

REVIEW ARTICLE

An overview of evidence for a causal relation between iron deficiency during development and deficits in cognitive or behavioral function<sup>1, 2, 3</sup>

Joyce C McCann and Bruce N Ames

<sup>1</sup> From the Nutrition and Metabolism Center, Children's Hospital Oakland Research Institute, Oakland, CA

This review, intended for a broad scientific readership, summarizes evidence relevant to whether a causal relation exists between dietary iron deficiency with (ID+A) or without (ID-A) anemia during development and deficits in subsequent cognitive or behavioral performance. An overview of expert opinion and major evidence in humans and animals is provided. Cognitive and behavioral effects observed in humans with ID-A and in animals with ID±A are provided in tables. The degree to which 5 conditions of causality are satisfied and whether deleterious effects of ID-A might be expected to occur are discussed. On the basis of the existing literature, our major conclusions are as follows. Although most of the 5 conditions of causality (association, plausible biological mechanisms, dose response, ability to manipulate the effect, and specificity of cause and effect) are partially satisfied in humans, animals, or both, a causal connection has not been clearly established. In animals, deficits in motor activity are consistently associated with severe ID+A, but adverse effects on performance in tests that target cognitive function have not been clearly shown. Resistance to iron treatment was observed in most trials of children <2 y of age with ID+A, but not in older children. Similar observations were made in rodents when ID+A occurred before rather than after weaning. In children >2 y of age and in adolescents with ID-A, evidence suggests cognitive or behavioral deficits; however, the surprisingly small number of studies conducted in either humans or animals prevents a thorough assessment.

Key Words: Iron • anemia • iron deficiency • cognition • behavior • learning • memory • gestation • pregnancy • brain • neurology • infants • childhood • rodent studies

**This Article**

- ▶ [Full Text](#)
- ▶ [Full Text \(PDF\)](#)
- ▶ [Purchase Article](#)
- ▶ [View Shopping Cart](#)
- ▶ [Alert me when this article is cited](#)
- ▶ [Alert me if a correction is posted](#)
- ▶ [Citation Map](#)

**Services**

- ▶ [Similar articles in this journal](#)
- ▶ [Similar articles in PubMed](#)
- ▶ [Alert me to new issues of the journal](#)
- ▶ [Download to citation manager](#)
- ▶ [Get Permissions](#)

**Citing Articles**

- ▶ [Citing Articles via HighWire](#)
- ▶ [Citing Articles via Google Scholar](#)

**Google Scholar**

- ▶ [Articles by McCann, J. C](#)
- ▶ [Articles by Ames, B. N](#)
- ▶ [Search for Related Content](#)


**PubMed**


- ▶ [PubMed Citation](#)
- ▶ [Articles by McCann, J. C](#)
- ▶ [Articles by Ames, B. N](#)

**Agricola**

- ▶ [Articles by McCann, J. C](#)
- ▶ [Articles by Ames, B. N](#)

This article has been cited by other articles:

 **Nutrition in Clinical Practice** ▶ HOME  
S. F. Clark  
Iron Deficiency Anemia  
Nutr Clin Pract, April 1, 2008; 23(2): 128 - 141.  
[\[Abstract\]](#) [\[Full Text\]](#) [\[PDF\]](#)

 **THE FASEB JOURNAL** ▶ HOME  
J. C. McCann and B. N. Ames  
Is there convincing biological or behavioral evidence linking vitamin D deficiency to brain dysfunction?  
FASEB J, April 1, 2008; 22(4): 982 - 1001.  
[\[Abstract\]](#) [\[Full Text\]](#) [\[PDF\]](#)

