Interviewer Ratings of Mother-Child Interaction and the Home Environment in the Context of Survey Research: Contributions and Concerns

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The purpose of these analyses is to assess the reliability and validity of interviewer ratings of maternal/child interactions and the home environment as used in the survey adapataion of the HOME Inventory, the HOME-Short Form. Although the results indicate that interviewer ratings are internally consistent and contribute to the prediction of child outcomes (albeit only slightly), there are a number of warning signs which suggest that further attention needs to be directed at improving the quality of interviewer ratings before they become a standard component of survey design. In particular, across-time and across-interviewer agreement was quite low, not even approaching acceptable levels particularly of inter-rater reliability. In addition, we saw no significant correlations between the maternal report and interviewer rating components comprising particular HOME-SF subscales.

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Introduction

In the past decade, social science investigators from different disciplinary backgrounds, interested in issues concerning the family and children's development, have taken steps to merge methodological techniques in order to gain a more comprehensive understanding of demographic trends *and* the micro-level processes underlying these trends (Chase-Lansdale, Mott, Brooks-Gunn, & Phillips, 1991). As a result, methodologies and data that were once used almost exclusively *within* disciplinary lines have become accessible to a wider range of investigators.

A key example of this interdisciplinary transfer of methodologies is the incorporation of a measure of family processes and the home environment into a major national survey. Originally developed as a screening instrument to assess the quality of children's home environments and experiences, the full HOME Inventory (Home Observation for Measurement of the Environment) has been used for a variety of purposes including the assessment of parenting (Klebanov, Brooks-Gunn, & Duncan, 1994; Metzl, 1980) and the prediction of children's cognitive abilities (Bradley & Caldwell, 1980; Bradley et al., 1989; Moore & Snyder, 1991; Ramey, Yeates, & Short, 1984;

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Van Doorninck, Caldwell, Wright, & Frankenburg, 1981; Widmayer et al., 1990; Yeates, MacPhee, Campbell, & Ramey, 1983). The long form of the HOME is an open-ended "conversation" between the interviewer and the parent whereby the interviewer completes the items that rely simply on observations of the environment and gathers the rest of the information through an informal interview with the parent (see Methods Working Paper # 98.1 in this series for more information about the development of the HOME and the HOME Short Form).

In 1986, the HOME was abbreviated and modified for use in the National Longitudinal Study of Youth-Child Supplement. The format was changed to a set of written questions for the parent/respondent and a set of ratings completed by the interviewer. Many examples could be given of the studies that have made use of the HOME-SF within the NLSY-CS dataset, fulfilling the goal of examining the micro-level processes underlying a demographic trend. To give just one example, the work of Menaghan and Parcel (1995) asks whether the home environment differs when mothers are employed. The longitudinal nature of the NLSY-CS has made it possible for these researchers to look over time, documenting change in the home environment with the onset of employment. These researchers have documented, for example, a deterioration in the quality of the home environment when single mothers initiate employment in jobs that involve low complexity (e.g., highly repetitive tasks) and stimulation.

Yet we must note that in a critical respect, the transfer of the methodology for observing the home environment in the context of survey research is incomplete. When used by developmental psychologists, the interviewer rating components of the HOME Inventory have regularly been submitted to scrutiny with respect to interrater reliability. As part of their

extensive training, interviewers must demonstrate that their ratings of the home environment are reliable: they agree to a sufficient extent with those of an experienced rater or with a set of ratings (for example, ratings for a videotaped interview in the home) that serve as a standard. Interrater reliability reported for the original HOME, either as percent agreement or Cohen's Kappas, is generally very high. Although it is noted in the NLSY-CS codebook that Bradley (a co-author of the HOME) suggested procedures which were used to train the interviewers administering the instrument (Baker, Keck, Mott, & Quinlan, 1993), *there are no indications that interrater reliability for the survey interviews administering the HOME-SF was established before or during fielding of the survey.*

In light of this gap, it becomes critical to examine the reliability of the interviewer ratings completed as part of the HOME-Short Form, as well as to ask to what extent these ratings are contributing to the overall usefulness of the measure. In this paper, we first examine the reliability of the interviewer ratings of the HOME-Short form when used by survey interviewers, specifically considering internal consistency, interrater reliability, and test-retest reliability. We then consider the contribution of the interviewer rating components and the maternal report components of the HOME-SF subscales in predicting to a set of child outcomes. To anticipate the major conclusions of this paper, we find reason for concern particularly about the interrater reliability of the HOME-SF ratings. At the same time we find evidence of the importance of the ratings in terms of their contribution to the prediction of child outcomes. We conclude by urging that steps be taken to revise and strengthen training on the interviewer ratings of the HOME-SF, thus completing the process of interdisciplinary transfer of the methodology.

Method

Sample

The participants in this study were 304 mother-child pairs who were part of the pilot "Study of Mothers and Children" (see Methods Working Paper 98.8 for additional details regarding the pilot study). The children (equally divided between boys and girls) ranged in age from 6 years, 0 months to 11 years, 11 months. The sample was evenly divided among three racial/ethnic groups: Mexican Americans, African Americans, and European Americans. Mexican-American families were recruited from Los Angeles, and African-American and European-American families were recruited from Philadelphia. Within each racial/ethnic group, the sample was also evenly divided between families with a boy or girl serving as the focal child (or child focused upon in the interview); families with children of between 6 and 8 years and 9 and 11 years; and families from lower income and more moderate income neighborhoods.

Block groups were selected within Los Angeles and Philadelphia based on three criteria from 1990 census data: (1) at least 75% of the residents were classified as the desired race/ethnicity; (2) median family income was less than $18,863 for classification into lower-income and was more than$18,863 for classification into middle-income block groups; and (3) the poverty rate was 20% or more in low-income and less than 20% in middle-income block groups. Residential blocks were then selected from within these block groups, using the following variables or proxies available at the block level: Hispanic race/ethnicity (proxy for Mexican-American race/ethnicity), count of children ages seven to seventeen years (proxy for count of

children six to eleven), and proportion of housing rented versus owned and mean value of homes or rent (proxy for income and poverty level).

Trained, race-matched female interviewers recruited subjects door to door in the selected blocks using a screening form. To qualify for the study, a mother had to identify herself as a member of the relevant race/ethnicity, have a biological child between the ages of six and eleven years living with her, and, if she was Mexican American, indicate that she had lived in the United States for at least three years. A focal child was randomly selected from among all the mother's biological children ages six to eleven, and if the allotted number of children of the age and gender group matching the chosen child had already been selected, a second focal child was selected. In Philadelphia, seventeen qualifying African-American families were located in blocks selected for recruiting European Americans, and two qualifying European-American families were in blocks selected for African Americans. In these nineteen cases, race-matched interviewers were later sent to complete the interviews.

Measures

Background/sociodemographic variables. Mothers were asked to report the child's sex, child's age, household income before taxes for the previous year, their own last grade of school completed, the number of children in their home, their own race/ethnicity, and whether a father/father figure of the child's lived in the home.

Parenting behavior. The Home Observation for Measurement of the Environment--Short Form (HOME-SF) was adapted from the full HOME Inventory (Caldwell & Bradley, 1984) for use in the National Longitudinal Survey of Youth--Child Supplement (NLSY-CS). Both

versions use a combination of maternal report and interviewer ratings to measure the quality of cognitive stimulation and emotional support provided in a child's home environment. Different versions of the instrument exist for infants, preschool, and school-age children. The HOME-SF for children ages six to ten (middle childhood version) was used in this study. It consists of 27 items from which two subscales, Cognitive Stimulation and Emotional Support, are created (as they were in the NLSY-CS). The Cognitive Stimulation subscale contains four interviewer and ten maternal report items, while the emotional support subscale contains five interviewer and eight maternal report items.

As mentioned above, although interrater reliability has been well-established for the full HOME Inventory, interrater reliability for the HOME-SF was not examined in the NLSY-CS. One goal of the present study was to assess the degree to which interviewers could be trained on the HOME-SF to achieve acceptable agreement on the interviewer rating items. Interviewers received approximately 2.5 hours of training, during which they reviewed the questionnaire items and specific guidelines for completing each item ("question by question specifications") with the trainer. They also viewed and discussed pictures illustrating the features of the home environment they were asked to rate (e.g., "minimally cluttered," "reasonably clean"). Finally, they viewed a videotape of sample mother-child interactions. One segment of the videotape was viewed and then jointly rated by the group of interviewers and the trainer through discussion; another segment of the videotape was then viewed but rated individually by the interviewers without discussion. The trainer then reviewed and discussed the ratings with the group. Interviewers were given a review sheet that summarized the key behaviors and aspects of the home environment that they

would be rating, and asked to review this sheet prior to each home visit. The question by question specifications for each of the interviewer ratings were printed in the questionnaires completed by the interviewers, so that the criteria for rating were immediately available and did not have to be memorized.

Child outcomes. Two child outcomes will be examined in assessing the predictive validity of the interviewer rating and maternal re port components of the HOME-SF. The Behavior Problems Index Externalizing (BPI) subscale is a sum of 6 items measuring acting out behaviors such as cheating and fighting. Each item is scored on a three-point scale of "not at all like my child" to "often like my child." More information about the BPI Externalizing subscale can be found in the NLSY Child Handbook (Baker et al., 1993).

A single item maternal report measure of the child's academic progress was created as a marker of academic achievement. Mothers reported whether their child's schoolwork was "outstanding," "above average," "average," "below average but improving," or "below average but not improving." While none of the mothers chose "below average but not improving", several did choose the second worst category, so the final item ranges from one to four.

Procedure for Assessing Reliability of the Interviewer Ratings

To examine interrater reliability, 51 families were re-interviewed by their original interviewer, accompanied by another interviewer. The second interviewer was also matched with the family in terms of race/ethnicity. At the end of the session, both interviewers completed the set of interviewer ratings. Cohen's Kappas were computed for these items. In addition, Kappas and correlations were computed for the HOME-SF subscales.

Strategy of Analysis

The analyses address the following questions: (1) How internally consistent are the maternal and interviewer components of the HOME-SF subscales? (2) Do the maternal and interviewer components of the HOME-SF subscales measure similar constructs? (3) Do multiple raters agree in completing the ratings of mother-child behavior and the home environment; does a single rater agree over time? (4) What contributions do the maternal and interview components make to the prediction of child outcomes?

To answer these questions, four primary analyses were conducted. First, Cronbach's alphas were calculated and compared for the interviewer and maternal report portions of the HOME-SF subscales. Next, correlations were computed among the maternal and interviewer portions of the HOME-SF subcales. We examine interrater reliability and test-retest reliability for the interviewer ratings. Finally, regression analyses were conducted to examine the predictive power of the maternal and interviewer portions of the HOME-SF subscales.

Results

Internal Consistency of Maternal Reports vs. Interviewer Ratings

Table 1 displays Cronbach's alphas for the maternal and interviewer components of the HOME-SF and its subscales. As can be seen, alphas for the interviewer components of the Cognitive Stimulation and Emotional Support subscales were slightly higher than those for the maternal components (.67 vs. .61 and .60 vs. .50, respectively). The alphas for the interviewer and maternal components of the full scale were approximately equal (.62 vs. .63, respectively),

and the full scale (with maternal and interviewer components combined) achieved an acceptable alpha (.68).

Correlations Between Maternal Reports and Interviewer Ratings

Table 2 displays Pearson correlations between the maternal and interviewer components of the HOME-SF and its subscales. The maternal and interviewer components of the Total scale were significantly correlated (r=.23, p<.001). The maternal and interviewer components of Cognitive Stimulation subscale were only marginally correlated (r=.10, p<.10), while the maternal and interviewer components of the Emotional Support subscale were not correlated.

In contrast, the interviewer component of Cognitive Stimulation subscale was correlated with the maternal component of the Emotional Support Subscale, (r=.24, p<.001), and the maternal component of the Cognitive Stimulation subscale was correlated with the interviewer component of Emotional Support subscale (r=.24, p<.001).

Finally, the correlations computed within the two sets of interviewer ratings and the two sets of maternal report (i.e. the interviewer component of Cognitive Stimulation with Emotional Support, and the maternal component of Cognitive Stimulation with Emotional Support) were moderate but significant (r=.15, p<.01 and r=.21, p<.001, respectively).

Intrarater (Time 1 vs. Time 2) and Interrater (Rater 1 vs. Rater 2) Reliability

Table 3 displays the intrarater (Time 1 vs. Time 2) and interrater (Rater 1 vs. Rater 2 at Time 2) reliability for the HOME-SF items and for the Cognitive Stimulation and Emotional Support subscales. A Kappa of .80 and above is generally considered to indicate good reliability.

At the bottom of the table we also give correlations for the ratings comprising the Emotional Support and Cognitive Stimulation subscales.

Individual ratings. Focusing first on the results for the individual ratings contributing to the HOME-SF subscales and total score, there are two notable features. First, three of the four items comprising the Cognitive Stimulation subscale and one item from the Emotional Support subscale occurred too infrequently (i.e., in the dichotomous rating, over 90% of the cases fell in one category) to calculate reliable Kappas. Second, the Kappas in general are extremely low, particularly for those questions which asked the interviewer to rate an aspect of the child's participation in the interview (e.g., "mother introduced the child to the interviewer by name"). Although still low, the Kappas are generally higher for questions asking the interviewer to rate overall maternal tone (e.g., "mother's voice conveyed positive feeling about this child") rather than discrete actions.

Ratings as composites within each subscale. At the bottom of the table, intrarater and interrater reliability are assessed through both correlations and Cohen's Kappa for the interviewer ratings composited across the Emotional Support and Cognitive Stimulation subscales. On the one hand, we see that there are significant correlations for the ratings completed for each subscale, both across time for a single rater (the column headed Time 1 vs. Time 2, Int. 1-- or interviewer # 1), and across raters within a single time (Time 2, Int 1 vs. Int 2). The correlations, however, generally fall in the moderate range. Only the correlations across time for the Cognitive Stimulation subscale approach the strong range (r=.58).

On the other hand, the picture obtained from the Cohen's Kappa is discouraging. The interrater reliability for the Emotional Support Scale, while statistically significant, is still quite low (.18). The interrater reliability for the ratings of the Cognitive Stimulation subscale does not reach statistical significance. Across time for a single rater, the Cohen's Kappa is significant (though again not high) for the Cognitive Stimulation subscale but not the Emotional Support subscale.

Comparing the Predictive Power of Maternal Reports and Interviewer Ratings

Hierarchical regression analyses were conducted to examine the contribution of the maternal and interviewer components of the HOME-SF and its subscales to the prediction of child outcomes (externalizing behavior and poor schoolwork). Eight control variables were entered on the first step of the analyses: child's sex, child's age, household income, maternal education, number of children in child's home, presence of a father/father figure in the child's home, and dummy variables for child's race. Next, the maternal component of the relevant scale (either the Cognitive Stimulation or Emotional Support subscale) was entered. Lastly, the interviewer component of the relevant scale was entered. Table 4 displays the results of these regression analyses.

For the HOME-SF Total, only the maternal ratings contributed significantly to the prediction of behavior problems (change in R-square=.03). Both the maternal and the interviewer ratings contributed to the prediction of poor schoolwork, although the interviewer ratings contributed a higher proportion of the variance (change in R-square=.03 vs. .01).

As seen in Table 4, the maternal component of the Cognitive Stimulation subscale was a significant predictor of behavior problems and poor schoolwork. Note, however, that the magnitude of the change was small (change in R-square=.02). The interviewer component of the Cognitive Stimulation subscale did not significantly predict behavior problems, but it did significantly predict poor schoolwork. Again, the magnitude of the R-square change was small (change in R-square=.02).

The pattern of results for the Emotional Support subscale was notably different from that described for the Cognitive Stimulation subscale (see Table 4). The maternal component of Emotional Support significantly predicted behavior problems but not poor schoolwork, while the interviewer component of Emotional Support showed the opposite pattern of associations: it significantly predicted poor schoolwork but not behavior problems. The changes in R-square for these equations were again small (.03 for maternal Emotional Support predicting behavior problems and .02 for interviewer Emotional Support predicting poor schoolwork).

Discussion

The purpose of these analyses was to assess the reliability and validity of interviewer ratings of maternal/child interactions and the home environment as used in the survey adapataion of the HOME Inventory, the HOME-Short Form. Although the results indicate that interviewer ratings are internally consistent and contribute to the prediction of child outcomes (albeit only slightly), there are a number of warning signs which suggest that further attention needs to be directed at improving the quality of interviewer ratings before they become a standard component of survey design.

First, we noted distressingly low levels of interrater reliability across the interviewer items on the HOME-SF. Kappas on a number of the interviewer items were significantly above chance, but they were not in a range considered acceptable (above .70) by researchers who routinely use Kappas to document the reliability of observers.

Second, we found that 75% of the items comprising the Cognitive Stimulation subscale and one item on the Emotional Support subscale occurred too infrequently to calculate reliable Kappas. It will be important to examine the base rates of these items in other surveys (e.g., the NLSY-CS) to determine their frequency and value in the prediction of child outcomes.

Third, we found virtually no association between maternal and interviewer ratings of the same domain (i.e., cognitive stimulation or emotional support). We did find strong correlations of maternal and interviewer ratings *across* domains, however. This result implies that further clarification of the content of the HOME-SF subscales (as used in the NLSY-CS) is necessary. Investigators using the measures should be aware that the subscale titles developed for the NLSY-CS are somewhat arbitrary and do not reflect a coherent underlying construct. Indeed, a number of investigators have factor analyzed the HOME-SF items to develop more meaningful and conceptually-based subscales (see Methods Working Paper # 98.1 in this series for more detailed information).

Based on these results, we recommend that three steps be taken to improve the quality of interviewer ratings:

(1) Estimates of interrater reliability must be obtained in surveys so that investigators can better assess the quality of interviewer ratings and move beyond a simple examination of their

internal consistency. Investigators and survey administrators alike can use the information to weigh the contribution of interviewer ratings against the cost and time of training interviewers to an acceptable level of agreement.

(2) It will be important to assume that more in-depth training sessions be conducted for survey interviewers who complete ratings of parenting and the home environment. Low reliability was noted in this study despite an attempt to train interviewers with standardized definitions of behavioral occurrences and environmental features. The two hours of training the interviewers received in this study was less than observers in developmental research typically receive. It is important to note, however, that interviewers for the NLSY-CS received little special training on how to complete the interviewer ratings, nor was interrater reliability established before or during the fielding of the survey. Thus, the training in the present study was designed to be a realistic pilot of what may be financially feasible in survey research. Unfortunately, it appears that more extensive training will be needed to bring interviewers to acceptable levels of agreement on their ratings.

(3) To facilitate standardized interviewer training across different surveys, we recommend that a set of training tapes be developed. After viewing the tapes and prior to entering the field, interviewers should be required to demonstrate an acceptable level of agreement with a "standard" set of ratings. Once in the field, interrater reliability data should be gathered on at least 10% of the interviews. Frequent checks of interrater reliability minimize the phenomenon of "observer drift" (i.e., the tendency for observers, over time and with experience, to incorporate

their own definitions of behavioral dimensions into the standardized set on which they were trained) and ensure that data quality will be maintained throughout the course of data collection.

Table1

Cronbach's Alphas for the HOME-SF, Interviewer and Maternal Components

Scale	Cronbach's Alphas
HOME-SF Total	0.68
Interviewer	0.62
Maternal	0.63
HOME-SF Cognitive	0.62
Interviewer	0.67
Maternal	0.61
HOME-SF Social	0.47
Interviewer	0.60
Maternal	0.50

Table 2

Correlations Between the Maternal and Interviewer Componentsof the HOME-SF and Subscales

Scale	HOME-SF Total			HOME-SF Cog.Stim.			HOME-SF Emot.Support		
	Full	*Maternal*	*Interviewer*	*Full*	*Maternal*	*Interviewer*	*Full*	*Maternal*	*Interviewer*
HOME-SF Total–Full	–								
HOME-SF Total–Maternal	.87***	–							
HOME-SF Total–Interviewer	.69***	.23***	–						
HOME-SF Cognitive Stimulation–Full	.87***	.82***	.50***	–					
HOME-SF Cog.Stim.–Maternal	.76***	.85***	.24***	.90***	–				
HOME-SF Cog.Stim.–Interviewer	.50***	.20**	.68***	.53***	.10+	--			
HOME-SF Emotional Support–Full	.80***	.62***	.67***	.40***	.32***	.29***	–		
HOME-SF Emot.Support–Maternal	.58***	.69***	.12*	.29***	.21***	.24***	.72***	--	
HOME-SF Emot.Support–Interviewer	.54***	.16*	.83***	.27***	.24***	.15**	.68***	-0.02	–

Table 3

Stability and Interrater Reliability of Interviewer Ratings in Methods Pilot Test

Item	Means			Cohen's Kappa		
	Int.1 at Time 1	Int.1 at Time 2	Int. 2 at Time 2	Time 1 vs. Time 2, Int. 1	Time 1 vs. Time 2, Int. 1 vs. Int. 2	Time 2, Int. 1 vs. Int. 2
1. Mother encouraged Child to contribute to the conversation (1=yes)	.53	.41	.39	.30*	.10	.14
2. Mother answered Child's questions or requests verbally (1=yes)	.53	.45	.39	.22	-.05	.40*
3. Mother conversed with Child (1=yes)	.75	.63	.63	.01	-.08	.33*
4. Mother introduced Interviewer to Child by name (1=yes)	.18	.10	.14	.02	-.18	.06
5. Mother's voice conveyed positive feeling about Child (1=yes)	.82	.76	.88	.22	.46*	.34*
6. Interior of the home is dark or perceptually monotonous (1=no)	.12	.22	.16	.51*	.17	.16
7. All visible rooms of the house/apartment are reasonably clean (1=yes)	**.92**	**.96**	**.94**	[.64*]	[.23+]	[.37*]
8. All visible rooms of the house/apartment are minimally cluttered (1=yes)	**.90**	**.92**	**.92**	[.15]	[.15]	[.46*]
9. Building has no potentially dangerous structural or health hazards within a school-aged child's range (1=yes)	**.12**	**.06**	**.06**	[.40*]	[.34]	[.30*]
HOME Emotional Support (items 1-5, score = 1 to 5)	2.18	2.35	2.43	.01 (.15) r=.29*	-.07 (.01) r=.04	.18* (.25*) r=.29*
HOME Cognitive Stimulation (items 6-9, score = 1 to 4)	3.59	3.63	3.55	.32* (.43*) r=.58*	.15 (.20) r=.22	.15 (.28) r=.39*

Notes: + p<.10, * p<.05
Bolded means have less than 10% (5 cases) in one category and over 90% (45 cases) in the other, in a dichotomous rating. These ratings and their Kappas, reported in brackets, may not be useful or accurate due to the skew of the distribution.
Kappas in parentheses are weighted Kappas, giving partial weight to moderate agreement.

Table 4

Predicting Child Outcomes from HOME-SF Maternal Ratings vs. Interviewer Ratings

BPI Externalizing Score from HOME-SF Total			
Predictors	Beta	R^2	Change R^2
1. Controls Alone	--	.13	--
2a. +HOME-SF Total	***	.16	0.03***
2b. +HOME-SF -- MR	***	.16	0.03***
2c. +HOME-SF -- IR		.14	.01
Poor Schoolwork Item from HOME-SF Total			
Predictors	Beta	R^2	Change R^2
1. Controls Alone	--	.06	--
2a. +HOME-SF Total	***	.09	0.03***
2b. +HOME-SF -- MR	*	.07	0.01**
2c. +HOME-SF -- IR	**	.09	0.03***
BPI Externalizing Score from HOME-SF Cognitive			
Predictors	Beta	R^2	Change R^2
1. Controls Alone	--	.13	--
2a. +HOME-SF Cog.	*	.15	0.02*
2b. +HOME-SF Cog.-- MR	*	.15	0.02*
2c. +HOME-SF Cog. -- IR		.13	.00
Poor Schoolwork Item from HOME-SF Cognitive			
Predictors	Beta	R^2	Change R^2
1. Controls Alone	--	.06	--
2a. +HOME-SF Cog.	**	.09	0.03***
2b. +HOME-SF Cog. -- MR	*	.07	0.01**
2c. +HOME-SF Cog. -- IR	*	.08	0.02*
BPI Externalizing Score from HOME-SF Social			
Predictors	Beta	R^2	Change R^2
1. Controls Alone	--	.13	--
2a. +HOME-SF Social	***	.16	0.03***
2b. +HOME-SF Soc. -- MR	**	.16	0.03**
2c. +HOME-SF Soc. -- IR		.14	.01
Poor Schoolwork Item from HOME-SF Social			
Predictors	Beta	R^2	Change R^2
1. Controls Alone	--	.06	--
2a. +HOME-SF Social	*	.08	0.02**
2b. +HOME-SF Soc. -- MR		.06	.00
2c. +HOME-SF Soc. -- IR	*	.08	0.02*

Note. *p<.05, **p<.01, ***p<.001
Change in R^2 refers to the change between Model 1 and Model 2 (a, b, or c).

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