The impact of feedback valence and communication style on intrinsic motivation in middle childhood: Experimental evidence and generalization across individual differences

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ABSTRACT

Prior research among adolescents and emerging adults has provided evidence for the beneficial effects of positive (relative to negative) feedback and an autonomy-supportive (relative to a controlling) communication style on students' intrinsic motivation. Unfortunately, similar experimental research in middle childhood is lacking. Moreover, little attention has been paid to the question of whether individual differences in personality and perceived parenting play a role in these effects. In the current experimental study ($N = 110$; $M_{age} = 10.71$ years), children completed puzzles at school under one of four experimental conditions, thereby crossing normative feedback valence (i.e., positive vs. negative) with communication style (i.e., autonomy supportive vs. controlling). Prior to the experiment, children filled out questionnaires tapping into the Big Five personality traits and into perceived maternal autonomy support and psychological control. After the experimental induction, children rated several motivational constructs (i.e., intrinsic motivation and need-based experiences). In addition, their voluntary behavioral persistence in a subsequent challenging puzzle task was recorded objectively. Providing positive normative feedback in an autonomy-supportive way yielded the most favorable motivational outcomes. Both feedback valence and communication style yielded an independent impact on children's experiences of competence and autonomy during task engagement, which in turn helped to explain children's elevated intrinsic motivation, as reflected by their perceived interest and behavioral

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persistence. A few effects were moderated by children's perceived parenting and personality traits, but the number of interactions was limited. The discussion focuses on the motivating role of positive normative feedback and an autonomy-supportive communication style for children.

Introduction

When intrinsically motivated, children are attracted by the content of an activity at hand, thereby finding the activity interesting, enjoyable, and challenging in its own right (Deci & Ryan, 2000). Intrinsic motivation has been found to predict manifold beneficial outcomes, including better learning, higher persistence, and improved well-being, a finding that emerged in both middle childhood (e.g., Dishman, McIver, Dowda, Saunders, & Pate, 2015) and adolescence (e.g., Beiswenger & Grolnick, 2010). Given the educational advantages associated with intrinsic motivation, abundant—yet mainly correlational—research has addressed its contextual antecedents. For instance, research has documented beneficial effects of positive (relative to negative) feedback (Deci, 1971; Deci, Koestner, & Ryan, 1999; Mouratidis, Vansteenkiste, Lens, & Sideridis, 2008) and an autonomy-supportive or inviting (relative to a controlling or pressuring) communication style (Ryan, 1982) on intrinsic motivation.

However, most of this research has been conducted in older age groups, that is, among adolescents (De Muynck et al., 2017) and university student populations (Hagger, Koch, & Chatzisarantis, 2015). As a result, there is a paucity of research, and of experimental research in particular, on the contextual determinants of intrinsic motivation in middle childhood. This is unfortunate because middle childhood represents a developmental period in which the acquisition of new skills represents a key development task (Erikson, 1968) that can be spurred by children's intrinsic motivation. Moreover, children's intrinsic motivation has been found to undergo significant declines (Gottfried, Marcoulides, Gottfried, & Oliver, 2009; Lepper, Corpus, & Iyengar, 2005). This raises the question of what can be done to preserve their intrinsic motivation. A second issue that has received virtually no attention is the extent to which individual differences play a role in these effects. Do children, regardless of their personality profile and the perceived child-rearing style of their parents, benefit similarly from contextual resources of intrinsic motivation? Or do certain individual differences or perceived environments create a heightened sensitivity to contextual influences on intrinsic motivation?

In light of these lacunae, the current experimental study aimed to contribute to the extant literature (a) by examining the effects of experimentally induced normative feedback valence and communication style on elementary school children's intrinsic motivation, (b) by addressing the mechanisms accounting for these effects, and (c) by addressing the possible moderating role of individual differences in personality and perceived parenting in these effects. In doing so, we used self-determination theory (SDT; Ryan & Deci, 2000, 2017) as a theoretical framework.

Intrinsic motivation and psychological need satisfaction

Because intrinsic motivation comes with a high degree of volition and spontaneity, it represents the hallmark of high-quality motivation (Ryan & Deci, 2017). When intrinsically motivated, enjoyment of and interest in the behavior itself provide the basis for carrying out the activity (Deci & Ryan, 2000). Intrinsically motivating activities serve as 'magnets' in individuals' lives. That is, people spontaneously gravitate to these activities because of their manifold benefits (Vansteenkiste et al., 2018). Indeed, intrinsic motivation is a powerful resource for learning and development (Larson & Rusk, 2011; Taylor et al., 2014). A recent meta-analysis clearly documented the positive effects of intrinsic

motivation on school achievement in elementary school, high school, and university populations (Cerasoli, Nicklin, & Ford, 2014).

According to cognitive evaluation theory, one of SDT's six mini-theories (Ryan & Deci, 2017), intrinsic motivation is nurtured by the satisfaction of three basic psychological needs that are considered to be universally important for individuals' well-being and growth (Deci & Ryan, 2000). First, the need for competence refers to the need to feel effective and to be able to meet challenges. When children feel capable to engage in a requested activity, they typically find more interest in the activity itself (Sheldon & Filak, 2008). Whereas children enjoy activities they feel skilled at, they lose their interest when they feel like a failure. Second, the need for autonomy refers to the need to experience a sense of volition and psychological freedom in carrying out an activity. For children to begin enjoying an activity, they need to experience a sense of choice regarding the initiation and maintenance of the activity. In contrast, interest in an activity typically wanes when children feel pressured to partake and persist in the activity. Autonomy and competence are considered to be the most proximal predictors of intrinsic motivation (Ryan & Deci, 2017; Vansteenkiste, Niemiec, & Soenens, 2010). Relatedness, which represents a third basic need in SDT, has a more distal relation to intrinsic motivation. Children may enjoy doing an activity more with beloved others. However, a sense of warmth and reciprocal care is not always required to develop and maintain interest in an activity given that many intrinsically motivating activities are done without the company of others (e.g., reading).

Abundant research has demonstrated that when these needs are satisfied, people are more likely to become intrinsically motivated. That is, people indicate on self-reports that they like the activity more, but their intrinsic motivation also manifests behaviorally, for instance, through their continued persistence in the activity (Deci et al., 1999) and their choice to engage in challenging activities (De Muynck et al., 2017). The conducive role of psychological need satisfaction for individuals' intrinsic motivation has been documented in different developmental periods, including adolescence (e.g., Schneider & Kwan, 2013), emerging adulthood (e.g., Grouzet, Vallerand, Thill, & Provencher, 2004), and middle childhood (e.g., Rutten, Boen, & Seghers, 2012; Sebire, Jago, Fox, Edwards, & Thompson, 2013).

Contextual supports of intrinsic motivation

In analogy with the claim that fulfillment of the needs for competence and autonomy is implicated in individuals' intrinsic motivation, social contexts that support these psychological needs are argued to foster intrinsic motivation, whereas contexts that thwart these needs would hinder or even forestall the development of intrinsic motivation. One key strategy to promote intrinsic motivation is through the provision of feedback (Deci, 1972), the motivational effect of which depends on the feedback valence (Vallerand & Reid, 1984) and on the communication style (Ryan, 1982).

Feedback valence

Whereas positive feedback contains information signaling that one has performed well, negative feedback contains information signaling that one's performance is inadequate (Askew, 2000; Kluger & DeNisi, 1996). Both positive and negative feedback can be provided in relation to different types of standards (Elliot, Murayama, & Pekrun, 2011; Pekrun, Cusack, Murayama, Elliot, & Thomas, 2014). That is, the standards can be normative (i.e., feedback comparing performance with an age-specific norm table), task oriented (i.e., feedback concerning how the task is executed), or self-referential (i.e., feedback comparing performance with an individual's previous task execution). When the positive feedback is explicitly aimed at confirming and reinforcing desirable behaviors, it has also been labeled as promotion-oriented feedback (Carpentier & Mageau, 2013). In contrast, negative feedback that aims to modify behavior and ameliorate performance has also been labeled change-oriented (Carpentier & Mageau, 2013) or corrective feedback (Mouratidis, Lens, & Vansteenkiste, 2010).

Effects of feedback have been addressed in both correlational and experimental studies. Whereas the nature of feedback is typically undifferentiated in correlational studies (with items tapping into general positive or negative feedback without specifying the standards used to provide feedback), experimental studies have focused on specific forms of feedback, with especially normative feedback being examined. Correlational studies have shown that perceived positive feedback relates positively to intrinsic motivation, whereas perceived negative feedback yields a negative relation (e.g., Koka &

Hein, 2005; Mouratidis et al., 2008). In experimental studies, negative (compared with positive) feedback was found to lead to lower self-efficacy (Dahling & Ruppel, 2016), to produce performance deficits on a memory test (Eckert, Schilling, & Stiensmeier-Pelster, 2006), and to elicit greater negative affect (Slagt, Dubas, van Aken, Ellis, & Dekovic, 2017) and tension (Cianci, Klein, & Seijts, 2010). In a meta-analysis summarizing the effects of experimentally induced positive feedback on intrinsic motivation (Deci et al., 1999), positive feedback was found to enhance both self-reported interest and behavioral persistence across age groups. Yet, when breaking down the findings based on age group, positive feedback enhanced intrinsic motivation among college students while yielding a null effect among children. Because of the limited number of studies on positive feedback on children's motivation, Deci et al. (1999) called for additional experimental studies in middle childhood.

In the current study, we heeded this call by examining whether normative positive (compared with normative negative) feedback would engender intrinsic motivation among middle school children because it enhances competence need satisfaction (Deci & Ryan, 2000; Guay, Bogiano, & Vallerand, 2001). Although previous studies have contrasted the effects of positive (relative to negative) feedback on the intrinsic motivation of adolescents (e.g., De Muynck et al., 2017) and university students (e.g., Weidinger, Spinath, & Steinmayr, 2016), to the best of our knowledge, no such studies have been conducted to date among elementary school children. The studies with elementary school children included in the meta-analysis by Deci et al. (1999) instead compared the effects of positive feedback relative to a neutral control condition or a reward (either tangible or symbolic) condition in the prediction of intrinsic motivation (e.g., Anderson, Manoogian, & Reznick, 1976; Danner & Lonky, 1981; Dollinger & Thelen, 1978).

Because positive feedback signals to children that they are skilled at the activity at hand, it may stimulate interest and challenge seeking via enhanced competence satisfaction. Because negative feedback, in contrast, signals failure, participants' intrinsic motivation would plummet because of engendered feelings of competence frustration. There is some evidence for the hypothesized mediating role of competence in associations between positive feedback and intrinsic motivation, findings that emerged in correlational research in the domains of sport (e.g., Hollembeak & Amorose, 2005), physical education (e.g., Koka & Hagger, 2010), and general education (Levesque, Zuehlke, Stanek, & Ryan, 2004). Similarly, experimental studies conducted with university students or adults indicated that positive feedback positively affects individuals' intrinsic motivation via the satisfaction of the need for competence (e.g., Burgers, Eden, van Engelenburg, & Buningh, 2015; Vallerand & Reid, 1984, 1988). To the best of our knowledge, the intervening role of competence in effects of positive feedback on intrinsic motivation has not been examined to date in experimental research with elementary school children.

Communication style

In addition to feedback valence, the communication style used to convey feedback and to introduce the task more broadly also matters (Deci et al., 1999; Hattie & Timperley, 2007). That is, regardless of their valence, tasks and feedback can be administered in a more informational, inviting, and autonomy-supportive way or in a more pressuring, evaluative, and controlling way (Ryan, 1982). Research has focused on three features of an autonomy-supportive (relative to controlling) communication style. First, experimental research indicated that the use of pressuring language (e.g., "should") to introduce a task undermines both adolescents' (e.g., Hooyman, Wulf, & Lewthwaite, 2014; Vansteenkiste, Simons, Soenens, & Lens, 2004) and middle school children's (e.g., Vansteenkiste, Simons, Lens, Soenens, & Matos, 2005) autonomy, interest, and free-choice persistence compared with introducing the same task in a more inviting and autonomy-supportive way. Second, the communication style can differ in the extent to which it either elicits ego involvement, thereby hooking participants' self-worth on successful task completion (e.g., signaling that the task is diagnostic of participants' intelligence or a highly valued skill), or instead prompts task involvement, thereby securing that participants are focused on their task execution and derive a sense of enjoyment from engaging in the activity (e.g., Ryan, Mims, & Koestner, 1983; Wuyts, Vansteenkiste, Mabbe, & Soenens, 2017). Third, to vary communication style, some studies have presented the task as an evaluative test in the controlling condition (e.g., "The task you will perform is a test, which involves …"), whereas it

was portrayed as an interesting challenge (e.g., "The task you will perform is an exercise, which involves . . .") in the autonomy-supportive condition (e.g., De Muynck et al., 2017).

The use of a more autonomy-supportive (compared with more controlling) communication style can be applied to both the introduction of the task at hand and the provision of feedback on performance during the task. Indeed, according to SDT, the benefits associated with positive feedback will be attenuated when it has an evaluative connotation rather than an informational connotation (Deci et al., 1999; Pittman, Davey, Alafat, Wetherill, & Kramer, 1980; Ryan, 1982). In an experimental laboratory study among university students (Ryan, 1982), controlling (relative to autonomy-supportive) feedback was found to hamper intrinsic motivation even though the provided feedback was kept constant and was positive (e.g., "Good, you're doing as you should"). In another experimental study with undergraduates, Zhou (1998) demonstrated that the most favorable motivational outcomes were obtained in the condition where positive feedback was delivered in an autonomy-supportive way, suggesting that the combination of two facilitating factors is most beneficial. More recently, De Muynck et al. (2017) demonstrated in an ecologically valid task among adolescent tennis players that both the style and valence of feedback yielded a unique impact on intrinsic motivation and challenge seeking, as operationalized through participants' behavioral persistence at more challenging tennis exercises. Whereas autonomy-supportive feedback promoted intrinsic motivation via autonomy need satisfaction, the facilitating effect of positive feedback could be explained via increased competence satisfaction. To the best of our knowledge, no previous experimental research to date has addressed the combined effects of positive feedback delivered in an autonomy-supportive way on intrinsic motivation among elementary school children.

The role of individual differences

Not only is there a paucity of experimental work on the effects of feedback and communication style on intrinsic motivation in middle childhood, even less is known about the role of individual differences in these effects. As such, it is unclear whether some children are more sensitive than other children to the benefits of positive feedback and an autonomy-supportive communication style. From an SDT perspective, it is maintained that experiences of autonomy and competence (and perceived contextual support for these needs) yield motivational benefits for all children because psychological need satisfaction is universally important (Deci & Ryan, 2000). However, this universality claim does not imply that individual differences are neglected in SDT (Soenens, Vansteenkiste, & Van Petegem, 2015). Indeed, as a function of personality differences or exposure to different socialization experiences, children may develop individual differences in their sensitivity to potentially need-supportive contexts.

According to Moller, Deci, and Elliot (2010), individuals' sensitivity to need-supportive events depends on their more general levels of experienced need satisfaction. When children grow up in a need-supportive environment or routinely experience greater need satisfaction due to their personality, they may more easily perceive contextual support of the needs as actually meeting their needs, thereby more easily reaping the motivational benefits of contextual need support (e.g., in terms of intrinsic motivation). While preliminary evidence for these assumptions is available from research with high school students (Mouratidis, Vansteenkiste, Sideridis, & Lens, 2011) and adults (Moller et al., 2010; but see Hagger et al., 2015, for contrasting evidence), no research to date has examined the possibility of such a "sensitization effect" in middle childhood. Here, we considered the role of individual differences both in personality and in perceived maternal parenting.

Differences in personality

The five-factor model (FFM) currently represents the most comprehensive and widely used framework to describe children's and adults' personality (Caspi & Shiner, 2006). It describes personality in terms of the dimensions extraversion, emotional stability, conscientiousness, agreeableness, and openness to experience. Past research on the intersection between the FFM and SDT has found that individuals scoring higher on more adaptive traits, in particular agreeableness, openness to experience, and extraversion, report more need satisfaction and less need frustration (Mabbe, Soenens, Vansteenkiste, & Van Leeuwen, 2016; Nishimura & Suzuki, 2016). Similarly, individuals scoring higher

on conscientiousness and openness to experience reported higher levels of intrinsic motivation (Komarraju, Karau, Schmeck, & Avdic, 2011).

Although individuals with particular personality traits may more easily experience need satisfaction and intrinsic motivation, the precise mechanism underlying this association is unclear. That is, such individuals may self-select them into different environments or activities (i.e., through a proactive mechanism), interpret the same environment differently (i.e., through a reactive mechanism), or evoke different responses from others (i.e., through an evocative mechanism) (Caspi & Roberts, 2001). Here, we standardized (through experimental induction) the specific event to which children were exposed, which allowed us to zoom in on the reactive mechanism. That is, we could examine whether children scoring higher on adaptive personality traits would interpret the same environment more favorably, thereby displaying more sensitivity to need-supportive cues in the environment. Specifically, these children would report greater psychological need satisfaction and display more intrinsic motivation following the exposure to positive and autonomy-supportive feedback.

Differences in perceived maternal parenting

In addition to personality-based differences in children's need-based experiences, children can build a history of need satisfaction through interactions with need-supportive parents. Such a history of parental need support is reflected in children's perceptions of parents as being generally autonomy supportive. Autonomy-supportive socializing agents take children's perspective, which allows them to better follow children's pace of development, to acknowledge children's feelings, to provide age-appropriate choices, and to give a child-focused rationale when choices are constrained (Grolnick, Ryan, & Deci, 1991; Reeve, 2009; Soenens, Deci, & Vansteenkiste, 2017; Soenens et al., 2007). An autonomy-supportive style can be contrasted with a more controlling style, which involves pressuring children to act, think, and feel in certain ways (Grolnick & Pomerantz, 2009; Soenens & Vansteenkiste, 2010). Whereas autonomy-supportive environments support satisfaction of the basic psychological needs and the need for autonomy in particular, controlling environments thwart children's needs (Grolnick, 2003; Soenens & Vansteenkiste, 2010). Research has shown consistently that children and adolescents who perceive parents as autonomy supportive report more satisfaction of the basic psychological needs and—through satisfaction of these needs—display high-quality motivation and well-being (Costa, Cuzzocrea, Gugliandolo, & Larcan, 2016; Grolnick et al., 1991), whereas an opposite pattern emerged in the case of controlling parenting (Ahmad, Vansteenkiste, & Soenens, 2013; Mabbe et al., 2016).

Again consistent with the principle of sensitization, children who perceive their parents as autonomy supportive may be more sensitive to new need-supportive situations (Moller et al., 2010; Van Petegem et al., 2017), resulting in a more pronounced effect of positive and autonomy-supportive feedback on psychological need satisfaction and intrinsic motivation. It is particularly intriguing to examine whether this potential process of sensitization is operative across contexts; will children experiencing a need-supportive (i.e., autonomy-supportive) style in one context (at home) be more sensitive to the potential benefits of need support in a different context (i.e., positive and autonomy-supportive feedback provided in a school context)? If so, the findings would point to a cross-contextual transfer of need-based experiences (cf. Hagger et al., 2009).

The current study

The broad aim of this study was to examine the effects of normative feedback valence and communication style on elementary school children's intrinsic motivation, to detect the processes (i.e., need satisfaction) underlying these effects, and to examine the generalizability of these effects across differences in personality and perceived autonomy-supportive and controlling parenting. To do so, children filled out questionnaires tapping into personality and perceived parenting prior to being placed in one of four experimental conditions in a 2 × 2 design. The four conditions were created by crossing normative feedback valence (i.e., positive vs. negative) with communication style (i.e., autonomy supportive vs. controlling). We chose to manipulate normative (instead of task-related or self-referential) feedback because elementary school children are often exposed to normative grading practices at school and are known to engage in social comparison processes to detect their position relative to others (Pomerantz, Ruble, Frey, & Greulich, 1995).

The general conceptual model guiding this study is depicted in Fig. 1. We hypothesized, first, that both normative feedback valence and communication style will have an independent impact on children's intrinsic motivation (Hypothesis 1), such that positive (relative to negative) and autonomy-supportive (relative to controlling) normative feedback would predict elevated intrinsic motivation, as indexed by a self-report measure and by continued behavioral persistence at challenging activities. Second, with respect to mechanisms explaining these effects, we expected that an autonomy-supportive (relative to a controlling) communication style would be conducive to experiences of high autonomy (Hypothesis 2a) and that positive (relative to negative) feedback would prompt greater feelings of competence (Hypothesis 2b). In addition, feedback valence was expected to predict feelings of autonomy satisfaction (relative to pressure) as well because the feedback was provided both halfway through the task and at the end of the task. Participants who find out that they are doing well relative to their peers may feel more volitional and less pressured to engage in the puzzle-solving activity (see Cianci et al., 2010). Third, we examined possible interactions between experimentally induced feedback valence and communication style and individual differences in child personality and perceived autonomy-supportive and controlling maternal parenting in the prediction of children's psychological need-based experiences and intrinsic motivation. We aimed to test these interaction effects in the prediction of all intervening and outcome variables so as to obtain a comprehensive picture of the moderating role of children's personality and perceived parenting. The variables depicted in Fig. 1 are situated at different "distances" from the manipulated variables, with the intervening variables being more proximally related to the manipulations (i.e., autonomy and competence) and with the dependent variables yielding a more distal relation to the manipulations (i.e., intrinsic motivation). Given that few studies have addressed this possibility of moderation, we were interested in examining whether the moderation would occur primarily for the more proximal outcomes or instead would be found primarily for the "downstream" outcomes.

Method

Participants

The ethical committee at Ghent University approved the protocol of this experiment. The experimental study took place in four elementary schools in Flanders, the Dutch-speaking part of Belgium.
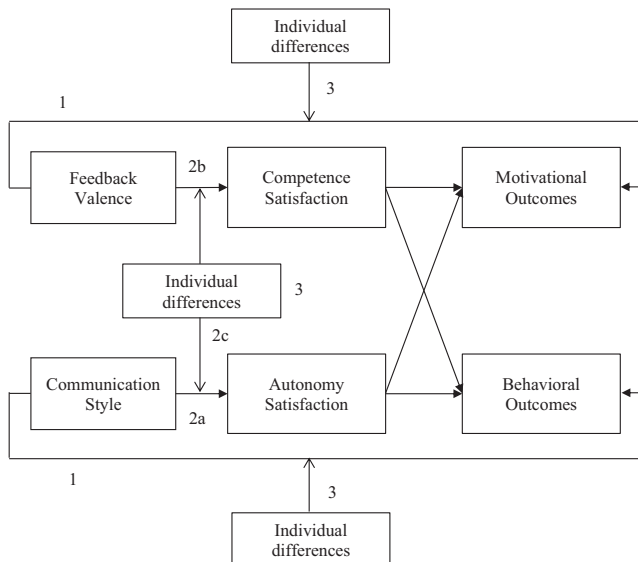

Fig. 1. Theoretical model. Numbers refer to hypotheses.

In total, 158 children and their parents received an information letter about the study and an informed consent form that was signed when they agreed to participate. We received signed informed consents from 112 families (i.e., 71% of the families who were contacted). From these families, 2 children were excluded: 1 because he was sick on the day of the experiment and 1 because he discontinued participation during the experiment. This resulted in a final sample of 110 children (M_{age} = 10.71 years, SD = 0.85, range = 9–13; 48% boys).

Procedure

The experiment took place in the participants' school within the school hours. At the beginning of the school day, the three female experimenters introduced themselves in class. Children were told that the experimenters were interested in how children of their age solved three-dimensional (3D) puzzle tasks. Children who got permission from their parents to participate and who filled out the informed consent themselves were asked to fill out a questionnaire in class. Children who did not get permission from their parents were instructed by their teacher to work independently on a task. After all children had finished filling out the questionnaire, 1 child at a time went along with one experimenter to another room, where the experimenter and child sat at a table in front of each other. During these sessions, the experimenter informed children that they would be making 3D puzzles while being filmed. Children were reassured that the tapes were confidential and that only the researchers would view these tapes. After provision of this information, the experimenter explained the different parts of the study, saying that she would first give instructions about the puzzle task and that children would then be given time to work on the puzzles and fill out a short questionnaire afterward.

The task itself involved solving a series of SOMA puzzles, a 3D puzzle task in which several different figures can be constructed with seven colored blocks. The experimenter presented two booklets, each of which contained eight different figures (e.g., an airplane, a dog). Children were told that they had 6 min to work on the puzzles in the first booklet and another 6 min to work on the puzzles in the second booklet. After this information was provided, the camera was turned on and children got the opportunity to practice two puzzles (i.e., a train and a skyscraper). Children got all the time they needed to solve both puzzles.

Next, children were provided with more specific instructions for how to solve the first series of puzzles. Children were instructed to make the puzzles in the order as they appeared in the booklet and were asked to indicate on a sheet whether they had made the puzzle correctly. If a puzzle was too hard to make, they could move to the next puzzle and needed to put a cross next to "failed" on their sheet. They were informed that an alarm would sound after 6 min, indicating that their puzzle time was over. Children could see the timer so that they could estimate how much time they had left to solve puzzles.

Experimental manipulation

Depending on children's random condition assignment (27 or 28 children per condition), they received instructions in either an autonomy-supportive or controlling fashion (see Appendix A). Whereas the autonomy-supportive instructions included inviting language and emphasized task enjoyment and challenge, the more controlling instructions included pressuring language and emphasized the evaluative nature of the situation, thereby prompting ego involvement. Specifically, the autonomy-supportive instructions differed in three different aspects from the controlling instructions. The first aspect was the type of language being used: either inviting/informational (e.g., "Let's take a look at how you have solved the puzzles") or pressuring/evaluative (e.g., "You have to perform at least equally well as before"). The second aspect was the way in which the task was presented: either as a challenge (e.g., "You will get an exercise where you can try to make the figures in this booklet") or as a test (e.g., "You will get a test where you will have to make the figures in this booklet"). The third aspect was the type of focus and involvement that was prompted: either ego involvement (e.g., "If you want to be proud again, you have to perform at least equally well as before") or task involvement (e.g., "Try to focus on how such a puzzle is built").

After 6 min, the researcher entered the room and provided children, congruent with their condition assignment but independent of their actual performance, with either positive or negative normative

feedback in an autonomy-supportive or controlling way (see Appendix B). Feedback valence was manipulated by telling children that they performed better or worse in comparison with their age mates.

After feedback provision, children were again instructed in either an autonomy-supportive or controlling way to work independently (i.e., in the absence of the instructor) on the second puzzle task, which also lasted 6 min. After 6 min, the researcher entered the room, pretended to switch off the camera (in reality the camera was still running), and provided feedback for a second time, again consistent with children's condition assignment (see Appendix B).

Free-choice phase

To tap into behavioral perseverance, a free-choice period was implemented (Deci et al., 1999). This was done by the experimenter informing children that the final stage of the experiment involved filling out a questionnaire. The experimenter then pretended that she needed to pick up those questionnaires in the school's secretariat, thereby leaving children alone for 5 min in the presence of three new booklets with puzzles and three comic books. Children were told that two of the three booklets were of similar difficulty compared with the puzzles they solved before, whereas one booklet contained more challenging puzzles. The latter puzzles were more difficult to solve because they were printed in grayscale instead of color. Before leaving the room, the experimenter told children that they could freely choose to either work on the puzzles or read the comic books. The time spent on puzzles and comic books was unobtrusively registered with the camera. After 5 min, the experimenter reentered the room and asked children to fill out a questionnaire tapping into their experiences during the puzzle task.

Measures

All measures were administered in Dutch, the participants' native language. Reliability information of the measures can be found in Table 1.

Pre-experimental measures
Perceived parenting. Children filled out the Autonomy Support Scale of the Perceptions of Parents Scale (POPS; Grolnick et al., 1991), which contains 7 items (e.g., "My mother allows me to decide things for myself"). Children were also administered the well-validated and frequently used Psychological Control Scale–Youth Self-Report (PCS-YSR; Barber, 1996), which contains 8 items (e.g., "My mother is always trying to change how I feel or think about things"). All items tapping into perceived parenting were scored on a 5-point Likert scale ranging from 1 (*completely not true*) to 5 (*completely true*).

Personality. Children completed the short version of the Hierarchical Personality Inventory for Children (HiPIC; Mervielde & De Fruyt, 1999), scoring the Big Five personality traits of children, namely conscientiousness (e.g., "I work with sustained attention"; 12 items), extraversion (e.g., "I talk throughout the day"; 12 items), agreeableness (e.g., "I take care of other children"; 15 items), emotional stability (e.g., "I am afraid to fail"; reverse scored, 6 items), and openness to experience (e.g., "I have a rich imagination"; 9 items). The items were scored on a 5-point Likert scale indicating how well the items described children, ranging from 1 (*not*) to 5 (*very good*).

Post-experimental measures
Manipulation check. Several items were included to serve as a manipulation check. There were 2 items measuring perceived controllingness (e.g., "The experimenter pressured me to perform well on the task"), 3 items tapping into perceived autonomy support (e.g., "The experimenter told me I had found my own way to solve the puzzles"), 2 items tapping into perceived positive feedback (e.g., "The experimenter was positive about my performance"), and 2 items tapping into negative feedback (e.g., "The experimenter told me I am not that smart with this kind of task").

Need experiences. To tap into children's experience of competence, we made use of the perceived competence subscale (e.g., "I think I am pretty good at this puzzle task"; 6 items) of the Intrinsic Motivation Inventory (IMI; Ryan, 1982). To measure autonomy satisfaction, the autonomy satisfaction scale

Table 1
Descriptive statistics and correlations between study variables.

	Mean (SD)	α	1	2	3	4	5	6	7	8	9	10
Pre-experimental measures												
1. Perceived maternal autonomy support	3.80 (0.58)	.62										
2. Perceived maternal control	2.04 (0.57)	.67	−.44***									
3. Extraversion	3.60 (0.52)	.65	.26**	−.15								
4. Agreeableness	3.57 (0.50)	.75	.31**	−.41***	.28**							
5. Conscientiousness	3.22 (0.52)	.63	.28**	−.31**	.28**	.52***						
6. Emotional stability	3.34 (0.74)	.68	.20*	−.29**	.41***	.35***	.30**					
7. Openness to experience	3.32 (0.64)	.74	.56***	−.23*	.35***	.22*	.35***	.15				
Post-experimental measures												
8. Autonomy satisfaction	3.40 (0.73)	.74	.27**	−.20*	.19†	.27**	.09	.24*	.18†			
9. Competence satisfaction	3.39 (1.04)	.90	.15	−.08	.08	.07	.03	.00	.22*	.61***		
10. Self-reported intrinsic motivation	4.05 (0.82)	.87	.21*	−.14	.25**	.30**	.12	.10	.19†	.64***	.75***	
11. Behavioral challenge seeking	64.54 (100.41)	–	.01	−.12	.00	.02	−.14	−.10	.12	.21*	.31**	.28**

† $p < .10$.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

of the Basic Psychological Need Satisfaction and Need Frustration Scale (BPNSNF; Chen et al., 2015), which contains 4 items (e.g., "During the puzzle task, I had the feeling that I could choose what I did"), was used. In addition, experiences of pressure and tension while working on the puzzle task (e.g., "I was anxious while working on this puzzle task"; 5 items) were assessed with the "felt pressure" subscale of the IMI (Ryan, 1982). As can be expected theoretically (Ryan & Deci, 2017), autonomy satisfaction and pressure were negatively correlated, $r(110) = −.29$, $p = .002$. To restrict the number of explanatory variables to two, a composite score was created by averaging the reverse-scored pressure items and the autonomy satisfaction items.

Intrinsic motivation. Intrinsic motivation was measured using both a self-report measure and a behavioral measure. Children indicated how interesting and enjoyable they found the puzzles using the IMI (Ryan, 1982; e.g., "Making the puzzles was fun to do"; 7 items). In addition, time spent on the most challenging puzzles during the free-choice period was used as a behavioral indicator of intrinsic motivation.

Results

Preliminary analyses

Descriptive statistics and correlations among the study variables are shown in Table 1.

Background variables

To determine whether children's scores on the study variables varied by several background variables, a multivariate analysis of covariance (MANCOVA) was conducted with gender, school, and

experimenter as fixed factors, with age as a covariate, and with all study variables as dependent variables. There were no overall multivariate effects for age (Wilks's λ = .87), $F(12, 67)$ = 0.84, p = .61, gender (Wilks's λ = .83), $F(12, 67)$ = 1.12, p = .36, school (Wilks's λ = .51), $F(36, 199)$ = 1.43, p = .06, or experimenter (Wilks's λ = .78), $F(24, 134)$ = 0.73, p = .81.[1]

Manipulation check

To examine whether the feedback valence and communication style manipulations were effective, a multivariate analysis of variance (MANOVA) was conducted with the manipulation check variables as dependent variables. The feedback valence manipulation yielded a significant effect on children's perceived positive feedback, $F(1, 102)$ = 761.97, p = .00, η^2 = .84, and negative feedback, $F(1, 102)$ = 125.36, p = .00, η^2 = .46, with children in the positive feedback condition reporting having received more positive feedback (M = 4.66, SD = 0.55) and less negative feedback (M = 1.27, SD = 0.60) compared with children in the negative feedback condition (M = 1.96, SD = 0.63 and M = 3.00, SD = 1.28, respectively). The communication style manipulation yielded a significant effect on children's perceived autonomy support, $F(1, 102)$ = 11.15, p = .001, η^2 = .07, and control, $F(1, 102)$ = 10.71, p = .001, η^2 = .09, with children in the autonomy-supportive condition reporting less control (M = 1.84, SD = 0.86) and more autonomy support (M = 3.22, SD = 0.85) compared with children in the controlling condition (M = 2.44, SD = 1.11 and M = 2.74, SD = 0.90, respectively).

Randomization

A MANOVA was conducted with the two manipulations as fixed factors and with child age, experienced parenting, and personality as dependent variables. Neither the feedback valence manipulation (Wilks's λ = .97), $F(8, 92)$ = 0.36, p = .94, nor the communication style manipulation (Wilks's λ = .86), $F(8, 92)$ = 1.94, p = .06, yielded an effect on these variables. Chi-square tests indicated that child gender, Pearson $\chi^2(3)$ = 2.68, p = .44, school, Pearson $\chi^2(9)$ = 1.58, p = .97, and experimenter, Pearson $\chi^2(6)$ = 0.56, p = .98, were equally distributed across the four conditions. Randomization across conditions was successful.

Primary analysis

Hypothesis 1: Independent impact of feedback valence and communication style on children's intrinsic motivation and need experiences

The effects of the manipulations were investigated using a MANOVA. Feedback valence and communication style were entered as independent variables. The self-reported post-experimental measures and the behavioral challenge-seeking measure obtained during the free-choice period were entered as dependent variables. Results indicated a multivariate effect for feedback valence (Wilks's λ = .33), $F(4, 97)$ = 48.83, p = .00, η^2 = .67, and communication style (Wilks's λ = .88), $F(4, 97)$ = 3.44, p = .01, η^2 = .12, whereas the multivariate effect for the interaction was nonsignificant (Wilks's λ = .94), $F(4, 97)$ = 1.61, p = .18, η^2 = .06.

Table 2 shows the means and standard deviations for the four experimental conditions together with the effects of the feedback valence and communication style manipulations. The effect size on the outcomes was investigated by inspecting the partial eta-squared and Cohen's d values. A partial eta-square of .01 and a Cohen's d between 0.20 and 0.50 represent a small effect, a partial eta-square of .06 and a Cohen's d between 0.50 and 0.80 represent a medium effect, and a partial eta-square of .14 and a Cohen's d greater than 0.80 represent a large effect (Cohen, 1992). Both manipulations yielded a main effect on self-reported intrinsic motivation, autonomy satisfaction, and competence satisfaction. As hypothesized, children reported more intrinsic motivation (η^2 = .33 and η^2 = .07 for effects of feedback valence and communication style, respectively), autonomy satisfaction (η^2 = .22 and η^2 = .06, respectively), and competence satisfaction (η^2 = .65 and η^2 = .08, respectively) when receiving positive (relative to negative) feedback and when exposed to an autonomy-supportive (rel-

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[1] Because the background variable "school" had a marginally significant effect on the study variables (p = .06), the primary analyses were rerun including school as a covariate. All of the initially reported findings remained significant after controlling for school.

Table 2
Means (and standard deviations) for the four experimental conditions together with the effects of the feedback valence, communication style, and their interaction on assessed outcomes.

	Autonomy-supportive style		Controlling style		Valence manipulation			Style manipulation			Valence by style	
	Positive	Negative	Positive	Negative	F	η_p^2	Cohen's d	F	η_p^2	Cohen's d	F	η_p^2
Self-reports												
Autonomy satisfaction	3.86 (0.69)	3.27 (0.65)	3.61 (0.64)	2.86 (0.56)	28.02***	.22	1.05	6.89*	.06	0.52	0.39	.00
Competence satisfaction	4.24 (0.63)	2.86 (0.73)	4.14 (0.49)	2.27 (0.59)	195.78***	.65	1.58	9.67**	.08	0.55	4.50*	.04
Self-reported intrinsic motivation	4.54 (0.44)	3.88 (0.88)	4.45 (0.49)	3.29 (0.74)	52.56***	.33	1.37	7.45**	.07	0.53	4.00*	.04
Behavioral indicator												
Behavioral challenge seeking	89.36 (116.64)	23.59 (65.62)	88.14 (111.18)	55.26 (88.88)	7.09**	.06	0.51	0.54	.01	0.15	0.74	.01

* $p < .05$.
** $p < .01$.
*** $p < .001$.

ative to a controlling) communication style. The valence manipulation (but not the communication style manipulation) also had a main effect on behavioral challenge seeking (η^2 = .06), with children in the positive (relative to the negative) feedback condition spending more time making puzzles in the most challenging booklet.

For competence satisfaction (η^2 = .04) and self-reported intrinsic motivation (η^2 = .04), an interaction effect emerged between the two manipulations (see Fig. 2). The undermining impact of negative feedback on perceived competence and self-reported intrinsic motivation was less pronounced for those participants being addressed in an autonomy-supportive way. Although these interactions are informative, they should be interpreted with caution because the interaction between the two manipulations was not significant at the multivariate level.

Hypothesis 2: The intervening role of psychological need experiences

To test the intervening role of psychological need satisfaction in the effects of the manipulations on self-reported intrinsic motivation and behavioral challenge seeking, an integrated path model was tested. Path analysis with manifest variables using Mplus 7 software with robust maximum likelihood estimation (Muthén & Muthén, 2010) was used to estimate this model. We inspected the comparative fit index (CFI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR) as indicators of model fit. Values lower than or close to .06 for *RMSEA* and .09 for *SRMR*, and values of .95 or higher for *CFI*, reflect adequate fit (Hu & Bentler, 1999).

In this model (see Fig. 3), self-reported intrinsic motivation and behavioral challenge seeking were modeled as outcome variables. The model showed adequate fit, $\chi^2(4)$ = 2.84, *p* = .59, *RMSEA* = .00, *CFI* = 1.00, *SRMR* = .03. Both positive (compared with negative) feedback and an autonomy-supportive (compared with a controlling) communication style predicted more competence satisfaction (β = .79, *p* = .000, confidence index (*CI*) = [.73, .85] and β = .17, *p* = .003, *CI* = [.06, .28], respectively) and autonomy satisfaction (β = .44, *p* = .000, *CI* = [.30, .59] and β = .23, *p* = .005, *CI* = [.07, .39], respectively).
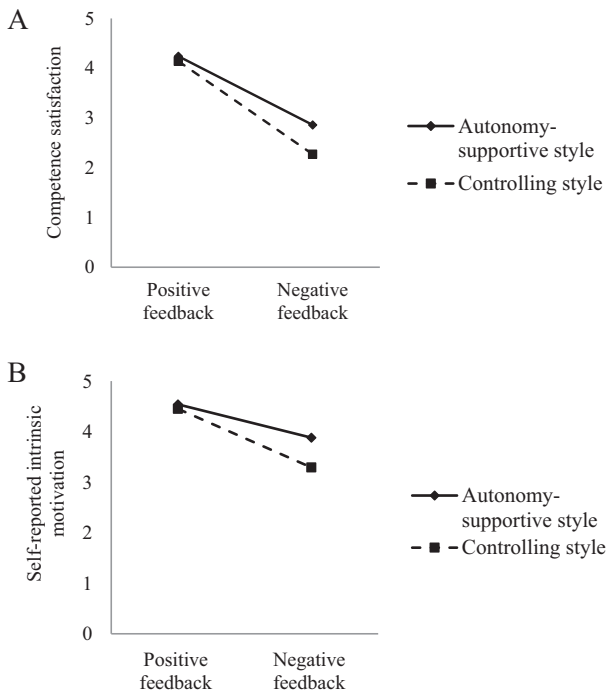

Fig. 2. Significant interaction effect of valence by style of feedback in the prediction of self-reported competence (A) and intrinsic motivation (B).
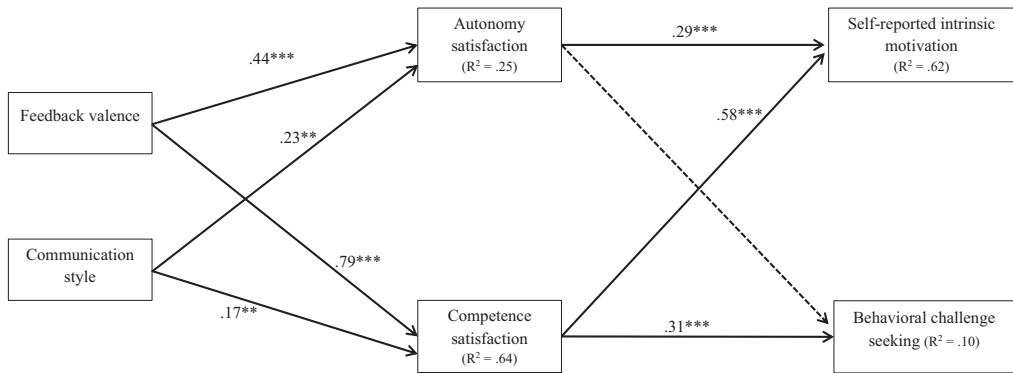
Fig. 3. Obtained structural model. Coefficients are standardized. Dotted lines are nonsignificant pathways. [**]$p < .01$; [***]$p < .001$.

In turn, the more participants' needs for autonomy and competence were satisfied, the more intrinsic motivation they reported ($\beta = .29$, $p = .000$, $CI = [.15, .42]$ and $\beta = .58$, $p = .005$, $CI = [.45, .70]$, respectively). In addition, competence satisfaction ($\beta = .31$, $p = .000$, $CI = [.14, .47]$), but not autonomy satisfaction ($\beta = .01$, $p = .89$, $CI = [-.17, .20]$), was associated with behavioral challenge seeking.

A test for indirect effects in Mplus indicated significant indirect associations from feedback valence to self-reported intrinsic motivation through competence satisfaction ($\beta = .45$, $p = .000$, $CI = [.34, .55]$) and autonomy satisfaction ($\beta = .13$, $p = .000$, $CI = [.06, .18]$) and from feedback valence to behavioral challenge seeking through competence satisfaction ($\beta = .24$, $p = .000$, $CI = [.11, .37]$). As for feedback style, there was a significant indirect association from feedback style to self-reported intrinsic motivation through competence satisfaction ($\beta = .10$, $p = .004$, $CI = [.03, .16]$) and autonomy satisfaction ($\beta = .07$, $p = .03$, $CI = [.01, .13]$), whereas the indirect effect from feedback style to behavioral challenge seeking through competence satisfaction was equally significant ($\beta = .05$, $p = .02$, $CI = [.01, .10]$).

Hypothesis 3: The moderating role of personality and perceived parenting

To examine the potential moderating role of the personality traits (i.e., extraversion, agreeableness, conscientiousness, emotional stability, and openness to experience) and perceived parenting (i.e., perceived autonomy-supportive and controlling maternal parenting), each of these variables was included separately in the integrated model. In each of these separate models, the main effects of the experimental manipulations, one single potential moderator, and the interaction terms between the manipulated variables and the potential moderator were introduced as predictors of all intervening and dependent variables. The predictor and moderating variables were standardized before calculating a product term (Aiken & West, 1991) so as to make the interpretation of the coefficients simpler (Cohen & Cohen, 1983; Kleinbaum, Kupper, & Muller, 1988).

Given the presence of seven moderators, four outcomes, and two condition variables, a total of 56 interactions were tested. Of these, seven interactions were significant, with three of them involving parenting and four involving personality traits. In addition, one interaction emerged in the prediction of competence satisfaction, four interactions emerged in the prediction of self-reported intrinsic motivation, and two interactions emerged in the prediction of behavioral persistence in the most challenging booklet. Finally, five interactions emerged in relation to communication style, and two interactions emerged in relation to feedback valence.[2,3]

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[2] Applying a Bonferroni correction results in an adjusted alpha level of .00089 (.05/56). When taking this adjusted alpha level into account, none of the significant interactions remained significant.

[3] An a priori power analysis using G∗Power software (Faul, Erdfelder, Buchner, & Lang, 2009) based on effect sizes obtained in the De Muynck et al. (2017) study showed that the sample was sufficiently large to detect main effects. For instance, one of the central effects in the De Muynck et al. study (i.e., the effect of feedback valance on competence) had an effect size of .43. The a priori power analysis showed that this effect would require a sample size of 113, which is very close to our sample size of 110. Given the lack of any previous studies that examined similar interactions as the ones we examined here, it was impossible to conduct a power analysis because no estimation could be made of the expected effect size.

With respect to the main effects of the personality traits, children scoring high on agreeableness and extraversion reported more self-reported intrinsic motivation (β = .22, *p* = .002, *CI* = [.08, .35] and β = .11, *p* = .04, *CI* = [.01, .21], respectively) and autonomy satisfaction (β = .24, *p* = .002, *CI* = [.09, .39] and β = .22, *p* = .04, *CI* = [.01, .42], respectively). Children scoring high on extraversion and openness to experience reported more competence satisfaction (β = .13, *p* = .02, *CI* = [.02, .23] and β = .16, *p* = .002, *CI* = [.06, .27], respectively). Children scoring high on emotional stability reported more autonomy satisfaction (β = .24, *p* = .003, *CI* = [.08, .39]).

The interaction effects with personality can be found in Figs. 4–6. The graphical presentation of interactions was limited to those for which at least one simple slope was found to be significant, thereby creating groups 1 standard deviation above and below the moderator. A significant interaction between agreeableness and communication style (β = −.22, *p* = .02, *CI* = [−.40, −.04], R^2 change = .05) in the prediction of challenge seeking was found (Fig. 4). A simple slopes test indicated that children scoring high on agreeableness persisted less in the most challenging booklet after receiving feedback in an autonomy-supportive (relative to a controlling) way (*B* = −31.59, *t* = −2.34, *p* = .02), whereas there was no difference in behavioral challenge seeking in both conditions among children low on agreeableness (*B* = 17.00, *t* = 1.11, *p* = .27). Second, although there was a significant interaction between extraversion and feedback valence (β = −.20, *p* = .00, *CI* = [−.30, −10]) in the prediction of self-reported intrinsic motivation, the regressions at both values of the moderator turned out to be nonsignificant (*B* = 0.31, *t* = 1.57, *p* = .12 and *B* = −0.19, *t* = −1.11, *p* = .27). Third, there was a significant interaction between conscientiousness and communication style (β = .12, *p* = .05, *CI* = [.01, .25], R^2 change = .01) in the prediction of competence satisfaction (Fig. 5). Children scoring high on conscientiousness benefited more from positive feedback in terms of experienced competence (*B* = 0.29, *t* = 4.50, *p* = .00) compared with those scoring low on conscientiousness (*B* = 0.04, *t* = 0.59, *p* = .56). Fourth, there was a significant interaction between conscientiousness and communication style (β = −.12, *p* = .03, *CI* = [−.23, −.01], R^2 change = .01) in the prediction of self-reported intrinsic motivation (Fig. 6). Children scoring low on conscientiousness reported a marginally significant decrease in self-reported intrinsic motivation in the controlling condition compared with the autonomy-supportive condition (*B* = 0.26, *t* = 1.73, *p* = .08), whereas such a difference was not found among children scoring high on conscientiousness (*B* = −0.04, *t* = −0.33, *p* = .74).

With respect to the main effects of perceived parenting, children who perceived their mother as autonomy supportive reported more autonomy satisfaction (β = .24, *p* = .001, *CI* = [.09, .39]) and more competence satisfaction (β = .12, *p* = .02, *CI* = [.02, .22]). Perceived maternal psychological control did not yield any significant main effects. With perceived maternal autonomy support, there were interactions between perceived maternal autonomy support and feedback valence (β = −.12, *p* = .02, *CI* = [−.22, .02]) and communication style (β = −.10, *p* = .04, *CI* = [−.19, .01]) in the prediction of self-reported intrinsic motivation. A closer inspection of the slopes at both values of the moderator indicated, however, that none of them was significant, either in the case of manipulated feedback style (*B* = 0.09, *t* = 0.88, *p* = .38 and *B* = −0.07, *t* = −0.57, *p* = .57, respectively) or in the case of feedback valence (*B* = 0.02, *t* = 0.10, *p* = .92 and *B* = −0.18, *t* = −0.80, *p* = .42, respectively).

With perceived maternal control, there was an interaction (Fig. 7) between perceived maternal control and communication style (β = .24, *p* = .001, *CI* = [.10, .39], R^2 change = .04) in the prediction of persistence in the most challenging booklet. Children perceiving low maternal control persisted less in the most challenging booklet after receiving feedback in an autonomy-supportive (relative to a controlling) way (*B* = −31.51, *t* = −2.28, *p* = .02), whereas for children high on experienced maternal control no difference between the two conditions was found (*B* = 13.11, *t* = 0.94, *p* = .35).

Discussion

Although previous research has addressed the motivational role of positive feedback (Deci, 1971; Deci et al., 1999; Mouratidis et al., 2008) and an autonomy-supportive communication style (Ryan, 1982; Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004), few experimental studies on the independent and combined role of both contextual influences have been conducted among elementary school children. This is unfortunate because intrinsic motivation is a powerful resource for children's school
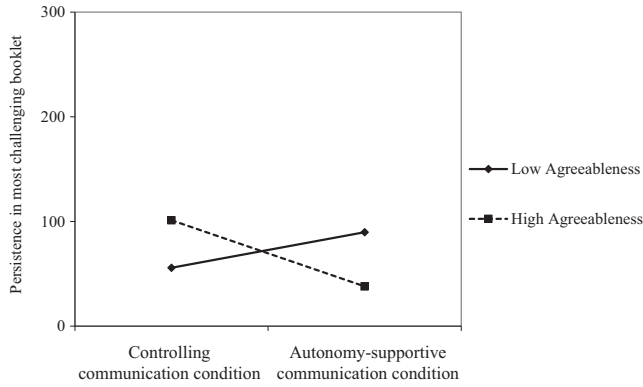
Fig. 4. Significant interaction effect between style of feedback and agreeableness in the prediction of persistence in the most challenging booklet.
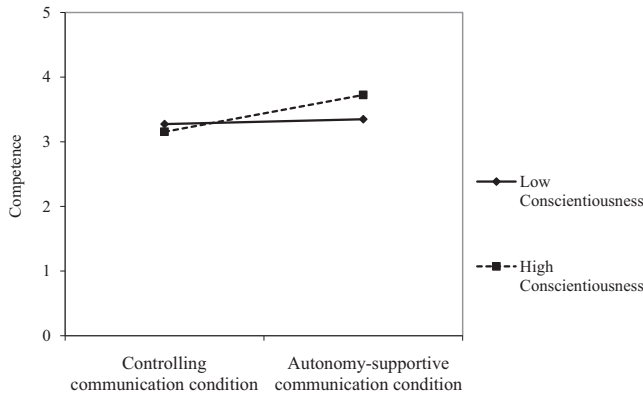

Fig. 5. Significant interaction between style of feedback and conscientiousness in the prediction of competence.
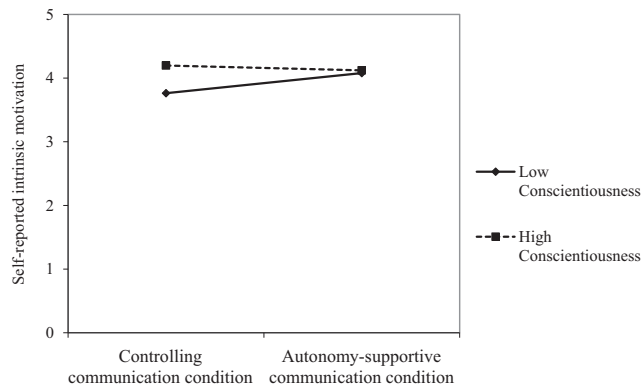

Fig. 6. Significant interaction between style of feedback and conscientiousness in the prediction of self-reported intrinsic motivation.

engagement and performance in this crucial developmental period (Larson & Rusk, 2011). In addition, little attention has been paid to the question of whether individual differences alter these hypothesized contextual supports for intrinsic motivation.

The motivating power of positive feedback

Feedback valence yielded a fairly strong effect across a variety of outcomes. The size of these effects is similar to effect sizes obtained by De Muynck et al. (2017) in a study with a similar design but with an older sample. In the current study, we found a stronger effect of feedback valence on autonomy satisfaction. Compared with the results of the meta-analysis (Deci et al., 1999), in which positive feedback effects among children yielded a nonsignificant composite effect size ($d = 0.11$), this study yields a stronger effect. In the meta-analysis, the effects of positive feedback relative to a neutral control condition or a reward condition (and not to negative feedback) were compared, which may help to explain the discrepancy.

As hypothesized, children receiving positive feedback reported more intrinsic motivation for the task and were eager to continue engaging in challenging activities afterward. Working on these more demanding puzzles can be seen as an expression of children's attempts to seek further challenge and of their desire to fully master the task at hand. Thus, persistence in the more challenging booklet serves as a proximal behavioral indicator of intrinsic motivation, as also exemplified by the significant positive correlation with the child-reported measure of intrinsic motivation.

Mediational analyses indicated that children receiving positive feedback maintained their interest because their psychological needs for both competence and autonomy were met. These findings are consistent with past work among adolescents and (emerging) adults (e.g., Deci et al., 1999; Viciana, Cervello, & Ramirez-Lechuga, 2007). At the same time, the current study extends this body of work by demonstrating the explanatory role of multiple need-based experiences (not only competence) in the relation between positive (relative to negative) feedback and intrinsic motivation. The finding that children who receive negative feedback feel less competent is somewhat self-evident. Yet, the observation that the negative feedback also decreased children's sense of autonomy, which in turn also forestalled their interest, is more novel. De Muynck et al. (2017) reported similar findings among adolescent tennis players, who also received standardized normative feedback. In both studies, the negative feedback was given halfway through task execution, which may have elicited feelings of pressure to improve one's performance during the second half of the task (see also Cianci et al., 2010).

Overall, the current findings hint at the possibility of a self-perpetuating positive cycle of motivation, with the experiences of competence emanating from positive feedback leading children to actively search for further competence-enhancing experiences through the choice of challenging activities. Future research may want to assess to what extent children derive a further sense of mastery and competence from engaging in these challenging activities, thereby actually testing the possibility of a positive spiral. Because the provided feedback was normative in nature, future research may examine whether task-based ("You did not pay enough attention to X") or self-referential ("You did worse than in the previous set of puzzles") negative feedback comes with similar motivational deficits (see Burgers et al., 2015; Pekrun et al., 2014). It is possible that task-based negative feedback may be more informational in nature because it contains specific hints of how to change one's task execution (Carpentier & Mageau, 2013, 2016). As a result, the demotivating impact of task-based negative feedback may be less strong, with the feedback style yielding a more pronounced effect compared with the effect observed in the current study.

The more subtle effects of an autonomy-supportive communication style

With respect to communication style, children receiving instructions and feedback in an autonomy-supportive (relative to a controlling) way reported being more interested in the task, although their increased intrinsic motivation did not manifest behaviorally via increased challenge seeking. At the same time, they experienced greater autonomy satisfaction, as we had hypothesized, and felt more competent, a finding that was not anticipated. The observed benefits for intrinsic motivation are in line with previous research among adolescents (Vansteenkiste et al., 2004) and young
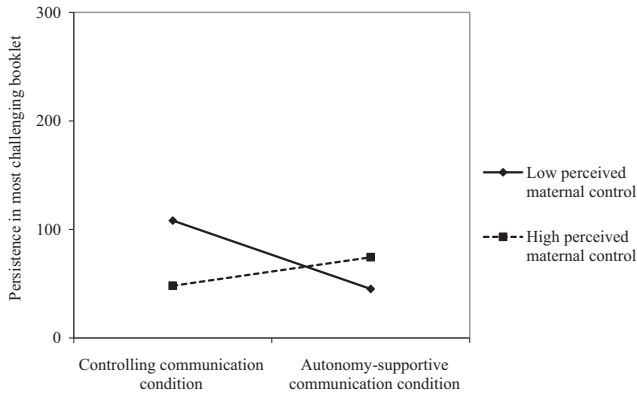
Fig. 7. Significant interaction between style of feedback and perceived maternal control in the prediction of persistence in the most challenging booklet.

adults (Ryan, 1982) and underscore the beneficial motivational impact of an autonomy-supportive communication style among elementary school children (see also Vansteenkiste et al., 2005). Both the increased autonomy and competence satisfaction accounted for the positive impact of an autonomy-supportive communication style on children's self-reported intrinsic motivation.

Compared with other studies examining informational versus controlling feedback (Kast & Connor, 1988; Pittman et al., 1980; Ryan, 1982; Ryan et al., 1983), with an average Cohen's d of 0.75, this study had a smaller effect size (Cohen's d values ranging between 0.15 and 0.55). Overall, effects of communication style were less pronounced than those of feedback valence, as reflected by (a) the lower effect sizes for communication and (b) the observation that, of the seven interactions, five involved communication style (discussed further below). The more variable effect of style may be due to differences in the *salience* of the manipulation. Whereas the manipulation of feedback valence in our study was quite clear and direct (with children being explicitly compared with peer-based norms), the difference between autonomy-supportive and controlling communication was manipulated in a subtler way (i.e., differences in verbal instructions and type of language used to convey feedback). It is possible that other manipulations of autonomy support (such as provision vs. denial of choice) may contribute more directly and strongly to motivational outcomes (Patall, Cooper, & Robinson, 2008).

Still, the effects of manipulated autonomy support should not be underestimated because they are in line with effects obtained in research with adolescents and adults (e.g., Vansteenkiste et al., 2004) and because they occurred over and above the strong effects of the very salient feedback valence manipulation. In addition, the manipulation of autonomy support qualified some of the effects of negative feedback, an issue that received little attention in prior work. Specifically, the obtained interaction effects indicate that the motivationally undermining effect of negative feedback on children's competence feelings and intrinsic motivation is dampened if the feedback is offered in an autonomy-supportive way. These results are consistent with previous correlational studies on the interplay between autonomy support and structure (Curran, Hill, & Niemiec, 2013; Mouratidis et al., 2010; Sierens, Vansteenkiste, Goossens, Soenens, & Dochy, 2009). In addition, whereas prior experimental work found individuals with a learning goal orientation to be more immune against the motivational costs associated with negative feedback (Dahling & Ruppel, 2016), the current findings suggest that contextual features also can play such a buffering role. In this respect, the current interactions have important practical implications because they suggest that the demotivating impact of negative feedback can be attenuated when the feedback is delivered in an autonomy-supportive way.

Although feedback style had an impact on self-reported intrinsic motivation, it yielded only an indirect association with behavioral seeking via increased competence need satisfaction. As such,

the findings obtained for the self-reported and behavioral indicator of intrinsic motivation were somewhat discrepant. Such discrepancies have also been observed in past work on the impact of monetary rewards on intrinsic motivation (see Deci et al., 1999). In the current study, two different reasons may explain the lack of parallel effects for communication style. First, the fact that feedback valence (but not feedback style) produced a consistent effect across self-reported and behaviorally recorded indicators of intrinsic motivation may be due to the more powerful effect of feedback valence. Indeed, the effect size for self-reported intrinsic motivation was much larger for the feedback valence manipulation relative to the manipulation of communication style. The effect of feedback valence may have been so strong that it also extended to a behavioral indicator (i.e., challenge seeking), whereas the effect of feedback style was not strong enough to influence children's behavior but merely affected their liking of and interest in the activity. Second, the type of persistence elicited under controlling circumstances might not have been purely intrinsically motivated, instead being also internally controlled in nature. That is, at least some children may have continued working on the puzzles to prove their worth and to demonstrate to themselves that they were capable of solving the puzzles (Ryan, Koestner & Deci, 1991).

The role of individual differences

In addition to providing robust evidence for the unique and combined impact of feedback valence and communication style, this study also examined whether these effects occur independent of children's personality and perceived quality of maternal parenting. On the basis of SDT, it was expected that effects of contextual support for competence and autonomy would generalize across individual differences in personality and perceived parenting because such contextual support appeals to universally important psychological needs. Still, SDT leaves open the option that some children are more sensitive to the benefits of contextual need support (Soenens et al., 2015). In particular, children who are generally prone to experience need satisfaction on the basis of either their personality or the supportive environment they find themselves in might be more sensitive to the motivating effects of contextual need support. The issue of generalization also has practical implications because more work around motivational tailoring would be required if it turns out that some children are less sensitive to effects of contextual need supports.

Of the 56 tested interactions, seven turned out to be significant. Before considering these interactions in greater detail, the main effects of experienced parenting and personality deserve being discussed. Children who experience their mother as more autonomy supportive in general reported more competence satisfaction and to experience more volition and autonomy during activity engagement. This finding provides indirect support for the transcontextual model of motivation (Hagger et al., 2009) because mothers' motivational style in one context (i.e., at home) seems to forecast motivational advantages in a different context (i.e., at school). As for the personality traits, more adaptive personality traits (i.e., agreeableness, conscientiousness, and emotional stability) related to more positive experiences during the experimental task. Such findings can be related to the trait congruency hypothesis (Rusting & Larsen, 1998), which states that personality dimensions associated with positive moods (i.e., extraversion) and negative moods (i.e., low emotional stability) predispose individuals to process information that is congruent with those traits and, as such, affect selective processing of emotional information.

With regard to the 7 significant moderation effects, 3 of them could not be interpreted meaningfully because the effects of the manipulation were nonsignificant at both low and high levels of the moderator. Because the shape of these interactions was unclear, we refrain from discussing these interactions, instead calling for replication work. As for the four remaining interactions, two different types emerged. One interaction was in line with the *sensitization* hypothesis (Moller et al., 2010). Specifically, children high on conscientiousness were more sensitive to the benefits of an autonomy-supportive communication style, thereby deriving a greater sense of competence from the activity.

The three other interactions were indicative of *resilience*. A second interaction with conscientiousness was found, this time in the interaction with communication style in the prediction of self-reported intrinsic motivation. Specifically, children high (relative to low) in conscientiousness did

not report a decrease in self-reported intrinsic motivation when facing a controlling communication style. Furthermore, children low on perceived maternal psychological control and high on agreeableness persisted more at the challenging booklet after receiving controlling feedback, suggesting that these children are more resilient against the negative effects of a controlling communication style. Interestingly, these two interactions occurred with respect to the behavioral indicator of intrinsic motivation only. Perhaps these children's challenge seeking was not entirely intrinsically motivated, instead also being undergirded by other motives such as the desire to restore their thwarted needs (Radel, Pelletier, Sarrazin, & Milyavskaya, 2011), the motive to please others, and an inclination to demonstrate their self-worth and value (Ryan et al., 1991; van der Kaap-Deeder et al., 2016).

Overall, when comparing the actual and potential numbers of interactions, we can conclude that personality and perceived maternal parenting play only a modest role in altering the effects of feedback valence and communication style. Similarly, the main effects of the personality and parenting variables assessed at baseline in the prediction of children's experiencing during the puzzle-solving activity were rather modest in terms of effect size. It is possible that the experimental induction suppressed associations between the general pre-experimental measures and the situation-specific post-experimental measures. Indeed, although the experimental induction was orthogonal to the pre-experimental measures, it accounted for part of the variance in the post-experimental measures. Overall, future research is needed to replicate the current pattern of main effects and interactions before any firm conclusions can be drawn.

Limitations and directions for future research

The current study had a number of methodological limitations that could be addressed in future work. First, due to the lack of a (neutral) control group, it remains unclear whether the provision of positive feedback in an autonomy-supportive way would really enhance positive motivational outcomes and whether negative feedback delivered in a controlling way would undermine motivational outcomes (see De Muynck et al., 2017). Second, we note that a number of scales had rather poor reliability. This was particularly the case for some of the pre-experimental measures. As a consequence of this modest reliability, the number of interactions between the pre-experimental measures and the experimental inductions may have been somewhat underestimated. Third, the explanatory mechanisms (i.e., autonomy and competence satisfaction) were assessed concurrently with the self-reported intrinsic motivation. As a consequence, the experienced enjoyment may have colored children's need-based experiences instead of the other way around. In the ideal case, the assessment of presumed mediators precedes the assessment of the dependent variables. Future research could assess the mediating mechanisms during the task instead of after task completion.

Fourth, although effects for communication style might become more pronounced in case feedback would not have been normative but instead task based in nature, it is also possible that repeated exposure to a certain communication style is needed to enhance its impact. In future research, it would be interesting, for instance, to manipulate a controlling style multiple times and to examine, through a longitudinal design, the cumulative effects of a controlling style on students' motivation (see Reeve & Tseng, 2011). Alternatively, the autonomy-supportive style used to introduce the task and to provide feedback could be differently operationalized so as to strengthen the manipulation. For instance, participants could be given a meaningful rationale for their task engagement (Jang, 2008), and the feelings of disappointment that come along with negative feedback could be acknowledged (Savard, Joussemet, Pelletier, & Mageau, 2013).

Fifth, to gain insight into the specific aspects of communication style driving the effects, future research could disentangle effects of these different aspects (e.g., the type of language being used, the way in which the task was presented, the type of focus and involvement that was prompted) and investigate their unique contribution to motivational outcomes.

Finally, content-wise, perceived parenting was operationalized in terms of maternal autonomy-supportive and controlling parenting only. Future research could address the role of other dimensions of parenting (e.g., warmth, structure). Research could also include perceived paternal parenting and possibly include parent ratings or observations instead of solely relying on child reports. Because we focused exclusively on maternal parenting in the current study, it is important for future research

to include ratings from both parents to obtain a more complete view of the role of parents. There is increasing evidence that mothers' and fathers' autonomy support and controllingness are related similarly to educational outcomes in children (Pinquart, 2016; Vasquez, Patall, Fong, Corrigan, & Pine, 2016). However, research has not yet addressed the unique role of mothers and fathers in the way children respond to feedback outside the home context. By doing so, it could also be examined whether one parent's style interacts with the other parent's style in the prediction of how children respond to experimentally manipulated feedback. For instance, children might be most resilient to negative and controlling feedback when both parents are simultaneously high on autonomy support. In future research, parent ratings of personality traits may also be included.

Practical implications

Our finding that contextual need support is largely effective across children's individual differences can be important to convince socializing agents (e.g., teachers, parents) to systematically adopt a need-supportive communication style when interacting with children. This is important because research shows that many adults, including parents and teachers, have reservations about the motivational effectiveness of a need-supportive style (Boggiano, Barrett, Weiher, McClelland, & Lusk, 1987). For instance, teachers tend to believe that an autonomy-supportive approach is effective only among students who are already optimally motivated for school (De Meyer et al., 2016). With such beliefs about the limited effectiveness of autonomy support, adults are less likely to support children's autonomy wholeheartedly. Findings from the current study could be used to inform adults about the relevance of contextual support for autonomy and competence irrespective of children's personality or experiences of need support in other contexts (e.g., the family).

Although in this study positive normative feedback delivered in an autonomy-supportive way was associated with the most favorable outcomes, we do not advocate the provision of positive normative feedback as an ideal practice in educational settings. Even when its valence is positive, normative feedback may elicit social comparison processes, with such processes leading to ego involvement in children and pressured attempts by children to demonstrate their worth. Although an autonomy-supportive communication style may offset some of the risks associated with normative feedback (and with negative normative feedback in particular), it can be recommended to rely on self-referential and task-based types of feedback instead. The informational value of the latter types of feedback is higher because they are more change oriented (Carpentier & Mageau, 2013). Moreover, these informational types of feedback provide more opportunities for socializing agents to be truly autonomy supportive, thereby attending to individual students' strengths and weaknesses (instead of making potentially stressful and ego-involving comparisons between students). Feedback can be provided in an autonomy-supportive way by providing a meaningful rationale for the given feedback, by eliciting children's own perspective with respect to task execution, and by refraining from the use of pressuring language and the expression of disappointment in children's performance (Carpentier & Mageau, 2013; Mouratidis et al., 2010). Yet, inevitably in real-life classrooms, elementary school children are often confronted (either explicitly or implicitly) with between-student comparisons. The current results show that the demotivating impact of messages conveying normative negative feedback can be counteracted if presented in an autonomy-supportive manner. Therefore, it is important that socialization figures be mindful of the language they use when providing instructions and when giving feedback.

This study also highlights the importance for children to experience parents as autonomy supportive. Irrespective of the experimental induction, perceived autonomy-supportive parenting seems to help children perceive situations in school in a more favorable way. Given these findings, intervention and prevention efforts could aim to increase parents' actual and perceived use of autonomy support. A number of intervention studies demonstrated that parents can indeed be taught to interact with children in a more autonomy-supportive fashion, with these increases in parents' use of autonomy support enhancing children's quality of motivation and psychosocial adjustment (Froiland, 2015; Joussemet, Mageau, & Koestner, 2014).

Conclusion

In this study, we tested the effects of both feedback valence and communication style on elementary school children's intrinsic motivation. The findings suggest that especially positive feedback, but also a more inviting and autonomy-supportive communication style, can help to explain why children get truly interested in the material at hand and choose to engage in more challenging activities while others lose interest and give up. There was some room for variation in the effectiveness of these strategies depending on children's personality and the perceived parenting style, especially with regard to the type of communication style. At the same time, we note that the number of interactions is limited and that the nature of the interactions is fairly diverse, which calls for further research on these matters so as to avoid drawing premature conclusions. Overall, it seems that socializing agents do well to communicate feedback in a way that is supportive of children's psychological needs for autonomy and competence.

Appendix A. Instructions

A.1. Autonomy-supportive instructions

"You will be given an exercise in which you can have a go at trying to build the figures in this booklet (blue one). Different people use different strategies to solve puzzles. We would like to see how you do it. Please try and complete as many puzzles as you can in 6 min. Let's see how you do the puzzles and how many puzzles you can make. I'm curious to see how you do it. Have fun!"

A.2. Controlling instructions

"You will be given a test, in which you will have to build the figures in this booklet (blue one). These puzzles reveal how much insight you have and measure how smart you are at these kinds of puzzles. You have to complete as many puzzles as possible in 6 min. After this task, I will judge how well you performed. It's up to you now to prove yourself."

Appendix B. Feedback manipulations

B.1. Positive feedback phase 1

Autonomy supportive communication style	Controlling communication style
"Let's take a look at how you solved the puzzles. I brought some tables to help us do this. I see that you solved X puzzles. When I look at the table, this is better than most kids your age. That's a good thing, because it means that you found your own strategy to solve the puzzles. I suggest we now go to the second booklet with exercises (the green one). The exercises in this booklet are more challenging than the exercises in the first booklet. Try to focus on how these puzzles are built."	"Let's see how well you did compared to other children who are the same age as you. I brought some tables to help see how well you performed. I see that you solved X puzzles. When I look at the table, that's better than most kids your age. That's good, because it shows that you are smart at these kinds of puzzles. If you continue this way, you can be proud of yourself. There is now a second test which is more difficult (the green one). If you want to feel proud of yourself again, then at the very least you have to perform as well as before."

B.2. Negative feedback phase 1

Autonomy supportive communication style	Controlling communication style
"Let's take a look at how you solved the puzzles. I brought some tables to do this. I see that you solved X puzzles. When I look at the table, this is not as good as most kids your age. This means that you can continue to search for other ways to solve the puzzles. I suggest we now go to the second booklet with exercises (the green one). The exercises in this booklet are more challenging than the exercises in the first booklet. Try to focus on how these puzzles are built."	"Let's see how well you did compared to other children who are the same age as you. I have tables with me to help me see how well you performed. I see that you solved X puzzles. When I look at the table, this is worse than most kids your age. That's not good because it shows that you're not so smart at these puzzles. Basically, this is quite disappointing. There is now a second test which is more difficult (the green one). If you don't want to disappoint again, then perform better. It's up to you to prove yourself."

B.3. Positive feedback phase 2

Autonomy supportive communication style	Controlling communication style
"Let's look at how you solved the puzzles. I see that you solved X puzzles. Also this time you did much better than most kids your age! This confirms once again that you came up with a good strategy to solve the puzzles."	"Let's see how you managed to solve the puzzles in comparison to other children of your age. I see that you have solved X puzzles. When I look at the table, this is the same as the last time, better than most kids of your age. This confirms once again that you are smart at these kinds of puzzles and that you can be proud of yourself. "

B.4. Negative feedback phase 2

Autonomy supportive communication style	Controlling communication style
"Let us look at how you solved the puzzles. I see that you solved X puzzles. This is not as good as most kids your age. It is definitely not easy to find a good strategy to solve these puzzles."	"Let's see how you managed to do the puzzles compared to other children of your age. I see that you solved X puzzles. When I look at the table this is worse than most kids your age. This reaffirms that you are not as smart at these kinds of tasks and that these are disappointing results."

Appendix C. Supplementary material

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.jecp.2018.01.008.

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