four group-based ESDM studies that have been published since 2010 are displayed in Table 3. Three studies directly evaluated the ESDM (Eapen et al., 2013; Fulton et al., 2014; Vivanti et al., 2014), while the fourth (Vivanti et al., 2018) compared outcomes of children with ASD who received ESDM in an inclusive preschool with those who received ESDM in a specialist ASD preschool. Across the four studies, which were all set in Australian preschools, 135 children with a clinical diagnosis of ASD, aged 15–63 months, received 15–25 h per week of group-based ESDM therapy. Participants from two studies (Eapen et al., 2013; Fulton et al.,

2014) received an additional hour of 1:1 ESDM therapy per week, and parents from two studies (Eapen et al., 2013; Vivanti et al., 2014) were offered regular information sessions on the ESDM strategies. Two studies (Eapen et al., 2013; Fulton et al., 2014) used a one group pre-post design, one (Vivanti et al., 2014) used a multiple group comparison design and the remaining study (Vivanti et al., 2018) used an RCT where participants were randomized to either a specialized or an inclusive preschool setting.

Child outcomes from these studies are summarized in Table 3. Overall, results were mixed as none of the four studies reported positive results for all child outcomes measured. Similarly, there were conflicting results for child outcomes across the four studies. Most studies reported no effect or mixed results for ASD severity, adaptive behavior, socialization, language, and motor skills, while results for cognition were primarily positive. Fulton et al. (2014) was the only study to measure maladaptive behavior and reported mixed results. Findings from three of the studies (Eapen et al., 2013; Fulton et al., 2014; Vivanti et al., 2018) should be interpreted with caution due to the absence of a control group that did not receive any ESDM intervention.

The study by Vivanti et al. (2018) includes several novel aspects that merit further discussion. Firstly, it was the only G-ESDM study to compare ASD-specific and inclusive delivery settings. No significant differences between settings were reported and the study's authors concluded that G-ESDM can be feasibly and effectively delivered in an inclusive preschool setting. This finding is significant given that children with ASD should be provided with ongoing opportunities for interaction with typically developing peers (United Nations, 2006) and the increasing commentary on inclusive education in the literature (Barton & Smith, 2015; Pellicano et al., 2018). The use of proximal child outcome measures in the Vivanti et al. (2018) study was also novel. Proximal measures were used for language, socialization and imitation with positive results reported for all three outcomes.

Moderators of Treatment Outcome

Several studies have examined the relations between certain child characteristics and treatment outcomes. The five most common characteristics were child age, cognition (also called developmental quotient), imitation skills, autism symptom severity, and language ability. Rogers et al. (2012b) and Vivanti & Dissanayake (2016) found that younger children showed greater increases in cognition during ESDM treatment than older children. However, Vivanti & Dissanayake (2016) also found that changes in non-verbal cognition, adaptive behavior, and autism symptom severity following treatment did not differ according to age. Vivanti et al. (2013) and Contaldo et al. (2019) found that chronological age did not predict treatment outcomes. Vivanti et al. (2013) found that cognition was not a

significant predictor of intervention outcomes. In contrast, Rogers et al. (2019a) found that cognition did not predict language outcomes but that, above the midpoint, higher cognition predicted greater decreases in autism symptom severity and Contaldo et al. (2019) found that cognition was positively associated with improvements in some domains of the ESDM curriculum checklist and not others. Vivanti et al. (2013) found that imitation skills predicted gains in fine motor skills, while Rogers et al. (2012b) and Contaldo et al. (2019) found no relation between imitation and treatment outcomes. Rogers et al. (2019a) did not find a relation between child language abilities or autism symptom severity and treatment outcomes, while found that communicative gestures, receptive language, and autism symptom severity were positively associated with improvements in some domains of the ESDM curriculum checklist. As a whole, these findings suggest that no conclusions can be drawn about which child characteristics are associated with positive or negative responses to ESDM treatment.

Few studies have examined the relations between parent characteristics and treatment outcomes. Estes et al. (2014) found that the number of parent-reported negative life events predicted increased parenting stress and decreased sense of competence in both the P-ESDM group and control group. Rogers et al. (2019a) found that parent education was not related to language or autism symptom severity following treatment.

There are also a limited number of studies which have investigated treatment characteristics such as intensity, duration, and fidelity as moderators of treatment outcomes. Rogers et al. (2012b) found that higher number of hours of intervention predicted improvements in autism symptom severity, cognition, and language across the ESDM and control groups, while Vivanti et al. (2013) found that intensity of treatment did not predict treatment outcomes. Rogers et al. (2012b) and Vismara et al. (2019) found that there was a significant association between parent ESDM fidelity and child improvements on the ESDM fidelity checklist, while Rogers et al. (2012b) did not find a significant association between the change in parent ESDM fidelity scores and any child outcome following treatment.

Future Directions

Although there is now a considerable body of research evaluating the ESDM, there are many areas for further research. Given the low quality of many of the studies' designs and the predominantly small sample sizes, most findings need to be replicated. Many of the studies have been published by the developers of the model (Geraldine Dawson, Sally Rogers, and Laurie Vismara), thus, independent replications are of the utmost importance. The results of the P-ESDM research appear to be more mixed than for the other delivery approaches, which suggests that more research is needed specifically in this area. This could include studies investigating

the effectiveness of longer parent coaching programs, as all studies except for Zhou et al. (2018) only involved 12 weeks of intervention. Researchers should also evaluate the effect of tailored parent coaching programs, which would involve the provision of additional support to parents who do not respond well to the initial coaching. Further, more research is needed to determine the characteristics of parents who may or may not respond well to P-ESDM. This could include parent education, stress levels, and sense of competence. In the wider ASD literature, peers and siblings are increasingly trained to deliver intervention to young children with ASD. It is not currently clear whether peers or siblings can be effectively taught to deliver ESDM, as only one pilot study has been conducted to date (van Noorden et al., 2020). Researchers should also compare the effects of different ESDM delivery methods, such as a comparison between P-ESDM and low-intensity ESDM, or intensive one-on-one ESDM and G-ESDM. As well as examining the effect on child outcomes, researchers could also examine parental perceptions or preferences for each delivery approach. This will allow practitioners to determine the best approach to intervention delivery, particularly in contexts where resources are limited.

More research is also needed to determine the effectiveness of ESDM with diverse populations. This includes children with diagnoses other than ASD, or children with significant comorbid diagnoses in addition to ASD, such as ADHD. To date, it appears that one study has evaluated the effects of ESDM for children without ASD. Vismara et al. (2019) found mixed results for a coaching programme for parents of children with fragile X syndrome, indicating a need for more research. There is also a need to evaluate the effects and acceptability of ESDM when adapted to suit different cultures. The only such study appears to have been conducted by Lin et al. (2020) within the Taiwanese public health system. Finally, given the increasing possibility of very early identification of individuals suspected of having ASD, researchers should evaluate the effects of an adapted version of ESDM for children under 12 months of age. Again, it appears that only one small study has done this, and the intervention was termed “Infant Start” (Rogers et al., 2014).

Researchers should further examine the “active components” of ESDM intervention, as correct implementation of some fidelity items may be more strongly associated with positive child outcomes. Indeed, in a pilot study involving four parent-child dyads, Waddington et al. (2020) found that parent use of some, but not all, of the ESDM techniques was positively associated with child engagement and/or expressive language. Further, ESDM is an NDBI, which by definition includes techniques with multiple different theoretical underpinnings. More research is needed to determine whether, for example, the use of developmental ESDM techniques is related to different child outcomes than the use of behavioral ESDM techniques.

Conclusion

At least 22 original studies (excluding follow-ups and further analyses) have examined the effects of the ESDM, making it one of the most widely evaluated early interventions approaches for children with ASD. This research has involved implementation of ESDM by therapists, parents and educators to individuals or groups of children in clinics, homes and preschools, across at least seven countries. This suggests that the ESDM is a relatively flexible approach which can be tailored to suit a variety of different contexts and cultures. At this stage the P-ESDM research has had more mixed results compared to ESDM implemented by therapists and other professionals, including educators. However, very few studies have reported positive results across all outcomes measures or all children. The research on moderators of treatment effectiveness is also very inconsistent. Taken as a whole, this research suggests that the ESDM may be beneficial in improving some outcomes for some children with ASD, but more research is needed to determine the best approach to delivery and the characteristics of children who may be best suited to this intervention.

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