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# Child Development in Parent-Child Interactions\*

Avner Seror<sup>†</sup>

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## Abstract

I present a model of child development that highlights the effect of parent-child interactions on the formation of skills. Through the parent's affection, the child learns and builds mental representations of the self as loved and competent. These mental representations shape the child's noncognitive skills and foster learning. I show that this model provides a unifying explanation for well-established evidence on child development. The model also sheds light on how early exposure to media devices can negatively impact skill acquisition. I discuss implications for the design of policies to reduce inequalities in child development.

**Keywords:** Child Development, Identity, Interaction, Parenting, Learning, Intergenerational transmission, Media.

**JEL codes:** D10, D91, Z10.

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“We are, all of us, molded and remolded by those who have loved us, and though that love may pass, we remain none the less their work.”

François Mauriac, *The Desert of Love*, 1949.

# 1 Introduction

Understanding how children develop is a fundamental challenge for academic research in many disciplines, from medicine to economics. Pioneered by [Cunha and Heckman \(2007\)](#), the economic approach to child development focuses on skills and the technology of skill formation to address major empirical regularities. Through estimations of the technology of skill formation, economists have demonstrated that gaps in child development reflect large differences in parents’ investment in their children.<sup>1</sup> They also showed that parents profoundly affect children’s personality and other skills not captured by cognitive abilities.<sup>2</sup> Focused on the technology of skill formation, however, the economic approach to child development says little about the interactions through which parents shape children’s multiple skills.

In this paper, My approach is rooted in developmental psychology. It is based on the idea, first introduced by [Bowlby \(1969, 1973, 1980\)](#), that through care, sensitivity, and positive feedback, a parent enables her child to build mental representations of himself as loved and competent. These mental representations shape the child’s noncognitive skills by increasing his motivation to learn and explore his surroundings. Hence, the parent’s interactions with the child create a fundamental complementarity in the formation of cognitive and noncognitive skills. As the child learns from the parent, he forms cognitive skills while acquiring noncognitive skills that increase his motivation to further learn.

The basic model is as follows. There are two agents, the parent (she hereafter) and the child (he hereafter). In each period, the child must choose an action. Only the parent knows the optimal action. For example, the child must act prosocially (e.g. share his toy), learn to walk, avoid danger, or adopt healthy eating habits. In the first period, the parent interacts with the child. She communicates with him by sending him a signal on the optimal action. She also rewards him if he behaves sufficiently well. There is some noise in the communication process so, in order to understand the parent’s signal and be rewarded, the child accumulates cognitive skills. The child also builds noncognitive skills through the rewards received from

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<sup>1</sup>[Cunha et al. \(2006\)](#), [Cunha and Heckman \(2008\)](#), and [Del Boca, Flinn and Wiswall \(2013\)](#). [Heckman and Mosso \(2014\)](#) provide a comprehensive review of the related literature.

<sup>2</sup>Comprehensive surveys are presented in [Borghans et al. \(2008\)](#), [Almlund et al. \(2011\)](#), and [Heckman, Jagelka and Kautz \(2019\)](#).

the parent, seeing himself as competent and loved for what he does. These noncognitive skills increase the child’s motivation to choose an action close to the optimum (e.g. his motivation to share one of his toys). In the second period, the child does not interact with the parent. He receives a signal on the optimal action directly from his surroundings, and chooses a learning effort and his action.

To illustrate the reasoning behind the model, consider the following example. A baby starts cooing. The parent approaches him and initiates an interaction. She watches the baby, smiles, and imitates his cooing. As a result, the baby works hard to coo again. If he succeeds, he may be rewarded with even more smiles, cuddles, and other types of positive feedback. Through the parent’s reactions, the child learns to see himself as loved and competent, able to emit specific sounds. Holding this self-view is a noncognitive skill that fosters further learning. The baby becomes increasingly good at deciphering the parent’s message of guidance. Eventually, he learns that “mum-mum-mum” triggers more caring effort than other sounds. Words begin to acquire meaning through the parent-child interactions. In a short time, the child is able to say a few words, typically mama.<sup>3</sup>

This model explains the evidence from a vast literature while generating new insights. First, the model provides a single unifying explanation for well-known properties of the production function of skills. It is well established that (a) skills are self-productive, (b) noncognitive skills foster cognitive skills, and (c) there is a dynamic complementarity between early and later investments.<sup>4</sup> All these properties can be explained by the mechanism of the model. By interacting with the parent, the child forms cognitive skills. He also builds mental representations of himself as competent and loved. These mental representations increase his noncognitive skills by making him more eager to learn. Properties (a) and (b) directly follow. Relative to (c), the more noncognitive skills the child acquires by interacting with the parent, the more he values the parent’s reward and the more he wants to learn from the parent. As early investments from the parent increase the child’s noncognitive skills, later investments become more productive.<sup>5</sup>

Beyond the previous properties of the production function of skills, I show that a child who increases his noncognitive skills by interacting with his parent is better equipped to learn from his surroundings. This prediction echoes the celebrated first experiments of [Ainsworth et al. \(1978\)](#) that enabled psychologists to classify different types of parent-child

<sup>3</sup>This example is inspired by [Brazelton \(1992, p. 65 - 80\)](#).

<sup>4</sup>These observations have been supported by the following studies. (a): [Cunha and Heckman \(2008\)](#) and [Cunha, Heckman and Schennach \(2010\)](#), (b): [Cunha and Heckman \(2007, 2008\)](#), [Borghans et al. \(2008\)](#), [Cunha and Heckman \(2009\)](#), [Cunha, Heckman and Schennach \(2010\)](#); [Almlund et al. \(2011\)](#), (c): [Cunha et al. \(2006\)](#), [Heckman and Kautz \(2014\)](#).

<sup>5</sup>This last result is demonstrated in an extension of the model to cases where the child interacts several times with the parent.

relationships, depending on children’s observed behavior. [Ainsworth et al. \(1978\)](#) argued that a child’s exploration of his surroundings while his parent is absent reflects a secure attachment to the parent, which is built through the parent’s care, sensitivity and positive feedback. Conversely, limited exploration reflects a parent-child relationship where the child is insecurely attached to the parent.

The model also accounts for evidence on the effect of parental characteristics on child development.<sup>6</sup> I find that a parent with “better” characteristics provides more caring effort. Her child therefore accumulates more noncognitive skills and becomes more motivated to learn from his surroundings. “Better” parental characteristics in this model include higher income, higher time preferences, a higher degree of altruism, or greater ability to interact with the child.

I then extend the basic model in order to study the effect of early exposure to the media devices that are ubiquitous in most economies. There is a growing consensus that early media exposure is negatively associated with a variety of child outcomes.<sup>7</sup> This negative association is not straightforward, since media devices (e.g. smartphones and tablets) stimulate children and can often foster substantial learning through game apps or educational content. Additionally, children growing up in more disadvantaged families appear to be particularly exposed to media.<sup>8</sup>

The model provides an intuitive explanation for these phenomena. First, I find that parents expose their child to media devices as a substitute for their own caring effort. The more a child is exposed to media devices, the less effort he puts into learning from the parent. Thus, he is less able to see himself as competent and loved, he acquires less noncognitive skills, and he becomes less motivated to further learn from his surroundings. Second, according to the model, a parent’s caring effort is less likely to be replaced by early exposure to media devices when the parent has “better” characteristics, which implies that child media exposure can amplify child development inequalities.

The paper contributes to several strands of literature. First, it contributes to the literature on child development by introducing a workable model rooted in developmental psychology.<sup>9</sup> Relying on the work of [Bowlby \(1969, 1973, 1980\)](#), I argue that the acquisition of noncognitive skills can be interpreted as resulting from the formation of self-representations

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<sup>6</sup>See for example [Hair et al. \(2015\)](#); [Cunha and Heckman \(2007\)](#); [Akee et al. \(2010\)](#); [Bernal and Keane \(2011\)](#); [Agostinelli and Wiswall \(2016\)](#); [Rubio-Codina, Attanasio and Grantham-Mcgregor \(2016\)](#); [de Neubourg et al. \(2018\)](#).

<sup>7</sup>[Tomopoulos et al. \(2007\)](#), [Duch et al. \(2013\)](#), [Hill et al. \(2016\)](#).

<sup>8</sup>[Rideout and Hamel \(2006\)](#), [Kabali et al. \(2015\)](#), [Kılıç et al. \(2019\)](#).

<sup>9</sup>e.g. [Cunha et al. \(2006\)](#); [Cunha and Heckman \(2007, 2008\)](#); [Borghans et al. \(2008\)](#); [Almlund et al. \(2011\)](#); [Cunha, Heckman and Schennach \(2010\)](#); [Heckman and Kautz \(2012\)](#); [Heckman, Pinto and Savelyev \(2013\)](#); [Heckman and Mosso \(2014\)](#); [Alan and Ertac \(2018\)](#); [Attanasio et al. \(2020\)](#); [Kosse et al. \(2020\)](#).

in parent-child interactions. This theoretical approach to child development explains many empirical regularities as well as the growing evidence of media devices’ impact on child development that cannot be accounted for with existing models. [Almlund et al. \(2011\)](#) also conceptualize noncognitive or personality skills within an economic model. Following [Roberts \(2006, 2009\)](#), the authors model personality skills as endowments that affect behaviors. I complement [Almlund et al. \(2011\)](#) by studying the formation of noncognitive skills in parent-child interactions.

Second, the paper fits into the emerging literature on the economics of parenting ([Weinberg \(2001\)](#), [Akabayashi \(2006\)](#), [Del Boca, Flinn and Wiswall \(2013\)](#), [Doepke and Zilibotti \(2017\)](#), [Kim et al. \(2018\)](#), [Doepke, Sorrenti and Zilibotti \(2019\)](#) and [Cobb-Clark, Salamanca and Zhu \(2019\)](#)). On the theoretical side, [Doepke and Zilibotti \(2017\)](#) study parenting styles, [Lizzeri and Siniscalchi \(2008\)](#) sheltering, and [Weinberg \(2001\)](#) child maltreatment. My paper most closely relates to [Akabayashi \(2006\)](#), who also explores how parent-child interactions affect human development. However, the author focuses on information frictions and child maltreatment, whereas I consider a model where the parent is fully informed, but disentangle the interactions’ effects on the child’s cognitive and noncognitive skills.

This paper also contributes to the growing literature on identity ([Akerlof and Kranton \(2000, 2010\)](#), [Bisin and Verdier \(2001\)](#), [Bénabou and Tirole \(2002, 2003, 2004, 2011\)](#), [Bénabou \(2015\)](#), [Doepke and Zilibotti \(2017\)](#), [Kranton \(2016\)](#), [Akerlof \(2017\)](#)). My main contribution to this literature is to establish a conceptual framework where children form their identity by interacting with their parents. My approach is closely linked to a key idea already formalized in the economic literature by [Bénabou and Tirole \(2011\)](#): that an individual’s own behavior affects his cognitive representations of himself. While this mechanism may explain a fundamental aspect of adult decision-making, I argue here that it is the parent’s reaction to a child’s behavior that the child uses to build cognitive representations of himself.

The rest of the paper is organized as follows. The basic model is described in [Section 2](#). [Section 3](#) examines the joint effect of the parent and media devices on child development. [Section 4](#) extends the basic model in several directions, while the implications of the model are discussed in [Section 5](#). [Section 6](#) concludes. Mathematical proofs are relegated to the online Appendix.

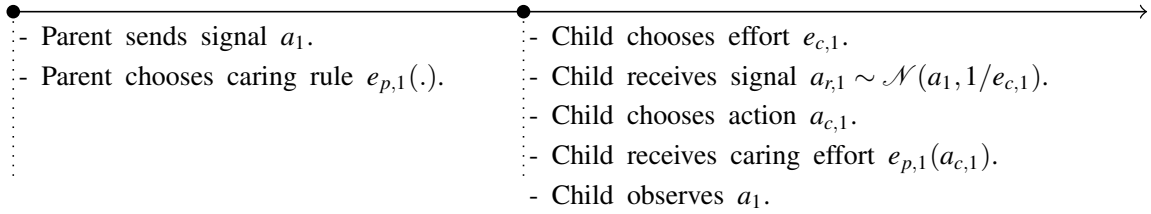
## 2 Basic model

**Agents.** The basic model features two agents, the parent (“she” hereafter) and the child (“he” hereafter).

There are two periods,  $t \in \{1, 2\}$ . In both periods, the child interacts with his surroundings and must perform an action  $a_{c,t}$  on the real line. The correct way to perform the action in any period  $t$  is denoted  $a_t$ . For example, the child must act prosocially (e.g. share a toy), learn to walk, avoid danger, or adopt a healthy eating habit. In the first period, the parent supervises the interaction of her child, whereas she is inactive in the second period.

**Information.** The child does not know  $a_t$ . He believes that  $a_t$  is drawn from a normal distribution centered on  $a$  with precision  $s_0$  (or variance  $1/s_0$ ) but does not know  $a$ . His prior is that  $a$  is drawn from a normal distribution centered on  $a_0$  with precision  $e_{c,0}$  (or variance  $1/e_{c,0}$ ). Unlike the child, the parent knows  $a_t$ . She also knows the prior of the child.

Figure 1: Period 1 - Supervised Interaction

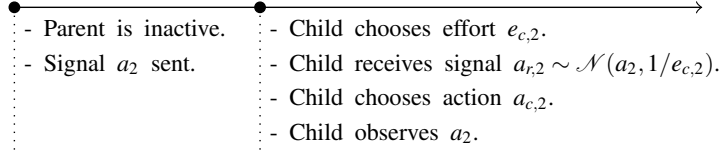


**Supervised Interaction.** The sequence of events during the supervised interaction is represented in Figure 1. The parent communicates to the child, sending him a signal on the optimal action  $a_1$ . She also commits to a caring rule  $e_{p,1}(\cdot)$  that specifies a caring effort  $e_{p,1}(a_{c,1}) \geq 0$  for each possible action of the child  $a_{c,1}$ . The caring effort  $e_{p,1}(a_{c,1})$  creates rewards in the child's utility, described below. The child chooses a learning effort  $e_{c,1}$ . There is some noise in the communication process, and the child receives a signal  $a_{r,1}$  on the parent's message. The signal received by the child depends on the learning effort he exerts and is not observed by the parent. I assume that  $a_{r,1}$  is drawn from a normal distribution centered on  $a_1$  with precision  $e_{c,1}$ . After observing  $a_{r,1}$ , the child updates his beliefs and chooses action  $a_{c,1}$ . He then receives a caring effort  $e_{p,1}(a_{c,1})$  from the parent. At the end of the supervised interaction, the child observes  $a_1$  and updates his beliefs accordingly.<sup>10</sup>

**Unsupervised Interaction.** The sequence of events during the unsupervised interaction is represented in Figure 2. The parent is inactive. The child's environment sends him a signal on  $a_2$ . This signal can be interpreted as a combination of clues and stimuli. The child chooses a learning effort  $e_{c,2}$ . There is some noise, and the child receives a signal  $a_{r,2}$  on the optimal action. The signal  $a_{r,2}$  is drawn from a normal distribution centered on  $a_2$

<sup>10</sup>Arguably, the child could also update his beliefs on the correct action after receiving the caring effort from the parent. However, given that the child also observes the realization of  $a_1$  at the end of the supervised interaction, the caring effort  $e_{p,1}(a_{c,1})$  conveys no additional information. Hence, how the child's beliefs evolve due to the parent's caring effort can be ignored without loss of generality.

Figure 2: Period 2 - Unsupervised Interaction



with precision  $e_{c,2}$ . After observing  $a_{r,2}$ , the child updates his prior and chooses action  $a_{c,2}$ . Finally, the child observes  $a_2$  and the game ends.

**Utility.** In any period  $t \in \{1, 2\}$ , the child's utility function takes the following form:

$$u_{c,t} = -e_{c,t} + M_t \{1 - \mathbb{E}([a_t - a_{c,t}]^2 \mid h_t) + e_{p,t}(a_{c,t})\}, \quad (1)$$

The child is assumed myopic.<sup>11</sup> In each period, he only cares about choosing the correct action. For the sake of obtaining straightforward analytical results, I assume that the utility of the child depends linearly on the quadratic distance between the optimal action  $a_t$  and his action  $a_{c,t}$ . This distance is conditional on the history of the game  $h_t$ , with  $h_1 = \{a_{r,1}\}$  and  $h_2 = \{a_{r,1}, a_{r,2}, a_1\}$ .

Parameter  $e_{c,t} \geq 0$  is the learning effort of the child. When the child exerts a learning effort  $e_{c,t}$ , he pays a linear cost  $e_{c,t}$ . I assume that the learning effort  $e_{c,t}$  is constrained by the child's cognitive capacity  $E > 0$ , so  $e_{c,t} \in [0, E]$ .<sup>12</sup> From (1), the caring effort of the parent  $e_{p,t}(a_{c,t})$  creates rewards for the child. The caring effort conveys to the child that he is behaving well. In period 2, the utility (1) holds with  $e_{p,2}(a_{c,2}) = 0$  for any action  $a_{c,2}$ , as the parent is inactive.

The child has two types of skills in this model. Parameter  $M_t > 0$  represents his noncognitive skills in period  $t$ . Noncognitive skills are private and durable assets that reflect the extent to which the child values choosing a correct action. The child is initially endowed with a stock  $M_1 > 0$  of noncognitive skills, corresponding to his genetic endowment.<sup>13</sup>

The utility (1) is flexible enough to account for different measures of noncognitive skills in the literature. For example,  $M_t$  can be interpreted as the child's self-esteem, the value he places on perceiving himself as able to adopt correct actions. The parameter can also be interpreted as capturing at least two dimensions of the well-accepted "Big Five" taxonomy

<sup>11</sup>Although this assumption is made for simplicity, existing evidence suggests that younger children display more impatience than older children (Andreoni et al. (2019)).

<sup>12</sup>More generally, I could instead have considered a cost function  $c(e_{c,t}, E)$  that depends on the effort of the child and his cognitive capacity. I simplified the problem by assuming that  $c(e_{c,t}, E) = e_{c,t}$  if  $e_{c,t} \leq E$ , and  $c(e_{c,t}, E) = \infty$  otherwise.

<sup>13</sup>Noncognitive skills derive in part from genetic (Johnson, McGue and Krueger (2005)).



of noncognitive skills.<sup>14</sup> First,  $M_t$  can be interpreted as measuring the child’s willingness to comply with rules, norms, and standards learnt in early parent-child interactions. These noncognitive skills belong to the “conscientiousness” factor in the Big Five taxonomy. Second,  $M_t$  can also be interpreted as representing the child’s motivation to behave prosocially: to be kind, friendly, and trust others. These noncognitive skills are also typically learnt in early parent-child interactions and form the “agreeableness” factor in the Big Five taxonomy.<sup>15</sup>

Depending on the nature of the optimal action  $a_t$ , other interpretations of the parameter are possible. When the parent communicates healthy eating habits (e.g. eating vegetables, limiting sugar intake),  $M_t$  measures the value the child places on adopting these habits. Finally, action  $a_t$  can also reflect the parent’s cultural values. My approach can then also account for potential variations in noncognitive skills as a function of the socioecological complexity (Lukaszewski et al. (2017)).

The child has cognitive skills that reflect his understanding of what he needs to do in any period  $t$ . I denote  $s_t$  the child’s cognitive skills in period  $t$ . Formally, I assume that  $s_t$  reflects the precision of the child’s beliefs on the average correct action  $a$ . Parameter  $s_t$  then corresponds to what is usually labeled “intelligence of cognitive abilities” in the literature.<sup>16</sup> From standard results in Bayesian updating (e.g., Cyert and DeGroot (1987)), before choosing his action  $a_{c,t}$  in period  $t \in \{1, 2\}$ , the child believes that  $a$  is drawn from a normal distribution with precision

$$s_1 = e_{c,0} + e_{c,1} \text{ in period 1, and } s_2 = e_{c,0} + e_{c,1} + e_{c,2} + s_0 \text{ in period 2.}$$

The child’s cognitive skills positively depend on the sum of his learning efforts. They also increase by  $s_0$  at the end of period 1 when the child observes  $a_1$  and updates his beliefs accordingly.

The parent displays altruism, and  $\alpha > 0$  denotes the weight of the child’s utility in the parent’s objective. The parent is also forward-looking, and  $\beta > 0$  corresponds to her time preferences. Let  $w$  denote the fixed income of the parent in a given period. For simplicity, I assume that the caring effort of the parent  $e_{p,1}(a_{c,1})$  comes at a unit cost of  $d$  units of income. Interacting more with the child requires more time and focus, so it directly competes with

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<sup>14</sup>Other taxonomies of noncognitive skills used in the literature are closely related to the Big Five (Costa and McCrae (1992), Heckman, Jagelka and Kautz (2019)). For comparisons of the existing taxonomies, see Borghans et al. (2008) and Almlund et al. (2011).

<sup>15</sup>For evidence on the effect of mother-child interactions on prosocial behavior, see Kosse et al. (2020).

<sup>16</sup>Cognitive ability is defined as the “ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought” (Neisser et al. (1996, p. 77), Borghans et al. (2008)).

alternative uses of the parent's income  $w$ . Parameter  $d$  represents the parent's ability to interact with the child.

The parent uses her resources both to interact with her child and for private consumption. Let  $c_t$  denote the private consumption of the parent in period  $t$ . The value function of the parent in period 1 is:

$$u_{p,1} = u(c_1) + \alpha \mathbb{E} v_{c,1} + \beta \{u(w) + \alpha \mathbb{E} v_{c,2}\}. \quad (2)$$

The utility function  $u$  is increasing and concave, with  $u'(0) \rightarrow \infty$ . The function  $v_{c,t}$  is the child's indirect utility in period  $t$ . The parent is uncertain about the actions of her child. Her utility thus depends on the child's expected utility in both periods. The parent faces a budget constraint  $c_1 + de_{p,1}(a_{c,1}) \leq w$ .

To simplify the problem, I assume that the caring rule  $e_{p,1}(\cdot)$  takes the following form:

$$e_{p,1}(a_{c,1}) = \begin{cases} e_{p,1} & \text{if } a_{c,1} \in [a_1 - \epsilon, a_1 + \epsilon] \\ 0 & \text{otherwise.} \end{cases} \quad (3)$$

Parameter  $\epsilon > 0$  corresponds to the parent's permissiveness. A more permissive parent will make a positive caring effort  $e_{p,1} \geq 0$  in response to a wider range of actions. For the parent, choosing caring rule  $e_{p,1}(\cdot)$  therefore amounts to selecting a caring effort  $e_{p,1} \geq 0$  when the child's action is such that  $a_{c,1} \in [a_1 - \epsilon, a_1 + \epsilon]$ .<sup>17</sup>

**Equilibrium.** The equilibrium can now be defined. My solution concept is Subgame Perfect Nash Equilibrium.

**Definition 1** *An equilibrium consists of:*

- (i) *the parent's optimal caring rule  $e_{p,1}^*(\cdot)$  and private consumption  $c_1^*$ .*
- (ii) *the child's optimal action  $a_{c,t}^*$  and effort  $e_t^*$  in any period  $t \in \{1, 2\}$ .*

Accordingly, the equilibrium will be denoted  $\{(a_{c,1}^*, e_{c,1}^*); (a_{c,2}^*, e_{c,2}^*); (e_{p,1}^*(\cdot), c_1^*)\}$  in the remainder of this section. Although the full derivation of the equilibrium is available in the Appendix, it is useful to detail several steps of the resolution. The next paragraphs formulate the child's and the parent's decision problems and partially solve the model by backward induction.

<sup>17</sup>However, the model can still be solved when the parent chooses her caring rule from a broader set of functions. The analysis can be extended to a case where the parent punishes the child when his behavior is far from the optimum. This case is explored in Section 4.3.

**Decision Problem of the Child.** During the unsupervised interaction, the child chooses an effort  $e_{c,2}$  and an action  $a_{c,2}$  that maximize his utility function (1) evaluated at  $t = 2$  subject to the constraint  $e_{c,2} \in [0, E]$ .

Before choosing action  $a_{c,2}$ , the child has observed two signals,  $a_{r,1}$  and  $a_{r,2}$ , and the realization of the correct action in period 1,  $a_1$ . From standard results in Bayesian updating (e.g. Cyert and DeGroot (1987)), he thus believes that  $a$  is drawn from a normal distribution with mean

$$\bar{a}_2 = \frac{1}{s_2}(e_{c,0}a_0 + e_{c,1}a_{r,1} + e_{c,2}a_{r,2} + s_0a_1)$$

and precision  $s_2 = e_{c,0} + e_{c,1} + e_{c,2} + s_0$  (or variance  $1/s_2$ ). The child will then choose action  $\bar{a}_2$  as he believes this action to be the closest to  $a_2$  while his effort  $e_{c,2}$  will solve the following first-order condition:

$$-1 + \frac{M_2}{s_2^2} = 0 \quad (4)$$

when the solution is interior. Although increasing his learning effort in the unsupervised interaction is costly for the child, it ensures he receives a better signal. Hence, by increasing his learning effort, the child can reduce the average distance between his optimal behavior and the correct action, and the value of doing so increases with  $M_2$ , his noncognitive skills.

During the supervised interaction, the child is uncertain as to whether his action deserves a positive caring effort from the parent. He chooses an effort  $e_{c,1}$  and an action  $a_{c,1}$  that maximize his expected utility

$$\mathbb{E} u_{c,1} = -e_{c,1} + M_1\{1 - \mathbb{E}([a_1 - a_{c,1}]^2 \mid a_{r,1}) + e_{p,1}\gamma\} \quad (5)$$

subject to the constraint  $e_{c,1} \in [0, E]$ , where  $\gamma \in [0, 1]$  is the probability of the parent making a positive caring effort. Before choosing action  $a_{c,1}$ , the child has observed signal  $a_{r,1}$  and believes that  $a$  is drawn from a normal distribution with mean

$$\bar{a}_1 = \frac{1}{s_1}(e_{c,0}a_0 + e_{c,1}a_{r,1}) \quad (6)$$

and precision  $s_1 = e_{c,0} + e_{c,1}$ . He then chooses action  $\bar{a}_1$  while his effort  $e_{c,1}$  solves the following first-order condition:

$$-1 + M_1\left\{\frac{1}{s_1^2} + e_{p,1}\frac{\partial \gamma}{\partial e_{c,1}}\right\} = 0, \quad (7)$$

which solution is assumed interior.<sup>18</sup> This condition implies that the child is making a trade-off between the cost of learning and two benefits. First, learning ensures he receives a clearer signal, so it decreases the average distance between his behavior and the correct action. Second, learning increases the probability of the parent making a positive caring effort as  $\frac{\partial \gamma}{\partial e_{c,1}} \geq 0$ .<sup>19</sup>

**Technology of Skill Formation.** The child's noncognitive skills evolve as a function of the supervised interaction. The child's final stock of noncognitive skills can be expressed as follows:

$$M_2 = M_1(1 + ke_{p,1}(a_{c,1})), \quad (8)$$

with  $k \geq 0$  and  $e_{p,1}(a_{c,1})$  the caring effort of the parent. The caring effort of the parent enables the child to accumulate noncognitive skills.

Parameter  $k \geq 0$  reflects the extent to which the parent's caring effort affects the child's noncognitive skills. The rationale behind equation (8) and the existence of parameter  $k \geq 0$  is rooted in developmental psychology. It is based on the idea, first introduced by Bowlby (1969, 1973, 1980), that a parent's care enables her child to create cognitive representations of himself. These representations equip the child with noncognitive skills. A child who receives more affection tends to see himself as valued and competent, and his noncognitive skills increase. Conversely, a child who does not experience much caring effort from the parent is unable to see himself as loved and competent, and does not accumulate noncognitive skills.<sup>20</sup>

To keep the model parsimonious, I do not explicitly formalize the child's cognitive representations of himself built in the supervised interaction. I simply assume through equation

<sup>18</sup>This is true under mild conditions on the parameter values, while the second-order condition is necessarily satisfied. See Appendix A.1.

<sup>19</sup>The parent makes a positive caring effort if  $a_{c,1} \in [a_1 - \epsilon, a_1 + \epsilon]$ , or equivalently if  $a_1 \in [a_{c,1} - \epsilon, a_{c,1} + \epsilon]$ , so

$$\gamma = \int_{-\infty}^{\infty} \left( \int_{a_{c,1}-\epsilon}^{a_{c,1}+\epsilon} \sqrt{\frac{s_0}{2\pi}} e^{-1/2s_0(y-a)^2} dy \right) \sqrt{\frac{s_1}{2\pi}} e^{-1/2s_1(a-\bar{a}_1)^2} da.$$

As demonstrated in Appendix A.1,  $\gamma$  simplifies to

$$\gamma = \int_{a_{c,1}-\epsilon}^{a_{c,1}+\epsilon} \sqrt{\frac{s}{2\pi}} e^{-1/2s(y-\bar{a}_1)^2} dy,$$

which implies that  $\frac{\partial \gamma}{\partial e_{c,1}} = \frac{\epsilon}{\sqrt{2\pi s}} \left( \frac{s_0}{s_0+s_1} \right)^2 e^{-1/2s\epsilon^2} \geq 0$ , with  $s = \frac{s_0 s_1}{s_0 + s_1}$ .

<sup>20</sup>The noncognitive skills acquired in child-parent interactions are referred to as "secure attachment" in the developmental psychology literature. They are typically inferred through experimental settings (Ainsworth (1985)). Sroufe (2005) and Sroufe et al. (2009) provide evidence that secure attachment at 12 months and 18 months is a strong predictor of personality characteristics throughout childhood and adolescence.

(8) that they are affected by the caring effort of the parent  $e_{p,1}(a_{c,1})$  and increase by a factor  $M_1 k e_{p,1}(a_{c,1})$  the child's noncognitive skills.<sup>21</sup>

Since the child chooses his learning effort to maximize his utility, the technology of cognitive skill formation can be derived from the first-order conditions associated with the child's optimization problems. The stocks of cognitive skills of the child in the two periods are

$$s_1(M_1, e_{p,1}), \quad (9)$$

and

$$s_2 = \max(s_1, \sqrt{M_2}), \quad (10)$$

with  $s_1(M_1, e_{p,1})$  implicitly defined by (7). In each period, the stock of cognitive skills depends on the stock of noncognitive skills and  $\frac{\partial s_t}{\partial M_t} \geq 0$ . Higher stocks of noncognitive skills foster more learning, thereby increasing stocks of cognitive skills. The direct effect of  $e_{p,1}$  in (9) captures the impact of the parent's caring effort on skill accumulation.

**Decision Problem of the Parent.** The parent chooses her caring rule  $e_{p,1}(\cdot)$  and her private consumption  $c_1$  to maximize her value function (2) subject to the budget constraint  $c_1 + d e_{p,1}(a_{c,1}) \leq w$  and technologies (8), (9), and (10). The parent understands that her caring rule affects both the child's willingness to learn and his stock of noncognitive skills.

The caring rule of the parent takes the form given in equation (3). Choosing the caring rule therefore amounts to selecting a caring effort  $e_{p,1} \geq 0$  when  $a_{c,1} \in [a_1 - \epsilon, a_1 + \epsilon]$ . I denote  $\bar{v}_{c,2}$  the indirect utility of the child in period 2 when he receives a positive caring effort in period 1 and  $\underline{v}_{c,2}$  his indirect utility in period 2 when he does not. The first-order condition associated with the determination of  $e_{p,1}$  can be written as:

$$-du'(w - d e_{p,1}) + \alpha M_1 \gamma^* + \beta \alpha \left\{ \gamma^* \frac{\partial \bar{v}_{c,2}}{\partial e_{p,1}} + \frac{\partial e_{c,1}^*}{\partial e_{p,1}} \frac{\partial \gamma^*}{\partial e_{c,1}} (\bar{v}_{c,2} - \underline{v}_{c,2}) \right\} \leq 0, \quad (11)$$

which holds with equality when the solution is interior, with  $\gamma^*$  the likelihood of the child receiving a positive caring effort in equilibrium.

In equation (11), the parent trades off the cost of increasing her caring effort in the supervised interaction against the welfare benefits to the child. Since the parent is altruistic, she knows that increasing her effort will increase the current utility of the child because he values her caring effort. Moreover, being forward-looking, the parent realizes that if she makes a higher caring effort, the child will accumulate more noncognitive skills and his

<sup>21</sup>Equation (8) is closely related to how B  nabou and Tirole (2011) conceptualize identity formation. The authors consider a model where an individual's own behavior affects his identity. While this mechanism may explain a fundamental aspect of adult decision-making, I argue through (8) that the child uses his parent's reaction to his action to build cognitive representations of himself.

welfare will increase in the next period. The parent's caring effort has both a direct and an indirect effect on the noncognitive skills of the child. There is a direct effect because the child's noncognitive skills positively depend on the parent's caring effort (see equation (8)). The direct effect is described by the first term in the bracket in equation (11). There is an indirect effect because when the parent increases her caring effort  $e_{p,1}$ , the child increases his learning effort. As a result, he is more likely to be rewarded with a positive caring effort. The indirect effect is described by the second term in the bracket in equation (11). I summarize the characterization of the equilibrium in the following proposition.

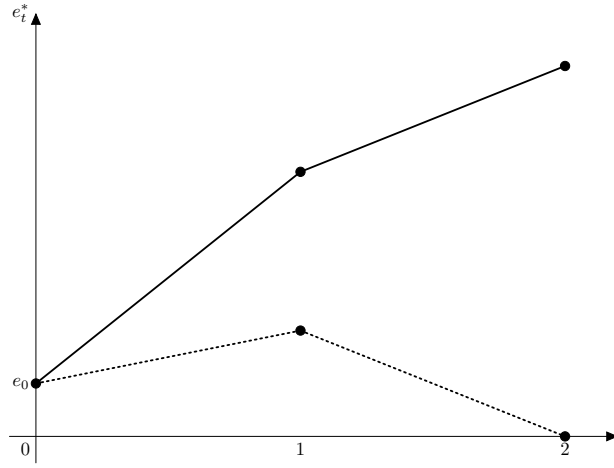
**Proposition 1** *Under regularity conditions on  $u(\cdot)$ , there exists a unique equilibrium such that:*

- *In the supervised interaction, the child's action is  $a_{c,1}^* = \frac{a_0 e_{c,0} + a_{r,1} e_{c,1}^*}{e_{c,0} + e_{c,1}^*}$  and his effort  $e_{c,1}^*$  is the unique solution of (7).*
- *In the unsupervised interaction, the child's action is  $a_{c,2}^* = \frac{a_0 e_{c,0} + a_{r,1} e_{c,1}^* + a_{r,2} e_{c,2}^* + a_1 s_0}{e_{c,0} + e_{c,1}^* + e_{c,2}^* + s_0}$ , and*
  - *if  $a_{c,1}^* \notin [a_1 - \epsilon, a_1 + \epsilon]$ , the child's effort is  $e_{c,2}^* = 0$ .*
  - *if  $a_{c,1}^* \in [a_1 - \epsilon, a_1 + \epsilon]$ , there exists a threshold  $k^* > 0$  such that the child's effort is  $e_{c,2}^* \geq 0$  if  $k \geq k^*$  and  $e_{c,2}^* = 0$  otherwise.*
- *The effort of the parent  $e_{p,1}^*$  is the unique solution of (11).*

The utility function  $u(\cdot)$  is assumed sufficiently concave, so that the second-order condition of the parent's optimization problem is satisfied. The first and third statements directly follow from the previous analysis. According to the second statement, for independent learning to occur, the parent must allow the child to accumulate a sufficient stock of noncognitive skills. If the child is unable to accumulate a sufficient stock of noncognitive skills despite the parent's positive caring effort, he will not learn during the unsupervised interaction. To understand this result, notice that during the supervised interaction, the child necessarily exerts more learning effort than he would with an inactive parent. Hence, if the noncognitive skills of the child do not increase sufficiently during the supervised interaction, the child has no incentive to learn during the unsupervised interaction. Moreover, since the child's utility is concave in the precision of his beliefs on the correct action, learning in period 1 reduces the child's incentive to learn in period 2, all else equal. Provided that  $k$  is sufficiently high however, the child accumulates enough noncognitive skills during the supervised interaction so the previous effect is dominated and the child keeps on learning during the unsupervised interaction.

Figure 3 illustrates the previous results by comparing the evolution of the learning efforts of two children. The learning effort of the first child is represented by the solid line. The parent of this child makes a much higher caring effort ( $e_{p,1}^*$  is high) when the child behaves well (i.e. when  $a_{c,1}^* \in [a_1 - \epsilon, a_1 + \epsilon]$ ). This child exerts a high learning effort in period 1 and chooses an action  $a_{c,1}^* \in [a_1 - \epsilon, a_1 + \epsilon]$ . His noncognitive skills increase and make him eager to learn in period 2. The evolution of the learning effort of the second child is represented by the dashed line. The parent of this second child makes a lower caring effort when her child behaves well. This child does not accumulate noncognitive skills and he is unwilling to learn during the unsupervised interaction.

Figure 3: Child learning



The final stocks of skills  $s_2^* = e_{c,0} + e_{c,1}^* + e_{c,2}^* + s_0$  and  $M_2^* = M_1(1 + ke_{p,1}^*(a_{c,1}^*))$  are not deterministic since the signal received by the child  $a_{r,1}$  is drawn from a probability distribution. I denote  $\mathbb{E} s_2^*$  and  $\mathbb{E} M_2^*$  the expected final stocks of cognitive and noncognitive skills, as evaluated in period 1. Similarly, I denote  $s_1^*$  the optimal stock of cognitive skills in period 1. The comparative statics are summarized in the following result.

## Proposition 2

- $e_{p,1}^*$ ,  $s_1^*$ ,  $\mathbb{E} s_2^*$  and  $\mathbb{E} M_2^*$  increase with  $w$ ,  $\alpha$ ,  $\beta$  and  $k$  and decrease with  $d$ .
- There exists a threshold  $\tilde{\epsilon}$  such that  $s_1^*$  increases with  $\epsilon$  when  $\epsilon \leq \tilde{\epsilon}$  and decreases with  $\epsilon$  otherwise. The effect of  $\epsilon$  on  $e_{p,1}^*$ ,  $\mathbb{E} s_2^*$ , and  $\mathbb{E} M_2^*$  is ambiguous.
- $k^*$  increases with  $d$  and decreases with  $w$ ,  $\beta$  and  $\alpha$ .

A parent with “better” characteristics faces either a lower marginal cost or a higher marginal benefit when she increases her caring effort in the supervised interaction. Indeed, the parent’s caring effort  $e_{p,1}^*$  increases when she has more resources (higher  $w$ ), higher time preferences (higher  $\beta$ ), if she is more altruistic (higher  $\alpha$ ), or if she is better able to interact with her child (lower  $d$ ).<sup>22</sup> Because a parent with “better” characteristics exerts a higher caring effort  $e_{p,1}^*$  when her child behaves well, she fosters more learning from him and he accumulates more noncognitive skills. As a result,  $s_1^*$  increases with  $w$ ,  $\alpha$ ,  $\beta$  and decreases with  $d$ .

Parental characteristics affect  $\mathbb{E} M_2^*$  through their effect on the parent’s caring effort  $e_{p,1}^*$ . When the parent makes a higher caring effort, the child accumulates more noncognitive skills and  $\mathbb{E} M_2^*$  increases. Moreover, the parent’s caring effort increases the child’s willingness to learn and  $s_1^*$  increases too. The parent’s caring effort therefore also indirectly increases the child’s expected final stock of noncognitive skills  $\mathbb{E} M_2^*$  through its effect on  $s_1^*$ .

Parental characteristics affect  $\mathbb{E} s_2^*$  through their effect on the child’s initial cognitive skills  $s_1^*$ . Indeed, cognitive skills are *self-productive*, as  $\frac{\partial \mathbb{E} s_2^*}{\partial s_1^*} \geq 0$  necessarily holds. Since “better” parental characteristics positively affect  $s_1^*$ , they also positively affect  $\mathbb{E} s_2^*$ . The mechanism explaining the self-productivity of cognitive skills is the following. When the child acquires more cognitive skills in the initial period, he is more likely to receive a high caring effort from the parent. His stock of noncognitive skills therefore increases and he becomes more eager to learn in period 2. Hence, his final stock of cognitive skills increases as well.

The effect of greater permissiveness  $\epsilon$  on the child’s learning effort in the first period is non-monotonous. When  $\epsilon$  is high, the child does not need to learn in order to receive a positive caring effort from the parent, so his learning effort remains low. Similarly when  $\epsilon$  is low, the child has a weak incentive to learn, being unlikely to receive a positive caring effort from the parent.

Additionally, the effect of greater permissiveness on the parent’s own caring effort is ambiguous. To understand why, compare the cases where  $\epsilon \rightarrow \infty$  and  $\epsilon < \infty$ . All else equal and keeping the parental effort fixed, in the supervised interaction, the child of a parent with  $\epsilon < \infty$  will make a higher learning effort and accumulate more cognitive skills than the child of a parent with  $\epsilon \rightarrow \infty$ . However, the first child might end up with less noncognitive skills than the second in period 2, since he might not receive a positive caring effort in

<sup>22</sup>A parent that has higher time preferences will only increase her caring effort if accumulating skills positively impacts the child’s period 2 expected utility. However, the parent’s effort could decrease the child’s period 2 utility by increasing his cost from making mistakes. I assume that the initial precision is such that  $s_0 \geq 2$  in the proof of Proposition 2, in which case the child’s marginal utility is positive when he accumulates noncognitive skills and  $\beta$  positively affects the parent’s caring effort. For similar reasons, the previous assumption also ensures that a more altruistic parent necessarily invests a higher caring effort.



equilibrium. Internalizing this, a parent with  $\epsilon < \infty$  might exert a lower caring effort than a parent with  $\epsilon \rightarrow \infty$ . Hence, intermediate levels of permissiveness do not necessarily lead to higher parental caring efforts. Since the effect of greater permissiveness on the parent’s own caring effort is ambiguous, so is the effect of greater permissiveness on the child’s acquisition of cognitive and noncognitive skills in period 2.

Finally, I find that “better” parental characteristics foster the accumulation of skills for a larger set of parameter values. The threshold  $k^*$  above which the child exerts a positive learning effort in the unsupervised interaction decreases with the parent’s income (higher  $w$ ), with her time preferences (higher  $\beta$ ), if she is more altruistic (higher  $\alpha$ ), and if she is better able to interact with her child (lower  $d$ ).<sup>23</sup>

This last result shows that differences in parental characteristics are key determinants of child development inequalities. Children of parents with “better” characteristics will learn more from their parents. These children will also accumulate more noncognitive skills by interacting with their parents, so they will be more eager to learn from their surroundings. To illustrate this result, consider again Figure 3 and the following example. The solid line represents the learning effort of a child whose parent’s ability to interact,  $d_1$ , is strong. The dashed line represents the learning effort of a child whose parent’s ability to interact,  $d_2$ , is weak ( $d_2 > d_1$ ). Consider the case where  $k \in (k^*(d_2), k^*(d_1))$ . The more capable parent makes a higher caring effort, so her child receives more rewards from her and accumulates more noncognitive skills. In period 2, only the child whose parent is better able to interact is eager to learn from his surroundings.

### 3 Media devices and Child Development

Young children have been spending increasing amounts of time watching screens over the past decades.<sup>24</sup> They use television, tablets, smartphones, video game consoles, and other devices to watch videos (YouTube, Netflix etc), play games, learn, or engage in communication. Yet medical experts typically recommend limited or no media exposure for young children, based on two related concerns.<sup>25</sup> First, media exposure may displace other activities crucial

<sup>23</sup>The child of a parent with “better” characteristics learns more in period 1. Since the child’s utility is concave in the precision of his beliefs on  $a_t$ , this effect tends to decrease the child’s incentive to learn in period 2, all else equal. This child might also accumulate more noncognitive skills. This effect tends to increase his incentive to learn in period 2. I find that the second effect dominates when the child’s period 1 utility from getting a positive caring effort is sufficiently concave compared to his period 2 utility from learning. As shown in the proof of Proposition 2, a sufficient condition for this to be true is that the prior beliefs of the child on both  $a_1$  and  $a$  are sufficiently precise.

<sup>24</sup>Rideout (2013), Hill et al. (2016), Taylor and Silver (2019), Kılıç et al. (2019), and Goode et al. (2020).

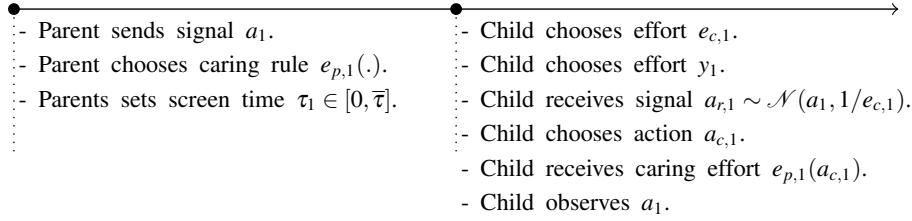
<sup>25</sup>The American Academy of Pediatrics recommends no screen time for children younger than 2 years and no more than 1 hour per day for children aged from 2 to 5 years (Hill et al. (2016)).

for child development, such as interactions with parents or peers, and play time. Second, content-wise, media may provide less stimulation than other types of interaction (Hill et al. (2016)).

In this section, I extend the basic model to examine the effect of media exposure on child development.

**Set-up.** The model features a media device and two agents, the parent and the child. There are two periods,  $t \in \{1, 2\}$ . In the first period, the parent supervises the interaction of her child, whereas in the second period she is inactive. The sequence of events of the supervised interaction is represented in Figure 4, and is identical to the basic model with two exceptions. First, the parent sets the child’s screen time on the media device,  $\tau_1 \in [0, \bar{\tau}]$ . Second, the child chooses the “learning effort”  $y_1 \geq 0$  he will exert during interaction with the media device. For example, playing an interactive game on a smartphone can require a significant effort from the child. The unsupervised interaction is similar to Section 2 and is described in Figure 2.

Figure 4: Period 1 - Supervised Interaction with Media Exposure



The child’s noncognitive skills still reflect the extent to which he values choosing correct actions. This evolves as a function of the supervised interaction, as described in equation (8). Only through his interaction with the parent is the child able to accumulate noncognitive skills.<sup>26</sup>

**Utility.** The value function of the parent remains identical to the basic model and is given by (2). Similarly, the utility of the child in period 2 is unchanged and is given by (1) with  $e_{p,2}(a_{c,2}) = 0$  for any action  $a_{c,2}$ . Only the utility of the child in period 1 changes relative to the basic model, in that it now depends on his exposure to the media device and takes the following form:

$$\tilde{u}_{c,1} = -(e_{c,1} + y_1) + M_1\{1 - \mathbb{E}([a_1 - a_{c,1}]^2 \mid h_1) + e_{p,1}(a_{c,1})\} + \tau_1^\eta y_1^{1-\eta}. \quad (12)$$

<sup>26</sup>Importantly, however, this assumption might not hold if the parent and the child are jointly exposed to the media device, or if the child uses the media device for educational purposes.

The child's utility from using the device depends on his allotted screen time  $\tau_1$  and his effort  $y_1$ . The utility function (12) reflects the idea that the value to the child of using the media device depends both on his own effort  $y_1$  and on screen time  $\tau_1$ . Parameter  $\eta \in (0, 1)$  is a characteristic of the media device. A device with a lower  $\eta$  is more effort-intensive. For example, playing a smartphone game might be more effort-intensive than watching television. Finally, the sum of the child's learning efforts is constrained by his cognitive capacity  $E > 0$ , so  $e_{c,1} + y_1 \leq E$  holds.

**Equilibrium.** The solution concept is still Subgame Perfect Nash Equilibrium.

**Definition 2** *An equilibrium consists of:*

- (i) *the parent's optimal caring rule  $\tilde{e}_{p,1}(\cdot)$ , private consumption  $\tilde{c}_1$ , and the screen time  $\tilde{\tau}_1$ .*
- (ii) *the child's optimal actions  $(\tilde{a}_{c,1}, \tilde{a}_{c,2})$  and learning efforts  $\{\tilde{e}_{c,1}, \tilde{y}_1, \tilde{e}_{c,2}\}$ .*

Accordingly, the equilibrium will be denoted  $\{(\tilde{a}_{c,1}, \tilde{e}_{c,1}, \tilde{y}_1); (\tilde{a}_{c,2}, \tilde{e}_{c,2}); (\tilde{e}_{p,1}(\cdot), \tilde{c}_1, \tilde{\tau}_1)\}$  in the remainder of this section. The next paragraphs formulate the child's and the parent's decision problems recursively.

**Decision Problem of the Child.** The decision problem of the child in the unsupervised interaction remains identical to the basic model. In the supervised interaction, the child chooses an action  $a_{c,1}$  and the efforts  $e_{c,1}$  and  $y_1$  that maximize his expected utility

$$\mathbb{E} \tilde{u}_{c,1} = -(e_{c,1} + y_1) + M_1 \{1 - \mathbb{E}([a_1 - a_{c,1}]^2 \mid h_1) + e_{p,1} \gamma\} + \tau_1^\eta y_1^{1-\eta}, \quad (13)$$

subject to the constraints  $e_{c,1} \geq 0$ ,  $y_1 \geq 0$  and  $e_{c,1} + y_1 \leq E$ .

As before, the child will choose action  $\tilde{a}_{c,1} = \bar{a}_1$  because  $\bar{a}_1$  minimizes his average error and maximizes the likelihood of receiving a positive caring effort from the parent. The child's optimal efforts  $\tilde{e}_{c,1}$  and  $\tilde{y}_1$  respectively solve the following conditions:

$$\begin{aligned} &-(1 + \lambda) + \frac{M_1}{s_1^2} + e_{p,1} M_1 \frac{\partial \gamma}{\partial e_{c,1}} = 0 \text{ and} \\ &-(1 + \lambda) + (1 - \eta) \left[ \frac{\tau_1}{y_1} \right]^\eta = 0, \end{aligned} \quad (14)$$

with  $\lambda \geq 0$  the scarcity coefficient associated with the constraint  $e_{c,1} + y_1 \leq E$ , with complementary slackness.

From (14), when the cognitive capacity constraint is saturated, the child makes a tradeoff between exerting more effort to try to understand the parent's signal and exerting more effort in using the media device. As before, more effort  $e_{c,1}$  in the interaction with the parent allows the child to decrease the average distance between his behavior and the correct action. It also

enables him to increase the likelihood of receiving a positive caring effort from the parent. I make the following Assumption:

**Assumption 1**  $(1 - \eta)^{1/\eta\bar{\tau}} > E$ .

Under Assumption 1, when the child is allowed the maximum screen time  $\bar{\tau}$ , from (14), he should exert an effort  $\tilde{y}_1$  that is beyond his cognitive capacity  $E$ . Hence, under Assumption 1, when the child is allowed the maximum screen time, he will have to make a tradeoff between the increased effort involved in the interaction with his parent and the increased effort involved in using the media device. If Assumption 1 does not hold, the model loses its interest, as the child's screen time will never affect his learning effort  $e_{c,1}$  in the supervised interaction.

**Technology of Skill Formation.** The technology of formation of noncognitive skills is still given by (8). As before, the first-order conditions associated with the child's optimization problem implicitly define the production function of skills. The child's final stock of cognitive skills is given by (10). Under Assumption 1, the stock of cognitive skills in period 1 is

$$\tilde{s}_1(M_1, e_{p,1}, \tau_1), \quad (15)$$

with  $\tilde{s}_1(M_1, e_{p,1}, \tau_1)$  implicitly defined by the first-order conditions (14). The key difference between (9) and (15) is that now the technology of skill formation depends on the screen time  $\tau_1$ , and  $\frac{\partial \tilde{s}_1}{\partial \tau_1} \leq 0$ . Indeed, media exposure decreases the child's learning effort in the parent-child interaction, so the child accumulates less cognitive skills.

**Decision Problem of the Parent.** The parent chooses the caring rule  $e_{p,1}(\cdot)$ , her private consumption  $c_1$ , and the child's screen time  $\tau_1$  so as to maximize her utility (2) subject to the budget constraint  $c_1 + de_{p,1}(a_{c,1}) \leq w$  and technologies (8), (10) and (15).

Increasing screen time  $\tau_1$  is cost-free for the parent. Under Assumption 1, this implies that the parent sets the screen time such that the child's cognitive capacity is saturated. The first-order conditions associated with the determination of  $e_{p,1}$  and  $\tau_1$  can be written as:

$$\begin{aligned} -du'(w - de_{p,1}) + \alpha M_1 \tilde{\gamma} + \beta \alpha \frac{\partial \mathbb{E} v_{c,2}}{\partial e_{p,1}} &= 0 \text{ and} \\ \eta \left[ \frac{E - \tilde{e}_{c,1}}{\tau_1} \right]^{1-\eta} + \beta \frac{\partial \tilde{e}_{c,1}}{\partial \tau_1} \frac{\partial \mathbb{E} v_{c,2}}{\partial e_{c,1}} &= 0, \end{aligned} \quad (16)$$

when the solution is interior, given that  $\tilde{e}_{c,1}$  solves (14),  $\mathbb{E} v_{c,2}$  denote the expected indirect utility of the child, and  $\tilde{\gamma}$  the likelihood of the child receiving a positive caring effort in equilibrium.<sup>27</sup>

The parent's decision regarding her caring effort  $e_{p,1}$  is described by the first line of (16) and is identical to the basic model. The parent's decision regarding screen time is described by the second line of (16). The parent faces a tradeoff between two welfare effects. On the one hand, she knows that increasing screen time will increase the current utility of the child, who values using the media device. On the other hand, she realizes that if she increases screen time, the child will learn less from her and therefore will accumulate less noncognitive skills. I summarize the characterization of the equilibrium in the following proposition.

**Proposition 3** *Under regularity conditions on  $u(\cdot)$  and provided that  $\beta$  is sufficiently low, there exists a unique equilibrium such that:*

- *In the supervised interaction, the child's action is  $\tilde{a}_{c,1} = \frac{a_0 e_{c,0} + a_{r,1} \tilde{e}_{c,1}}{e_{c,0} + \tilde{e}_{c,1}}$ . His effort  $\tilde{e}_{c,1}$  solves (14) and is such that  $\tilde{e}_{c,1} \leq e_{c,1}^*$ .*
- *In the unsupervised interaction, the child's action is  $\tilde{a}_{c,2} = \frac{a_0 e_{c,0} + a_{r,1} \tilde{e}_{c,1} + a_{r,2} \tilde{e}_{c,2} + a_1 s_0}{e_{c,0} + \tilde{e}_{c,1} + \tilde{e}_{c,2} + s_0}$ , and*
  - *if  $\tilde{a}_{c,1} \notin [a_1 - \epsilon, a_1 + \epsilon]$ , there exists a threshold  $\tilde{k}^- \geq 0$  such that  $\tilde{e}_{c,2} \geq 0$  if  $k \leq \tilde{k}^-$ , and  $\tilde{e}_{c,2} = 0$  otherwise.*
  - *if  $\tilde{a}_{c,1} \in [a_1 - \epsilon, a_1 + \epsilon]$ , there exists a threshold  $\tilde{k}^+ \geq 0$  such that  $\tilde{e}_{c,2} \geq 0$  if  $k \geq \tilde{k}^+$ , and  $\tilde{e}_{c,2} = 0$  otherwise.*
- *The optimal caring effort of the parent  $\tilde{e}_{p,1}$  and the optimal screen time  $\tilde{\tau}_1$  are the unique solutions of (16) and  $\tilde{e}_{p,1} \leq e_{p,1}^*$ .*

The conditions on  $u(\cdot)$  and  $\beta$  ensure that the optimization problem of the parent is concave. There is a substitution effect between the effort of the parent in the supervised interaction and the child's media exposure. As the parent sets a longer screen time, she feels less need to be directly involved in the interaction with her child. Indeed, at the optimum, when screen time increases, the child exerts more effort using the media device and less effort learning from the parent. As a result, the child places less value on receiving a caring effort from the parent. The parent then makes a lower caring effort  $\tilde{e}_{p,1}$  when the child behaves well (i.e. when  $\tilde{a}_{c,1} \in [a_1 - \epsilon, a_1 + \epsilon]$ ). This explains why  $\tilde{e}_{p,1} \leq e_{p,1}^*$  and  $\tilde{e}_{c,1} \leq e_{c,1}^*$ .<sup>28</sup>

<sup>27</sup>Formally,  $\mathbb{E} v_{c,2} = \tilde{\gamma} \bar{v}_{c,2} + (1 - \tilde{\gamma}) \underline{v}_{c,2}$  with  $\bar{v}_{c,2}$  (resp.  $\underline{v}_{c,2}$ ) the child's indirect utility when he gets (resp. does not get) rewarded by the parent's caring effort in period 1.

<sup>28</sup>There are two assumptions behind the substitution effect. First, the media device is cost-free. If the parent had to spend a share of her resources  $w$  on buying the media device, then the substitution effect would

Regarding the second point of the proposition, I still find that in order to set in motion independent learning, the parent must allow the child to accumulate a sufficient stock of noncognitive skills. Moreover, even when the parent does not make a positive caring effort in period 1, the child might still exert a positive learning effort in period 2 (i.e.  $\tilde{e}_2^- > 0$ ). This was not possible in the basic model, because the child automatically learned more in period 1 than he would have learnt alone. In the extended model, this is no longer necessarily true. Actually, the child might spend so much time using the media device that he will learn less in the supervised interaction than he would have learnt alone. In this case, the child would still be eager to learn in period 2, because his learning effort in the supervised interaction was extremely low. However, this is only possible when  $k$  is sufficiently low ( $k \leq \tilde{k}^-$ ); otherwise, the parent is still sufficiently involved with the child in the supervised interaction.

I denote  $\mathbb{E} \tilde{s}_2$  and  $\mathbb{E} \tilde{M}_2$  the expected final stocks of cognitive and noncognitive skills as evaluated in period 1. Similarly, I denote  $\tilde{s}_1$  the optimal stock of cognitive skills in period 1. The comparative statics are summarized in the following result.

#### Proposition 4

- $\tilde{\tau}_1$  decreases with  $w$ ,  $\alpha$ ,  $\beta$  and  $k$  and increases with  $d$ . Inversely,  $\tilde{e}_{p,1}$ ,  $\tilde{s}_1$ ,  $\mathbb{E} \tilde{s}_2$  and  $\mathbb{E} \tilde{M}_2$  increase with  $w$ ,  $\alpha$ ,  $\beta$  and  $k$ , and decrease with  $d$ . The effect of  $\eta$  is ambiguous.

In equilibrium, the strength of the substitution effect between the parent's effort in the supervised interaction and the child's media exposure depends on the characteristics of the parent. A parent with "better" characteristics incurs a lower marginal cost or obtains a higher marginal benefit when she increases her own effort in the supervised interaction. Hence, the parent's effort  $\tilde{e}_{p,1}$  increases while the screen time  $\tilde{\tau}_1$  decreases if the parent has more resources (higher  $w$ ), higher time preferences (higher  $\beta$ ), if she is more altruistic (higher  $\alpha$ ), or if she is better able to interact with her child (lower  $d$ ). Additionally, a parent with "better" characteristics fosters more learning by her child, who accumulates more noncognitive skills. As a result,  $\tilde{s}_1$  increases with  $w$ ,  $\alpha$ ,  $\beta$  and decreases with  $d$ . The effects of parental characteristics on  $\mathbb{E} \tilde{s}_2$  are still explained by the *self-productivity* of skills. The effects of parental characteristics on  $\mathbb{E} \tilde{M}_2$  follow from the fact that  $\mathbb{E} \tilde{M}_2$  increases with both  $\tilde{e}_{p,1}$  and  $\tilde{s}_1$ .

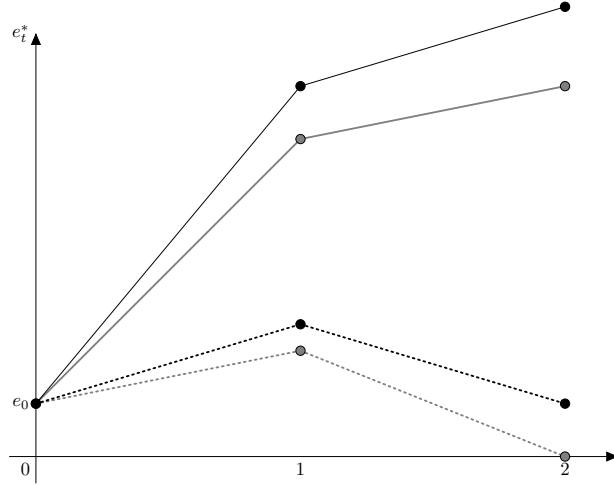
The effects of more time-intensive technology on both the child's learning effort and the parent's strategy are ambiguous. All things being equal, more time-intensive technology

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only arise under sufficiently high  $w$ , as poor parents could not afford to buy a media device. Second, the income of the parent is fixed. Hence, a parent's lower caring effort does not imply higher earnings. In a more complicated version of the model, a lower caring effort could both imply higher earnings and make the media device affordable.

might require less effort from the child, but the parent might set a longer screen time. Further empirical studies will be needed to get a clearer picture of the overall effect on child development of the various types of media device that are rapidly emerging.

Figure 5: Child learning and early media exposure



Critically, this model shows that inequalities in child development can be amplified by early exposure to media devices. A parent with “better” characteristics makes a higher caring effort and allows the child less screen time. Her child accumulates more noncognitive skills and becomes more eager to learn from his surroundings. To illustrate this result, consider Figure 5. The dotted black line represents the learning effort of a child whose parent has limited ability to interact,  $d_2$ , when the child is not exposed to the media device. The dotted gray line represents the learning effort of the same child when he is exposed to the media device. Similarly, the solid black (resp. gray) line represents the learning effort of a child whose parent has a high ability to interact,  $d_1$ , when the child is not exposed (resp. is exposed) to the media device, with  $d_1 < d_2$ . The parent more capable of interacting makes a higher caring effort. She also relies less on the media device than the other parent. Her child learns mostly from her and accumulates noncognitive skills. In this example, without the media device, the child of the less capable parent too would accumulate noncognitive skills, because his parent would have invested enough caring effort in the supervised interaction. Moreover, this child’s over-exposure to the media device means he will not invest enough effort in understanding his parent’s signal. Even if she makes a positive caring effort in equilibrium, it will be too weak to foster independent learning. This child’s exposure to the media device stops his learning process dead in its tracks.

One key assumption behind the results of Section 3 is that the child does not accumulate noncognitive skills by interacting with the media device. Indeed, from equation (8), the child can only build cognitive representations of himself and acquire noncognitive skills through his parent’s reaction. However, this assumption might not always hold, since the media device activity may be shared between parent and child. The parent might also steer her child toward specific educational content. In such cases, it is difficult to draw a line between what can be interpreted as media exposure and what comes under interaction between child and parent. The theoretical predictions on the effect of educational media or shared media experience are thus necessarily ambiguous in this model.

## 4 Additional Insights

Below, I describe several ways of making the model more broadly applicable.

### 4.1 Interpreting the model

**Noncognitive skills versus Attachment Capital.** In the model, the child’s noncognitive skills  $M_t$  reflect the extent to which he values choosing correct actions. However, correct actions are conflated with actions that are rewarded by a positive caring effort from the parent. Hence,  $M_t$  can also be interpreted as the value to the child of his tie with the parent. In this alternative interpretation,  $M_t$  stands for the *attachment capital* of the child for the parent. A child strongly attached to the parent will value adopting behaviors that are worthy of her caring effort. The model’s main results can be summarily re-interpreted as follows:

- Child independent learning is motivated by the child’s attachment to his parent (Proposition 1). A child whose parent has “better” characteristics becomes more attached to her and is more eager to learn from his surroundings (Proposition 2). “Better” characteristics include higher income (higher  $w$ ), higher time preferences (higher  $\beta$ ), greater ability to interact with the child (lower  $d$ ), and a higher degree of altruism (higher  $\alpha$ ).
- Early exposure to media devices decreases the child’s attachment to his parent and makes him less motivated to learn from his surroundings (Proposition 3). A child whose parent has “better” characteristics is less exposed to media devices. He becomes more attached to his parent and is more eager to learn from her and from his surroundings (Proposition 4).



**Caregiver versus Media Exposure.** In the model of Section 3, the child interacts both with his parent and with a media device. However, if the media device is replaced by another caregiver, like an early childhood professional, another interpretation might be possible. To the extent that the parent has a greater capacity to foster the acquisition of noncognitive skills compared to the childhood professional, the results of Section 3 are relevant.

In this alternative interpretation of the model, the parent chooses her caring rule  $e_{p,1}(\cdot)$  and the time that the child spends with the childhood professional  $\tau_1$ . Proposition 3 then implies that because the child spends more time with the childhood professional, he invests less learning effort in the supervised interaction with his parent, who also invests less effort in the supervised interaction. As a result, the child accumulates less noncognitive skills and becomes less motivated to learn.

## 4.2 Symbiotic parent-child Relationship

Although I focused on a two-period model in Sections 2 and 3, the theory can be extended to cases where the child interacts several times with the parent before the unsupervised interaction. In Appendix B.1, I develop a dynamic version of the basic model where there are  $T > 1$  supervised interactions followed by one unsupervised interaction under the simplifying assumption  $\beta = 0$ .

The information structure remains identical and the child's value function in period  $t$  is still given by (1). The noncognitive skills of the child evolve as a function of the supervised interactions. In period  $t \in \{2, \dots, T + 1\}$ ,  $M_t$  can be expressed as:

$$M_t = M_{t-1}(1 + ke_{p,t-1}(a_{c,t-1})),$$

with  $a_{c,t-1}$  the child's action in period  $t - 1$  and  $e_{p,t-1}(\cdot)$  the caring rule of the parent.

The value function of the parent in period  $t$  is

$$u_{p,t} = u(c_t) + \alpha \mathbb{E} v_{c,t}, \tag{17}$$

with  $c_t$  the parent's private consumption and  $v_{c,t}$  the indirect utility of the child.

In each period, the child chooses a learning effort  $e_{c,t}$  and an action  $a_{c,t}$  so as to maximize his utility (1) subject to the constraint  $e_{c,t} \in [0, E]$ . In each supervised interaction, the parent chooses her caring rule  $e_{p,t}(\cdot)$  and her private consumption  $c_t$  so as to maximize her value

function (17), subject to the budget constraint  $c_t + de_{p,t}(a_{c,t}) \leq w$  and having internalized the technologies of skill formation in the current period.<sup>29</sup>

The solution concept is still Subgame Perfect Nash Equilibrium and an equilibrium is denoted  $\{\{a_{c,t}^*, e_{c,t}^*\}_{t \in \{1, \dots, T+1\}}, \{e_{p,t}^*(\cdot), c_t^*\}_{t \in \{1, \dots, T\}}\}$ . An existence and uniqueness result similar to Proposition 1 is established in Appendix B.1.

Relative to the basic model, this extension reveals a symbiotic relationship between child and parent. Over time, the child accumulates noncognitive skills that make him increasingly eager to learn from the parent. The parent also makes increasingly higher caring efforts because she understands that her effort is increasingly valued by the child. I find that the symbiotic relationship between child and parent is stronger when the parent has a higher income (higher  $w$ ), greater ability to interact with the child (lower  $d$ ), or a higher degree of altruism (higher  $\alpha$ ). Hence, according to this model, the symbiotic relationship between child and parent is an additional determinant of inequalities in child development.

### 4.3 Dysfunctional parent-child Relationship

I have assumed so far that the parent only makes a positive caring effort when the action of the child is sufficiently close to the correct action. In Appendix B.2, I develop a dynamic extension of the model similar to that of Section 4.2, where in each supervised interaction, depending on the child's action, the parent chooses between two caring efforts. Either she makes a positive caring effort  $e_{p,t} \geq 0$ , or she punishes the child with a negative caring effort  $\bar{e} < 0$ . I assume that punishing the child is cost-free for the parent.<sup>30</sup> Formally, the caring rule takes the following form:

$$e_{p,t}(a_{c,t}) = \begin{cases} e_{p,t} & \text{if } a_{c,t} \in [a_t - \epsilon, a_t + \epsilon] \text{ and} \\ -\bar{e} & \text{otherwise} \end{cases}$$

in any period  $t \in \{1, \dots, T\}$ . Hence, from (8), the child's stock of noncognitive skills can be expressed as:

$$M_t = \begin{cases} M_{t-1}(1 + ke_{p,t-1}) & \text{if } a_{c,t} \in [a_t - \epsilon, a_t + \epsilon] \text{ and} \\ M_{t-1}(1 - k\bar{e}) & \text{otherwise,} \end{cases} \quad (18)$$

for any  $t \in \{2, \dots, T+1\}$ .

In any period  $t \in \{1, \dots, T+1\}$ , the child chooses a learning effort  $e_{c,t}$  and an action  $a_{c,t}$  so as to maximize his value function (1) subject to the constraint  $e_{c,t} \in [0, E]$ . In any period

<sup>29</sup>The first-order condition associated with the determination of  $e_{c,t}$  implicitly defines a technology of cognitive skill formation in any period  $t$ .

<sup>30</sup>Weinberg (2001) makes a similar assumption in his analysis of corporal punishment as a child-rearing practice.

$t \in \{1, \dots, T\}$ , the parent chooses her caring rule  $e_{p,t}(\cdot)$  and her private consumption  $c_t$  so as to maximize her value function (17), subject to the budget constraint  $c_t + de_{p,t}(a_{c,t}) \leq w$  and having internalized the technologies of skill formation in the current period. Still relying on the same equilibrium concept, I establish an existence and uniqueness result similar to Proposition 1.

Relative to the basic model with no punishment, I find that the parent-child relationship can be dysfunctional. When the child is punished in the first supervised interaction, his stocks of noncognitive skills decrease, so he becomes less motivated to learn. In the next period, the parent is less willing to make a caring effort because she understands that this is less valued by the child. The child invests less learning effort in the interaction with the parent, who becomes more likely to punish the child, whose noncognitive skills decrease even more.

Whether the parent-child relationship becomes dysfunctional or symbiotic hinges on the parent’s characteristics. I find that when the parent has a higher income (higher  $w$ ), greater ability to interact with the child (lower  $d$ ), or a higher degree of altruism (higher  $\alpha$ ), then the parent-child relationship is more likely to be symbiotic than dysfunctional.

## 5 Implications and Evidence on Child Development

The model sheds light on a wide range of issues arising from empirical and qualitative findings in different disciplines, as outlined below.

- **Attachment Theory.** Drawing on Freud (1989 [1940]) and evolutionary biology, Bowlby (1969, 1973, 1980) formulated the celebrated *attachment theory*. He argued that the ties formed between child and caregiver during the early years of life are key determinants of self-perceptions and long-term development. Bowlby proposed that through care, sensitivity, and positive feedback from caregivers, a child develops *internal working models*. Internal working models are cognitive representations of the self. They enable the child to identify who he is and to act accordingly.<sup>31</sup>

Ainsworth et al. (1978) designed laboratory experiments to infer children’s skills given their observed behavior.<sup>32</sup> The noncognitive skills acquired in parent-child interactions are referred to as “secure attachment” in the developmental psychology literature. According to Bowlby (1969, 1973, 1980) and Ainsworth et al. (1978), securely attached

<sup>31</sup>Since Bowlby (1969, 1973, 1980), psychologists have refined the concept of mental representations of the self to account for constructive memory processes (Thompson (2015)) and mentalization (Fonagy et al. (2002)). For an overview of the psychology literature on the attachment theory, see for example Thompson (2015).

<sup>32</sup>Heckman, Jagelka and Kautz (2019) review the recent studies measuring skills using behavior.

infants have working models of the self as valued and competent. In laboratory settings, these children are able to explore their environment, play and learn when their parents are absent (Ainsworth et al. (1978)). Parents’ support and affection are supposedly associated with the emergence of such positive internal working models. Conversely, children with working models of the self as devalued and incompetent show limited exploration and play. Such negative internal working models are considered the typical result of parents’ showing their children little affection and care (Fonagy et al. (2002, p. 23 – 64), Harter (2007)).

Two of the most comprehensive psychology studies on the attachment theory were performed by Sroufe (2005) and Sroufe et al. (2009). The authors provide evidence that secure attachment measured in experimental settings at 12 months and 18 months is a strong predictor of personality characteristics throughout childhood and adolescence, including emotional health, self-esteem, agency and self-confidence, positive affect, ego, and social competence in interactions with peers.

The present model is closely linked to the attachment theory and the experimental findings of Ainsworth (1985). The parent’s affection discussed by Bowlby (1969, 1973, 1980) is modeled here through the parent’s caring effort  $e_{p,1}$ . In equation (8), I hypothesized that the parent’s caring effort positively affects the child’s noncognitive skills when  $k > 0$ . Consistent with experimental evidence from Ainsworth et al. (1978), Proposition 1 shows that only a child accumulating a sufficient stock of noncognitive skills in the supervised interaction is able to learn from his surroundings. Finally, the model is broadly consistent with Sroufe (2005) and Sroufe et al. (2009), as it shows that skills acquired during early parent-child interactions are a strong predictor of behaviors.

- **Parental Characteristics and Child Development.** There is now clear evidence of higher achievement for children growing up in more advantaged families.<sup>33</sup> The theory developed in this paper suggests a mechanism behind this result. Richer parents are able to devote more resources to fostering their children’s learning, so their caring efforts are higher. Their children therefore accumulate more noncognitive skills and become more eager to learn (Propositions 2 and 4).

Heckman, Pinto and Savelyev (2013) study the mechanism behind the adult treatment effect of an influential early childhood program consisting of up to five home visits

<sup>33</sup>Contributions on the subject include for instance Hair et al. (2015); Cunha and Heckman (2007); Akee et al. (2010); Bernal and Keane (2011); Heckman, Pinto and Savelyev (2013); Agostinelli and Wiswall (2016); Rubio-Codina, Attanasio and Grantham-Mcgregor (2016); de Neubourg et al. (2018); Heckman and Karapakula (2019).

per week by teachers. The visits aimed at involving mothers in the socio-emotional development of their children. [Heckman, Pinto and Savelyev \(2013\)](#) find that over their life cycles, the children in the treatment group were far more successful, less antisocial and aggressive, and developed higher academic motivation.<sup>34</sup> The authors then show that these outcomes are primarily explained by differences in noncognitive skills. This mechanism is consistent with my model, where improving the quality of parent-child interactions (e.g., by decreasing  $d$ ) directly translates into higher caring effort from the parent and higher stocks of noncognitive skills accumulated by the child.

- **Maternal Depression and Child Development.** Symptoms of depression (higher  $d$  in the model) are increasingly documented as being associated with lower parental investment in child rearing and poorer child development outcomes. Assessing the impact of treating maternal depression (i.e. decreasing  $d$ ), [Baranov et al. \(2020\)](#) find that treatment increases parental investment in child rearing. [Hanington, Ramchandani and Stein \(2010\)](#) similarly find that both maternal and paternal depression induce adverse behavioral and emotional outcomes in offspring. This evidence is in line with my results from Proposition 2. Finally, several studies indicate that maternal depression might be associated with problems in the formation of an attachment bond between mother and child ([Forman et al. \(2007\)](#), [Śliwerski et al. \(2020\)](#)), consistent with the mechanism of this model.
- **Permissiveness and Child Development.** In the model, a more permissive parent makes a positive caring effort for a wider range of actions. In Proposition 2, I found that the effects of greater permissiveness on both the parent’s caring effort and the child’s acquisition of skills are ambiguous.

In the empirical literature, there is mixed evidence on the effect of permissiveness on child development outcomes. Several studies have suggested that harsh discipline (i.e. low  $\epsilon$ ) might have adverse effect on child outcomes (e.g., [Weiss et al. \(1992\)](#)). Alternatively, drawing on the classification of parenting styles established by [Baumrind \(1966\)](#), other studies have shown that authoritative parenting correlate with high child development outcomes ([Baumrind \(1991\)](#), [Steinberg \(2001\)](#), and [Lieneman et al. \(2017\)](#)). In this model, authoritative parenting corresponds to intermediate levels of  $\epsilon$ , given that it is defined as a balance between parental control and praise of the child’s behavior ([Baumrind \(1966\)](#)).<sup>35</sup>

<sup>34</sup>See also [Heckman and Karapakula \(2019\)](#).

<sup>35</sup>[Doepke and Zilibotti \(2017\)](#) have built an alternative model of parenting based on [Baumrind \(1966\)](#) where a parent can either influence her child’s preferences or restrict her child’s choice set. While my approach is

- **Early Media Exposure and Parenting: The Substitution Effect.** [Christakis et al. \(2009\)](#) studied the substitution effect uncovered in Proposition 3 between the parent’s caring effort in the supervised interaction and the child’s media exposure. The authors collected data on a sample of 329 children aged from 2 to 48 months. The children wore digital recorders on random days for up to 24 months. The authors found that exposure to television was associated with decreased exposure to discernible human adult speech and decreased child vocalization. These patterns are in line with the predictions of the model, as early media exposure is found to decrease both the parent’s caring effort ( $\tilde{e}_{p,1} \leq e_{p,1}^*$ ) and the child’s learning effort in the parent-child interaction ( $\tilde{e}_{c,1} \leq e_{c,1}^*$ ).
- **Early Media Exposure and Healthy Eating Habits.** [Taveras et al. \(2013\)](#) collected data on 1,116 mother-child pairs in the United States (63% white, 17% black, and 4% Hispanic). They found that at age 7 years, overweight and obesity prevalence among black and Hispanic children was significantly greater than for white children, and that this was explained by factors operating in early childhood. These factors included differences in feeding behaviors (e.g. breastfeeding, consumption of sugar) and television in children’s bedrooms. The theory developed in this paper suggests a mechanism behind these findings: healthy eating habits are learnt in parent-child interactions. Media exposure replaces the parent’s own effort in parent-child interactions and a child spending more time watching television accumulates less skills.
- **Early Media Exposure and Child Development.** In Proposition 3, I find that a child’s media exposure decreases his learning effort in the supervised interaction ( $\tilde{e}_{c,1} \leq e_{c,1}^*$ ). This prediction is well supported by the existing literature. Studying a sample of 110 Hispanic infants and toddlers participating in an Early Head-Start program, [Duch et al. \(2013\)](#) found that children who watched over 2 hours of television per day were more likely to have low communication scores.<sup>36</sup> Similarly, [Tomopoulos et al. \(2007\)](#) monitored the media exposure of a cohort of 99 Latino mother-infant pairs. Their analysis showed a robust association between media exposure and aggressive behavior and externalizing problems.

Proposition 4 shows that children whose parents have “better” characteristics are less exposed to media devices. “Better” characteristics include higher resources (higher  $w$ ), higher time preferences (higher  $\beta$ ), a higher degree of altruism (higher  $\alpha$ ), and greater

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closely related, it is built on two different mechanisms. First, the parent’s permissiveness does not restrict the child’s choice set but motivates him to behave correctly. Second, the parent indirectly influences her child’s preferences through the effect of her caring strategy on her child’s noncognitive skills.

<sup>36</sup>See also the survey-based study of [Zimmerman, Christakis and Meltzoff \(2007\)](#) for similar evidence.

ability to interact (lower  $d$ ). While existing studies show a positive association between low income and early media exposure, the effects of other parental characteristics have been explored less.<sup>37</sup> With data on 350 children aged from 6 months to 4 years attending a pediatric clinic in an urban, low-income minority community, [Kabali et al. \(2015\)](#) found that most children had their own media device by the age of 4, with patterns of use suggesting frequent and independent use. Most 2-year-olds used mobile devices on a daily basis, and most 1-year-olds had already used a mobile device. Although this study does not compare disadvantaged families with more affluent families, it still shows high average use of media devices by young children in a sample of low-income households. In a study on television, [Rideout and Hamel \(2006\)](#) used a U.S. national survey of 1,051 parents of children aged from 6 months to 6 years to identify positive correlations between lower earnings and longer television-watching by young children.

- **Daycare and Child Development.** As discussed in Section 4.1, the model presented in Section 3 can be interpreted in terms of interactions between the child and an early childhood professional. In this alternative interpretation, I find from proposition 3 that a parent will tend to replace her own effort in parent-child interactions with more time in daycare, and that a child spending more time in daycare will accumulate less skills. This result is explained by the parent’s greater capacity to foster the acquisition of skills compared to childhood professionals ([Csibra and György \(2011\)](#)). The study by [Fort, Ichino and Zanella \(2020\)](#) supports this prediction with robust evidence that daycare at age 0-2 has negative effects on both IQ and personality traits at age 8-14.

## Policy Implications

- **Improving the parent-child relationship.** My findings from this model suggest that early childhood interventions intended to enhance child development outcomes should aim at improving parent-child relationships for two reasons. First, according to propositions 2 and 4, subsidizing the parent’s effort in child rearing (i.e. increasing  $w$ ) or offering parental training and counseling (i.e. decreasing  $d$ ) directly increases the parent’s caring effort  $e_{p,1}^*$  in the supervised interaction. As a result, the child exerts a higher learning effort  $e_{c,1}^*$  in the supervised interaction. He accumulates more noncognitive skills and becomes more eager to learn. Second, from Section 4.3, interventions that increase  $w$  or decrease  $d$  strengthen the symbiosis in the parent-child relationship and decrease the likelihood of the relationship becoming dysfunctional.

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<sup>37</sup>[Kılıç et al. \(2019\)](#) find that early media exposure is negatively associated with parents’ educational attainments.



These predictions find support in the literature, as there is now ample evidence that early childhood programs that bolster home environments have significant and durable effects on child development.<sup>38</sup> Although the literature already argues for the inclusion of parents in early childhood programs, this model strengthens the case. I find not only that including the parent is paramount for child development, but that non-inclusion is detrimental to child development. Indeed, from Proposition 3, if the child spends more time with a childhood professional, he exerts less effort in learning from his parent, who also makes less effort in the supervised interaction. As a result, the child may accumulate less skills.

- **Targeting the bottom of the income distribution.** In Propositions 2 and 4, I show that a parent with a lower income  $w$  makes less effort in the supervised interaction. Hence, programs that target poor families will have a greater impact on child development than non-targeted programs. This prediction is supported by Elango et al. (2015), who find that early interventions not targeted at disadvantaged families have only limited effects.
- **Limiting early media exposure.** Finally, Propositions 3 and 4 indicate that early media exposure negatively affects child development, especially at the bottom of the income distribution (as  $\tilde{\tau}_1$  decreases with  $w$ ). An attempt to limit the pervasive effect of early media exposure on child development might therefore usefully be included in early intervention programs.

## 6 Conclusion

I present a model of child development. Through care, a parent enables her child to build mental representations of himself as loved and competent. These mental representations shape the child’s noncognitive skills by increasing his willingness to learn.

I show that this model provides a single, unifying explanation for well-known properties of the production function of skills. It also explains puzzling evidence on the critical role played by different agents in the process of child development. I find that early exposure to media devices negatively affects child development. As parents substitute their own caring effort with media exposure, children accumulate less noncognitive skills and tend to become less eager to learn from their parents. I finally demonstrate that the parent-child relationship can

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<sup>38</sup>See, for example, Elango et al. (2015), Heckman and Mosso (2014), Heckman, Pinto and Savelyev (2013), Campbell et al. (2014), and Campbell et al. (2014).



be a double-edged sword in terms of child development. It can be symbiotic or dysfunctional, depending on the parent’s characteristics.

There are several important limitations to this work. First, I consider the permissiveness of the parent as fixed, although differences in parenting styles might also affect child development.<sup>39</sup> Second, I assume that the parent has full information and observes the child’s learning efforts. Yet lack of parental awareness is also a key determinant of child development.<sup>40</sup> Finally, the child only interacts with two agents in this model. However, the interaction patterns of children also include young peers and multiple caregivers. Extension of the model in these directions could provide further insights on child development.<sup>41</sup>

This theory is grounded in the attachment theory, which enabled generations of psychologists and psychiatrists to study the complex linkage between children’s mental health and parent-child relationships. It could serve as a starting point for analysis of the socio-economic determinants of parent-child relationships and early childhood mental health.

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<sup>39</sup>See, for example, [Doepke, Sorrenti and Zilibotti \(2019\)](#).

<sup>40</sup>On the theory side, [Akabayashi \(2006\)](#) provides a first analysis on this issue. Empirical studies on the subject include [Rowe \(2008\)](#), [Aizer and Stroud \(2010\)](#), and [Cunha, Elo and Culhane \(2013\)](#). [Bergman \(2020\)](#) provides experimental evidence.

<sup>41</sup>A careful analysis of disruptions in the parent-child relationship and possible remediation might be of particular interest for future research. See, for example, the work of [Courtney \(2009\)](#) on foster care. An extension of this model could also provide an interpretation grid for a systematic analysis of the effect of the Covid-19 pandemic on child development. While the pandemic intensified parent-child interactions, it also disrupted other important interactions through school closures or lockdown measures. The overall effect on early child development is thus necessarily ambiguous. [Agostinelli et al. \(2020\)](#) study the impact of school closures following the Covid-19 pandemic on child development. They find negative effects on child development outcomes only for disadvantaged children.

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