

# Biology or SES? Examining the factors that impact motor development during infancy

Biology or SES? Examining the factors that impact motor development during infancy  
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**Background and Methods**

**Background**  
There has been a call for more research on environmental, biological and genetic factors in shaping infant motor development.  
High socioeconomic status (SES) has been found to predict greater achievement in school achievement, and higher income or educational attainment of mothers and fathers. Studies indicate that lower SES families have lower rates of stimulation (different responses to entering motor skills, such as crawling, walking).

**Conceptual Models**

**Conceptual Model for Fig 1: Direct effects of SES, parent attitudes, and gestational age on infant motor outcomes**

**Results**

**Age 1: Timing for Direct Effects of SES, Parent Attitudes, and Gestational Age by Infant Motor Outcome**  
SES was found to have a direct positive effect on infant fine motor and gross motor development, but showed no effect on infant gross motor development.

**Discussion**

Assessing whether effects identified differential effects of SES, parent attitudes, and gestational age across motor domains.  
- SES was found to predict fine motor and gross motor development. This is the first study to show a positive effect of SES on motor development. This is the first study to show a positive effect of SES on motor development. This is the first study to show a positive effect of SES on motor development.  
- Parental investment effects were found to predict gross motor development only, while parental attitudes were found to predict gross motor development only.  
- These results suggest that SES is a predictor of motor development only in early childhood.

**Conclusions**

We conclude that lower status of low socioeconomic parenting and biological factors impact infant motor development. Higher socioeconomic status, better parenting, and gestational age predict infant motor development.  
We also concluded that lower SES families have lower parental investment and gestational age are strong predictors of infant motor development. However, when SES is added as a predictor, SES remains for a large proportion of the variability in infant motor outcomes.  
Future studies should target lower SES populations in their sample to better assess the causal mechanisms by which SES shapes infant motor development.  
Several future studies will also explore additional biological components, such as genetic inheritance, and more fine measures of family SES, such as neighborhood, maternal education, and parental education.

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# BACKGROUND AND METHODS

## Background

There has been a call for more research on socioeconomic, biological and parenting factors in shaping infant motor development.<sup>1</sup>

High socioeconomic status (SES) has been found to predict greater affordances for motor development,<sup>2</sup> and higher scores on standardized assessments of motor development.<sup>3</sup> Further, infants from lower SES families have been shown to demonstrate different trajectories in attaining motor skills, such as manual exploration.

Parents' positive attitudes, or their positive feelings, thoughts, and perceptions toward parenting and their child, have also been shown to predict higher motor scores.<sup>4</sup> Conversely, negative parent attitudes have been shown to predict lower infant motor scores.<sup>5</sup>

The effect of pre-term birth on infant motor outcomes is well established.<sup>6</sup> However, there is limited evidence suggesting that variability in gestational age in full-term birth (37-42 weeks) is also predictive of infant motor scores.<sup>7</sup>

Individually, each of these factors suggest that global infant motor scores are predicted by SES, parent attitudes, and gestational age. However, it is unknown how each factor may differentially predict motor development within three domains of infant motor development.

Further, it is unknown how SES, parent attitudes, and gestational age may be interrelated, thus presenting a more complex model than direct effects on infant motor outcomes.

Therefore, the current study addresses two research questions:

**1) How do direct effects of SES, parent attitudes, and gestational age differ between gross motor, fine motor, and perception-action development?**

**2) How do SES, parent attitudes, and gestational age relate to each other in the context of gross motor, fine motor, and perception-action development?**

We hypothesize that:

- Higher family SES, positive parent attitudes, and later gestational age will positively predict infant motor development.
- The impact on early motor development will vary between different levels of parent attitudes and gestational age such that they will moderate the effect of SES.
- A third, alternate hypothesis was also established. If the effect of SES was *not* moderated by parent attitudes and gestational age, we hypothesized that parent attitudes and gestational age may represent indirect effects that act on infant motor development in the context of SES.

These three hypotheses are represented by the models pictured in the Conceptual Models section below.

## Methods

- 455 infants (45.7% female) ranging from 05 months to 26 months in age were collected from five research site.
- Infant motor development was assessed using the Early Motor Questionnaire (EMQ) at each site.
- Demographic information was collected about participant SES and gestational age according to project protocols at each site, resulting in different sample sizes for these variables.
- A subset of parents were also given a Parent Attitudes subscale consisting of 20 questions about:
  - Positive attitudes about parenting
  - Positive attitudes about their child
  - Negative attitudes about parenting
  - Negative attitudes about their child

Infant scores on the Early Motor Questionnaire were standardized using a quadratic fit based on all available observations. The resulting T-scores ( $m=50$ ,  $SD=10$ ) controlled for influences of age, gender, and administration method. The equations used are presented below:

### Equations for Age-Independent t Scores using Polynomial age term, Gender, and administration (Instruct) effects

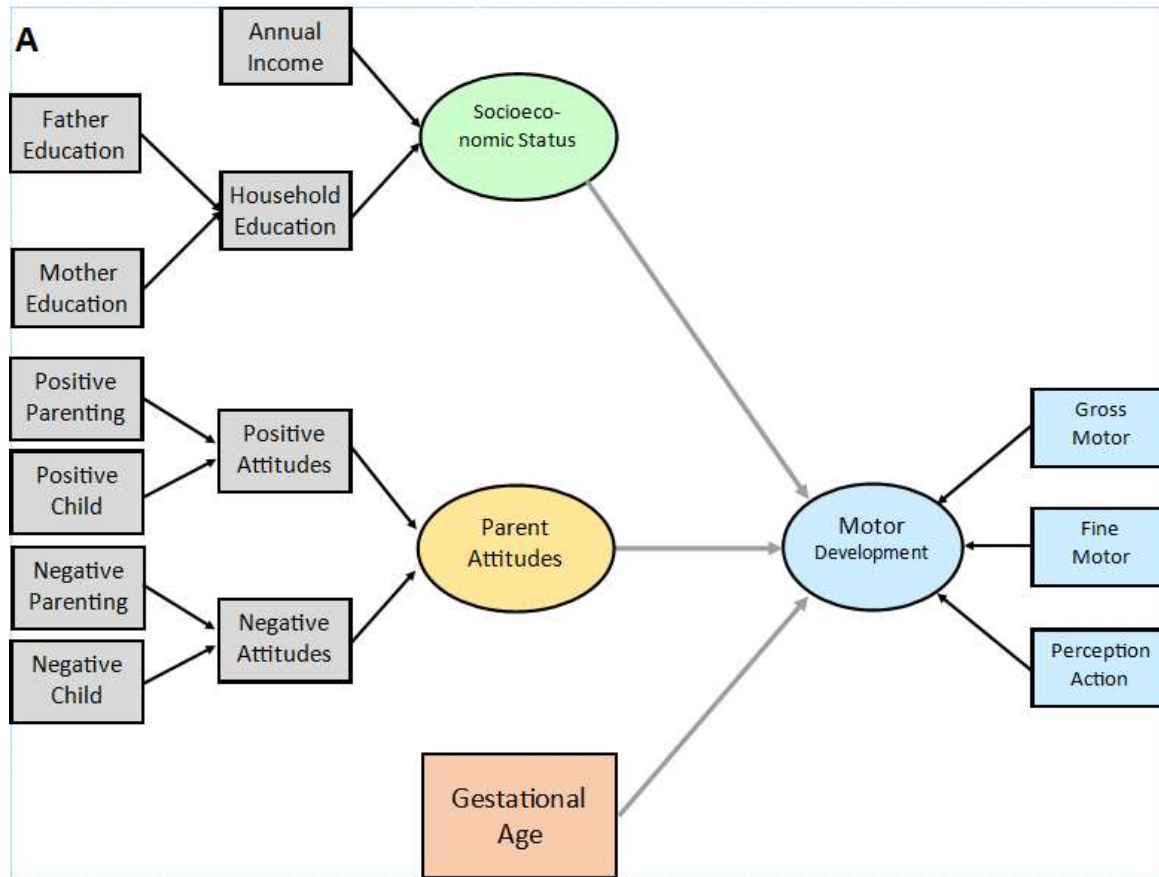
$$GM\_AIS\_PGI = ((((((GM\_OBS - ((-112.842910) + (0.471823 * Age) + (-0.000274 * Age^2) + (0.599276 * Female\_1) + (-0.049232 * Instruct))) - 9.160477) / 52.676133) * 10) + 50).$$

$$FM\_AIS\_PGI = ((((((FM\_OBS - ((-89.350214) + (0.378506 * Age) + (-0.000258 * Age^2) + (-0.554403 * Female\_1) + (-2.366526 * Instruct))) - -2.854111) / 38.197849) * 10) + 50).$$

$$PA\_AIS\_PGI = ((((((PA\_OBS - ((-49.412888) + (0.241562 * Age) + (-0.000134 * Age^2) + (0.985194 * Female\_1) + (-0.705987 * Instruct))) - 12.953581) / 28.920815) * 10) + 50).$$

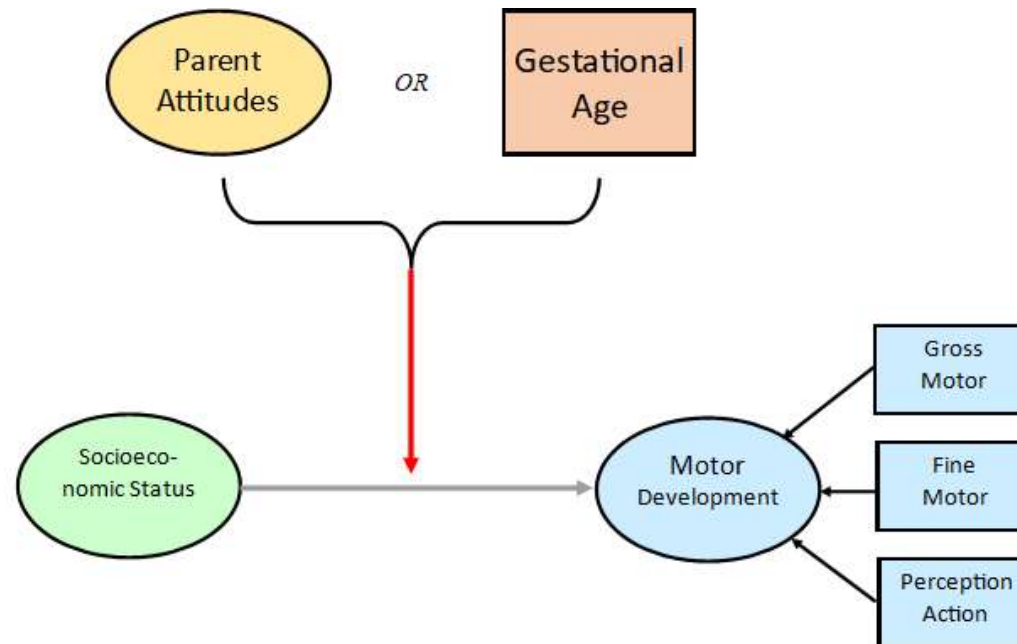
# CONCEPTUAL MODELS

Conceptual Model for Aim 1: Direct effects of SES, parent attitudes, and gestational age on infant motor outcomes



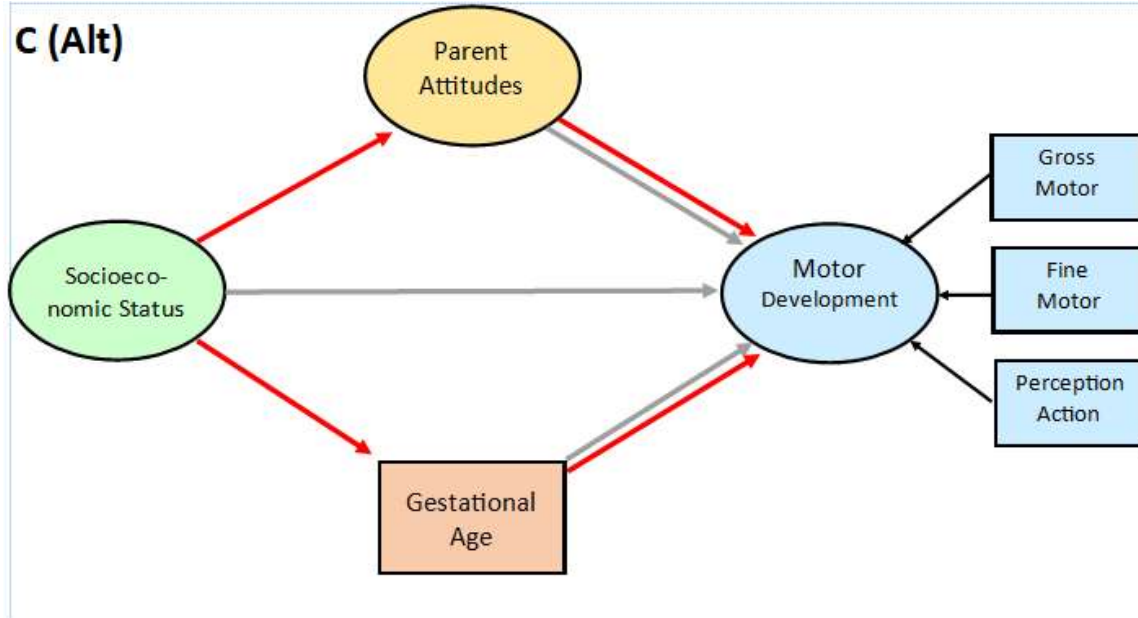
Conceptual Model for Aim 2: Moderating effects of parent attitudes or gestational age and SES on infant motor outcomes

**B**



**Conceptual Model for Alternative Hypothesis: Indirect effects of parent attitudes or gestational age account for variability in infant motor outcomes**

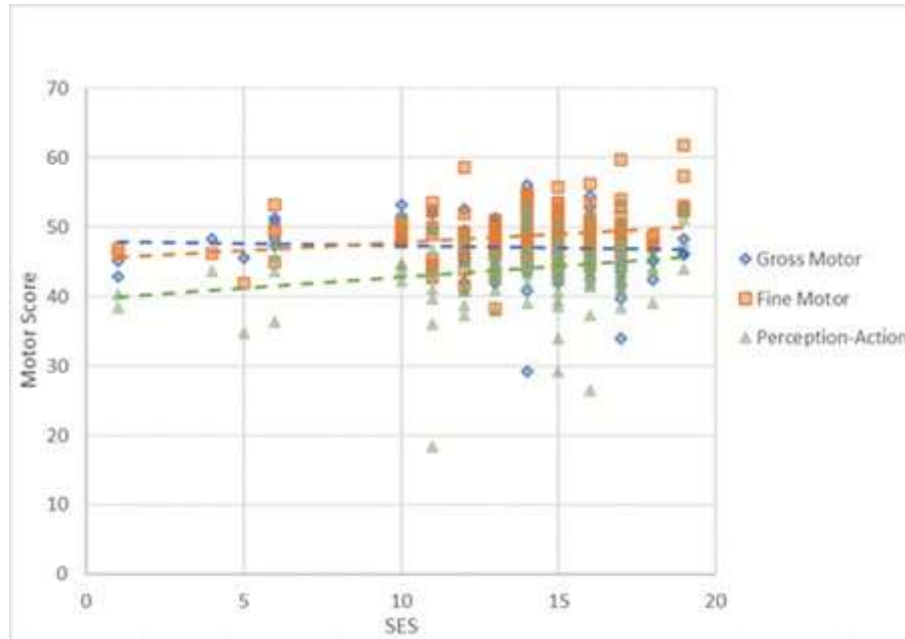
**c (Alt)**



# RESULTS

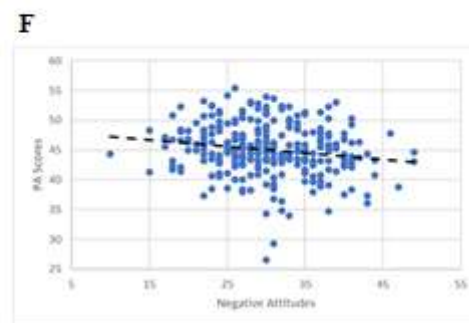
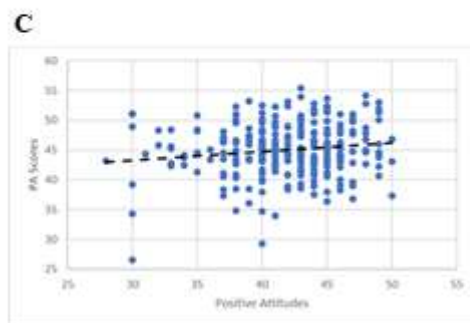
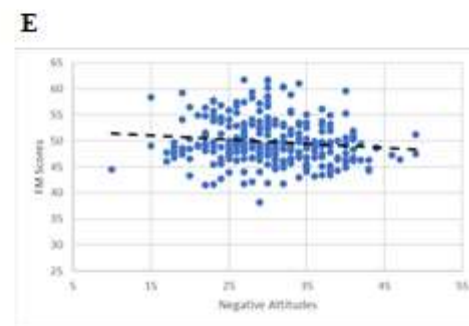
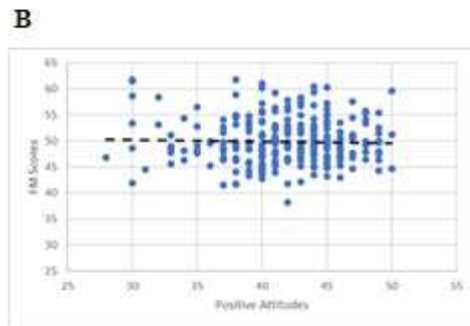
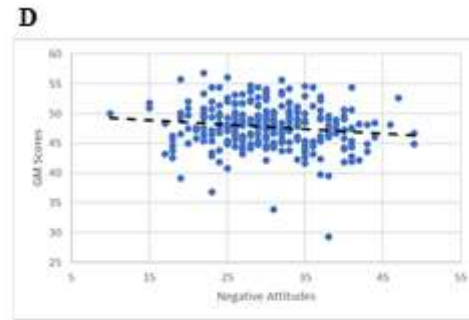
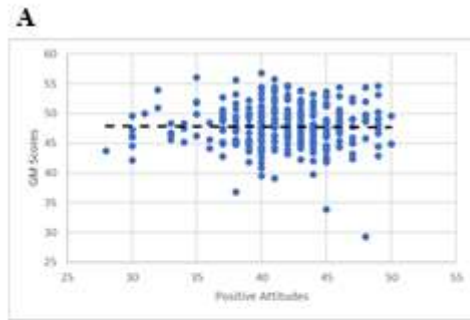
## Aim 1: Testing for Direct Effects of SES, Parent Attitudes, and Gestational Age by Infant Motor Domain

SES was shown to have a direct, positive effect on infant fine motor and perception-action development, but showed no effect on infant gross motor development.

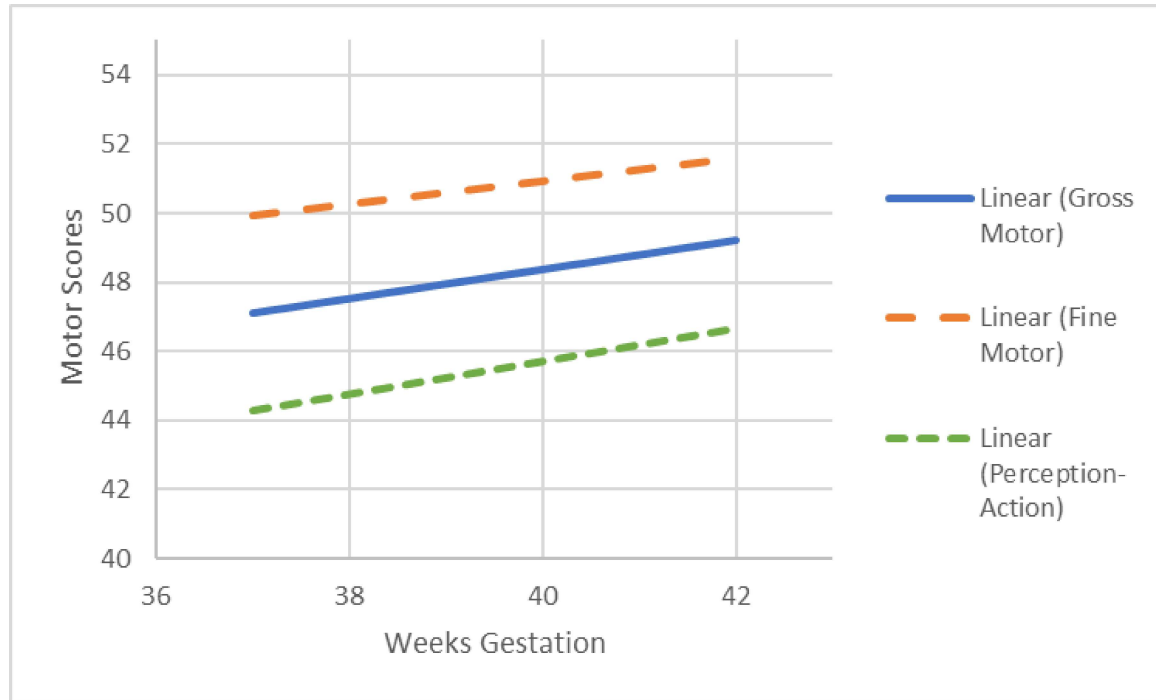


Parent attitudes were divided into positive and negative composites. Positive parent attitudes were found to only predict perception-action development (C). However, negative parent attitudes were found to have a more pervasive effect, predicting lower scores in gross motor, fine motor, and perception-action development.





Weeks gestation was found to have a global positive effect, with later gestational age predicting higher scores in gross motor, fine motor, and perception-action development.



**Aim 2: Moderating Effects of Parent Attitudes and Gestational Age on the Relation Between SES and Motor Outcomes**

Testing for moderating effects via significant interactions between SES and either parent attitudes or gestational age returned no significant interactions. We concluded that moderation was insufficient to model the relation between predictors, and proceeded to our alternate hypothesis.

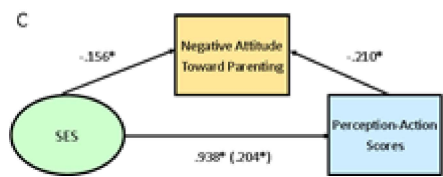
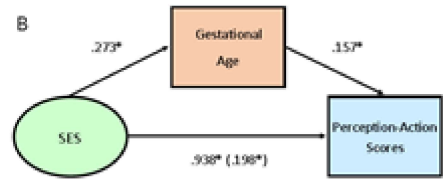
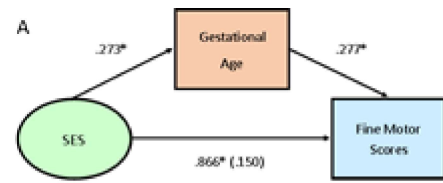
<b>Outcome Variable</b>	<b>Predictor</b>	<b>Estimate</b>	<b>SE</b>	<b>t</b>	<b>p</b>	<b>Adj R<sup>2</sup></b>
<b>GM Scores</b>	Negative Composite	-.05	.12	.35	.730	.008
	SES	.84	2.00	.42	.675	
	Neg X SES Interaction	-.05	.06	-.74	.462	
	Gestational Age (GA)	.27	.65	.41	.682	.039
	SES	-7.05	12.30	-.57	.567	
	GA X SES Interaction	.16	.32	.51	.608	
<b>FM Scores</b>	Negative Composite	-.09	.12	-.78	.434	.036
	SES	-.06	1.97	-.03	.976	
	Neg X SES Interaction	.03	.06	.56	.580	
	Gestational Age (GA)	.59	.63	.93	.354	.071
	SES	1.36	11.97	.11	.909	
	GA X SES Interaction	-.01	.31	-.05	.963	
<b>PA Scores</b>	Negative Composite	-.20	.16	-1.28	.201	.051
	SES	-.66	2.64	-.25	.803	
	Neg X SES Interaction	.06	.08	.75	.457	
	Gestational Age (GA)	-.09	.86	-.11	.915	.030
	SES	-5.67	16.29	-.35	.729	
	GA X SES Interaction	.18	.42	.42	.673	

**Alternate Hypothesis: Motor Outcomes are Predicted Directly by SES and Indirectly by Parent Attitudes and Gestational Age**

Using mediation modeling, the direct effect of SES was compared to the indirect effects of parent attitudes and gestational age in fine motor and perception-action development.

The indirect effect of negative parent attitudes was found to explain 2.0% of the variance in perception-action scores. 5.0% of the remaining variance in perception-action scores was explained by the direct effect of SES, suggesting that the direct effect of SES is stronger than the indirect effect of negative parent attitudes.

The indirect effect of gestational age was found to explain 3.4% of the variance in fine motor scores and 2.2% of the variance in perception-action scores. The direct effects of SES estimated in these models were 7.0% and 3.3%, respectively, suggesting that the direct effect of SES is also a stronger effect than the indirect effect of gestational age.



# DISCUSSION

Assessment of direct effects identified differential effects of SES, parent attitudes, and gestational age across motor domains.

- SES was found to predict fine motor and perception-action development. This confirms prior findings supporting effects of SES on skills within each domain. It also expands these findings beyond the level of skill assessment into a direct comparison of development across domains.
- Positive parent attitudes were found to predict perception-action development only, while negative parent attitudes were found to negatively predict motor scores across all three domains. These results suggest that prior studies assessing only positive or only negative parent attitudes should consider that each valence of parent attitudes may differentially contribute to infant motor development depending on the domain or skill studied.
- Weeks gestation was found to predict higher infant motor scores across all three domains of motor development. This finding confirms previous studies identifying variability in infant outcomes within the full-term range (37-42 weeks). This finding also extends the effects into the second year of life.

Assessment of interaction effects between SES and parent attitudes or gestational age produced null results. However, analyses based on our alternative aims suggest that the impacts of parent attitudes and gestational age are actually small, and are outweighed by the stronger, direct effect of SES.

- Parent attitudes may be related to SES through the presence of stress or resources represented by SES. Our study does confirm a relation between parent attitudes and SES, but narrows that relation to strictly negative parent attitudes about parenting. Future studies should collect more information about families that might explain the mechanism behind this relation, and how it relates to infant motor development.
- Our study confirmed a relation between SES and gestational age, but found that the direct effect of SES overpowers this relation in shaping infant fine motor and perception-action development.

## CONCLUSIONS

We conclude that future studies of how socioeconomic, parenting, and biological factors impact infant motor development should assess effects within gross motor, fine motor, and perception-action development individually.

We also conclude that within a single SES bracket, parent attitudes and gestational age are strong predictors of infant motor development. However, when SES is added as a predictor, SES accounts for a larger proportion of the variability in infant motor scores.

Future studies should target varied SES representation in their sample to better assess the exact mechanism by which SES shapes infant motor development.

Planned future studies will also explore additional biological components, such as an infant's birthweight, and more fine measures of family SES, such as household income, maternal education, and paternal education.

Our conclusions also have practical implications. Our findings regarding differential effects of SES across motor domains suggest that evaluation should be performed on a skill-by-skill basis, as development in one motor domain may not match development in other motor domains.

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