# Impact of Socioeconomic Status on Physiological Health in Adolescents: an Experimental Manipulation of Psychosocial Factors

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**Objective:** To examine the effects of a brief psychosocial manipulation on physiological responses to laboratory stress in lower and higher socioeconomic status (SES) adolescents. **Methods:** A total of 115 adolescents participated in two acute laboratory stress tasks: one with psychosocial intervention and one with no intervention. In the intervention condition, half of the adolescents were given control over the stressor parameters; the other half received social informational resources (hints provided by another person) for dealing with the stressor. Physiological reactivity was monitored. **Results:** Lower SES adolescents exhibited less physiological reactivity when provided with intervention compared with no intervention. Within the lower SES group, the resource condition reduced physiological reactivity more than the control condition did. Higher SES adolescents did not respond physiologically to intervention. **Conclusions:** This study provides a preliminary illustration of an experimental laboratory approach to studying SES-health relationships and suggests that providing informational support during a stressor may have beneficial implications for the physiological health of lower SES adolescents. **Key words:** socioeconomic status, cardiovascular, stress, control, resources.

**SES** = socioeconomic status; **HR** = heart rate; **SBP** = systolic blood pressure; **DBP** = diastolic blood pressure.

## INTRODUCTION

One of the most robust social variables that predicts health across the lifespan is low socioeconomic status (SES). Adults with lower SES have poorer health across a variety of mortality and morbidity outcomes as well as have more risk factors for diseases (1,2). Similarly, children from lower SES families are at greater risk for acute and chronic conditions and are more likely to engage in health-compromising behaviors (3).

One challenge in this field has been to identify the mechanisms behind these SES and health effects. Although many factors including access to health care, housing characteristics, and neighborhood characteristics (e.g., availability of grocery stores) likely play a role in this relationship (4,5), these factors cannot fully explain the disparities in health by SES (6). Thus, researchers have argued for the need to consider other factors such as psychosocial characteristics in explaining SES and health relationships (7–9). Whereas previous studies have largely examined correlational associations among SES, psychosocial characteristics, and health, the present study tested whether a brief intervention to manipulate psychosocial factors could have beneficial effects on physiological indices among lower SES individuals.

This study provided an intervention during an acute laboratory stressor and tested the impact on cardiovascular stress responses among adolescents. This laboratory model allowed us to use a controlled environment to test if SES effects are malleable. We focused on a community sample of adolescents, given the desire to provide intervention during potentially critical periods. That is, early prevention efforts may help to both maximize children's health as well as to move children onto healthier trajectories that persist across the lifespan, thus having the potential to improve health into adulthood as well. In targeting the period of adolescence, we sought to examine the potential influences of SES before they become entrenched but when children would be old enough to understand the intent of an intervention.

### Pathways Between SES and Health

Researchers have often distinguished two types of pathways for SES-health relationships. Some researchers have argued that the effects of SES operate primarily through the lack of resources available to low SES individuals (10). Others have argued that the psychosocial effects of living in low SES environments have important influences on health (11). The present study tests a laboratory conceptualization of each of these approaches to understand SES-health relationships.

*Control*

Researchers have proposed that low SES environments elicit a host of psychosocial consequences (11). These effects fall most commonly into four categories: individual difference characteristics (such as sense of control), stress, negative emotions, and health behaviors (7,9). Some researchers have argued for the primacy of individual difference characteristics such as control, in that the sense of control temporally precedes changes in negative emotions such as depression (12). In addition, social class differences cannot be explained solely by differences in factors such as stressful life events, suggesting the role of individual difference factors such as perceptions of control over life circumstances (13). Thus, in the present study, we focus on control as a fundamental characteristic of low SES environments. Previous research has demonstrated that low SES individuals perceive less control over their lives (14,15). In turn, lower levels of control have been associated with poorer health, such as higher risk of heart disease (16,17). Conversely, providing individuals with greater control over aspects of their daily lives improves physical health outcomes (18,19).

In addition, control appears to be especially important for low SES groups. Control had the biggest effects on physical health outcomes among those who were low in SES (20). Among low SES White women, control buffered the effects of an acutely stressful life situation on depressive symptoms (21). In observational studies, control has been found to form

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a significant pathway between low SES and poorer self-rated health (7,22,23).

*Resources*

In contrast, others have argued that a lack of resources is at the root of low SES effects on health. Resources are conceptualized as concrete objects, conditions, and supports that are valued by individuals or society (24,25). Resources can be characterized at the level of a) the environment (e.g., the amount of safe, clean parks a neighborhood has); b) the person (e.g., the knowledge about health that a person possesses); or c) the situation (e.g., the tools one has for dealing with a specific problem that arises). Resources can include material conditions, such as availability of food and health insurance (10) as well as tangible or informational support, such as having other people who can provide information or help during times of stress (24,26).

It has been hypothesized that individuals who are low in SES have heightened responses to stressors, in part, because they lack a reserve capacity of resources for dealing with stress (27). Low SES individuals are hypothesized to possess fewer resources both because they are exposed to stressors more frequently (thus, depleting their supply of resources) and because their environments make it difficult for resources to be acquired. Thus, the larger environment of low SES is hypothesized to create a shortage of resources that leaves these individuals vulnerable during times of stress. This shortage applies to resources defined in various ways—ranging from material possessions to social networks—that provide information and knowledge.

Possessing fewer resources has detrimental implications for physical health. For example, when resources are defined as support networks, associations with physiological and health outcomes have been found. In particular, these findings emerge with tangible or instrumental support resources, that is, having someone who provides concrete assistance with tasks or financial assistance. Low tangible support has been associated with increased risk of hypertension and coronary atherosclerosis (28,29). Tangible support has been found to buffer the effects of stress on the immune mechanisms (30) and on health behaviors such as alcohol use (31). High levels of tangible support also buffered the effects of negative life events on physical health symptoms (32). Finally, experimentally providing tangible support during an acute stressor reduced blood pressure (BP) reactivity among African American boys (33).

### Present Study

Researchers have suggested that both control and resources are two major explanatory factors for social class differences in health and well being (12,13,21,34). Debates have arisen in the literature over whether resources versus psychosocial factors, such as control, represent the more fundamental cause of health inequalities (10,11). Previous studies either have used observational designs or have experimentally manipulated control or resources but not linked them to SES. The present study conducted an experimental manipulation of control versus resources in lower versus higher SES adolescents.

First, we hypothesized that receiving one of these interventions, compared with no intervention, would result in reduced physiological reactivity among lower SES adolescents, given the previous research described above that documented benefits of these social factors for low SES individuals in particular. In contrast, we hypothesized that higher SES adolescents would not show comparable physiological benefits with intervention.

Second, we tested which would be more effective—control or resources—in reducing acute stress physiological reactivity. In the context of a laboratory stressor, a low SES background was hypothesized to create a lack of resources in terms of a knowledge base for optimally completing the stressor task. Hence, resources were operationalized as the provision of information to help with completing the stressor task. Control was operationalized as decision-making authority over task parameters. We speculated that giving adolescents control would operate specifically via changing subjective perceptions of control, which in turn have been associated with physiological and immune parameters (35–37). In contrast, informational resources might operate via multiple pathways. One might be similar to the control condition, in changing subjective perceptions of control; however, resources could also operate by supplying comfort or reassurance or by modeling effective coping. Thus, we hypothesized that, because of the potential multiple pathways, resources would have a greater effect than control.

## METHODS

### Participants

A total of 115 adolescents were recruited from public high schools in the St. Louis area in 2002. Eligibility criteria included being medically healthy and not taking any medication that could influence the cardiovascular system. Student ages in this sample ranged from 16 to 19 years (mean = 16.85 years). Sixty-two percent were female; 42% were White, 55% African American, 1% Native American, and 3% mixed ethnicity (part African American, part other). The Washington University Institutional Review Board approved this study.

### Materials

*Socioeconomic Status*

Parents or guardians were asked about their occupation and years of education. Hollingshead's Four Factor Index of Social Status (38) was used to compute family SES. A median split was used to categorize adolescents as coming from higher or lower SES families. The higher SES group on average had parents with a university degree (years education = 16.2 $\pm$ 1.8 (mean $\pm$ standard deviation)) and professional occupations (7.4 $\pm$ 0.9 on a 1–9 scale). The lower SES group on average had parents with 1 year beyond high school education (13.4 $\pm$ 1.7), and manual occupations (4.1 $\pm$ 1.4). Two families declined to provide SES information and were eliminated from the SES analyses below.

*Physiological Measures*

Heart rate (HR) was measured by electrocardiographic (EKG) monitoring. The EKG signal was filtered and amplified (MP100 system, Biopac Systems, Santa Barbara, CA). EKG signals were edited for movement artifacts. Four participants had extensive noise during at least one period of testing; these participants were not included in HR analyses for that period. Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were monitored (Dinamap Pro 100, Critikon, Tampa, FL) with a standard occluding cuff on the participant's nondominant arm.

*Self-Report Measures*

On a 6-point scale, participants rated how powerless they felt during the stressor, how demanding the stressor was, and how well they were able to cope during the stressor. Higher numbers indicated greater endorsement of each descriptor (more powerless, more demanding, more able to cope).

### Acute Laboratory Stressors

Participants underwent two acute laboratory stressors (one with intervention, and one without). One stressor was a debate, and the other was a verbal puzzle task. Both tasks involved speech and verbal interactions with the experimenter. In the debate task, adolescents debated a controversial topic (whether school officials should have the right to search students' lockers for weapons) with an experimenter. Experimenters had a standard set of response statements that they used during the debate.

In the puzzle task, adolescents verbally directed an experimenter on what moves to make to solve a series of 3D puzzles as quickly as possible.

### Intervention

Two types of intervention were provided: targeting control or resources. Control was manipulated by allowing the adolescents to decide the parameters of the task. In the debate task, adolescents who received control were allowed to pick which side of the controversial issue they wanted to argue, and if they wanted to speak first or second. They were also allowed to instruct their opponent to change arguments if they did not like the direction the debate was going. In the puzzle condition, adolescents who received control were allowed to pick the order in which they completed the puzzle (some puzzles were more difficult than others); once they started a puzzle, they were allowed to change to another puzzle if they were having difficulty with that puzzle. Adolescents who did not receive the control intervention were told which side of the debate to argue and who was to go first; they were not allowed to change the direction of the debate. In the puzzle condition, these adolescents were given an order for the puzzle task and they were not allowed to switch puzzles if they found one too difficult.

Resources were manipulated by providing adolescents with informational assistance during the stressor task. Participants were told that they would receive help during their next task. In the debate condition, participants were provided with two "hint cards," which demonstrated arguments for their side. These arguments were not commonly known (e.g., legal arguments); thus, adolescents were unlikely to think of these arguments on their own. In the puzzle task, adolescents were given two "hint cards," which indicated the two next correct moves for solving the puzzle. Adolescents could use hint cards when they were unsure of what to do next in the puzzle task.

### Procedures

Parents were interviewed about family SES. In a separate room, adolescents were fitted with EKG electrodes and a BP cuff. After a 10-minute adaptation, adolescents were given instructions for a baseline 10-minute rest period. During these rest periods, participants watched a nonnarrative video depicting nature scenes. HR and BP values were monitored during the last 5 minutes of the baseline period.

Adolescents then participated in the two stressor tasks for 8 minutes each. In one task, they received no intervention; in the other task, they received intervention. The pairing of type of task with intervention status was counterbalanced across all subjects. Additionally, the order of administration of the intervention-no intervention conditions was counterbalanced across all subjects. In the intervention condition, half the participants were randomized to receive resources; the other half received control. HR was monitored continuously and BP was obtained every minute during each task. A 10-minute rest period occurred between the two tasks.

To summarize, each adolescent had the following physiological measures recorded: baseline BP and HR; intervention task BP and HR; and no intervention task BP and HR (order counterbalanced for the latter two conditions). After each task, participants completed the self-report questions.

### Analytic Strategy

Cardiovascular reactivity scores were calculated as task values controlling for baseline cardiovascular measures. Analyses were conducted using 2 (SES group: lower, higher) × 2 (intervention status: intervention, no intervention) repeated-measures analyses of covariance (ANCOVAs), controlling for baseline values as well as task order.

## RESULTS

### Effect of Manipulation

We first tested if the interventions changed participants' perceptions of control. Among participants in the control condition, perceptions of powerlessness decreased in the intervention condition compared with the no intervention condition, $t(54) = 2.31$, $p < .05$ (intervention: 2.31 ± 1.62; no intervention: 3.00 ± 1.82). In contrast, ratings of powerlessness did not differ across conditions for participants who received resources, $t(52) = 0.06$ (nonsignificant, ns). Thus, there was specificity in that perceived control was altered by the control intervention, but not by the resources intervention. Because resources involved providing informational assistance that was objectively defined, the validity of this manipulation was not tested via subjective perceptions.

We next tested whether the two interventions were comparable. Participants were asked how well they were able to cope during the intervention task. Participants in the control condition did not differ from participants in the resources condition in ability to cope with the task, $t(112) = 0.34$, ns (control: 4.28 ± 1.21; resources: 4.36 ± 1.30). Participants in the control condition also did not differ from participants in the resources condition in how demanding they rated the task, $t(112) = 0.34$, ns (control: 3.93 ± 1.55; resources: 3.96 ± 1.41). These results indicated that the two intervention conditions were perceived similarly on these dimensions by adolescents.

### Effect of Race, Gender, and SES

For the purposes of race analyses, the three part-African American adolescents were considered part of the African American group, and the one Native American adolescent was excluded from these analyses. White and African American adolescents did not differ on any baseline measures (SBP: $t(112) = 0.84$, ns; DBP: $t(112) = 1.64$, ns; HR: $t(111) = 0.64$, ns) or reactivity measures (SBP intervention: $F(1,110) = 2.61$, ns; DBP intervention: $F(1,110) = 0.02$, ns; HR intervention: $F(1,105) = 1.22$, ns; SBP no intervention: $F(1,110) = 0.85$, ns; DBP no intervention: $F(1,110) = 0.04$, ns; HR no intervention: $F(1,106) = 1.09$, ns). See Table 1 for mean values. Thus, ethnicity was not included as a covariate in the analyses below.

Boys had higher resting values than girls (SBP: $t(113) = 5.45$, $p < .001$; DBP: $t(113) = 2.57$, $p < .05$; HR: $t(112) = 1.95$, $p = .05$). However, with respect to reactivity, girls and boys did not differ, the only exception being DBP during the no intervention condition (SBP intervention: $F(1,111) = 2.95$, ns; DBP intervention: $F(1,111) = 1.39$, ns; HR intervention: $F(1,106) = 0.03$, ns; SBP no intervention: $F(1,111) = 1.52$, ns; DBP no intervention: $F(1,111) = 4.42$, $p < .05$; HR no intervention: $F(1,107) = 0.24$, ns). See Table 1 for mean

**TABLE 1. Descriptive Information for Cardiovascular Variables (mean ± standard deviation)**

| | Baseline | No Intervention[a] | Intervention[a] |
|---|---|---|---|
| Lower SES ($n$ = 56) | | | |
| SBP | 112.21 ± 8.61 | 117.89 ± 10.67 | 114.98 ± 9.80 |
| DBP | 63.21 ± 6.69 | 69.73 ± 6.85 | 66.96 ± 6.65 |
| HR | 72.85 ± 9.42 | 78.33 ± 7.84 | 77.42 ± 6.76 |
| Higher SES ($n$ = 57) | | | |
| SBP | 110.23 ± 11.64 | 119.90 ± 10.68 | 120.90 ± 9.80 |
| DBP | 60.41 ± 6.44 | 69.84 ± 6.85 | 70.14 ± 6.65 |
| HR | 71.90 ± 11.01 | 79.28 ± 7.84 | 79.90 ± 6.76 |
| Black ($n$ = 66) | | | |
| SBP | 111.97 ± 9.53 | 118.07 ± 10.69 | 116.82 ± 10.11 |
| DBP | 62.74 ± 6.67 | 69.69 ± 6.86 | 68.62 ± 6.87 |
| HR | 72.79 ± 9.09 | 78.03 ± 7.75 | 77.99 ± 6.77 |
| White ($n$ = 48) | | | |
| SBP | 110.34 ± 11.23 | 119.94 ± 10.70 | 119.92 ± 9.90 |
| DBP | 60.67 ± 6.62 | 69.94 ± 6.88 | 68.83 ± 6.89 |
| HR | 71.53 ± 11.82 | 79.60 ± 7.75 | 79.44 ± 6.77 |
| Girls ($n$ = 71) | | | |
| SBP | 107.68 ± 9.07 | 117.83 ± 11.10 | 116.68 ± 10.56 |
| DBP | 63.06 ± 6.73 | 68.74 ± 6.73 | 68.09 ± 6.82 |
| HR | 73.68 ± 9.42 | 79.04 ± 7.80 | 78.73 ± 6.84 |
| Boys ($n$ = 44) | | | |
| SBP | 117.25 ± 9.28 | 120.64 ± 11.42 | 120.41 ± 10.85 |
| DBP | 59.86 ± 6.16 | 71.51 ± 6.78 | 69.66 ± 6.87 |
| HR | 69.86 ± 11.22 | 78.29 ± 7.84 | 78.51 ± 6.87 |

SES = socioeconomic status; SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate.
[a] Values for tasks represent mean values adjusted for baseline levels and task order.

values. Analyses reported below with DBP reactivity were repeated—controlling for gender, and patterns remained identical.

With respect to SES, at baseline, lower SES adolescents had higher DBP (SBP: $t(111) = 1.03$, ns; DBP: $t(111) = 2.27$, $p < .05$; HR: $t(111) = 0.49$, ns). Reactivity during the no intervention condition did not differ between SES groups (SBP no intervention: $F(1,110) = 1.10$, ns; DBP no intervention: $F(1,110) = 0.01$, ns; HR no intervention: $F(1,107) = 0.40$, ns). Differences with respect to the intervention are described in detail below, as these formed the primary study hypotheses.

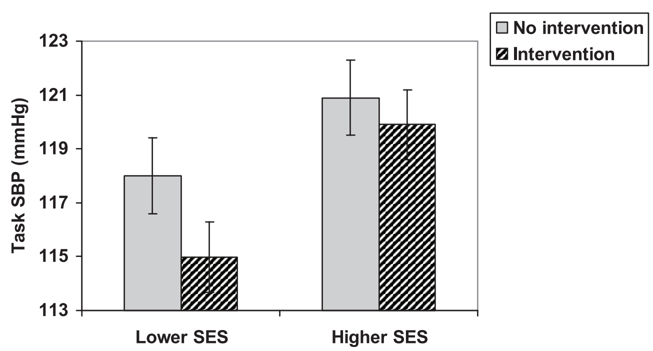


Figure 1. Average systolic blood pressure (SBP) during each condition (intervention, no intervention) by socioeconomic status (SES) group (lower, higher). Task means are adjusted for baseline values and task order. Error bars represent standard error of the mean.

### Effect of Intervention

There was a significant SES × Intervention interaction effect for SBP reactivity, $F(1,109) = 6.05$, $p < .05$. Among lower SES adolescents, those who received intervention had lower SBP reactivity scores during the acute stressor than those who did not receive intervention, $F(1,54) = 12.38$, $p < .01$. Among higher SES adolescents, there was no difference in physiological reactivity for those who received intervention compared with those who did not, $F(1,55) = 3.10$, ns. Effect size estimates were calculated for the lower SES group, and the effect of intervention was found to account for 18.7% of the variance in SBP reactivity ($\eta^2$) = 0.187 (Figure 1).

There was also a significant interaction effect for DBP reactivity, $F(1,109) = 7.49$, $p < .01$. Among lower SES adolescents, those who received intervention had lower DBP reactivity scores during the acute stressor than those who did not receive intervention, $F(1,54) = 14.25$, $p < .001$ ($\eta^2 = 0.209$). Among higher SES adolescents, there was no difference in physiological reactivity for those who received intervention compared with those who did not, $F(1,55) = 0.36$, ns (Figure 2). The interaction effect for HR was not statistically significant, $F(1,103) = 2.16$, ns.

### Effect of Control Versus Resources

Given that intervention effects were seen among lower SES adolescents, we then tested if the control intervention versus the resources intervention had a bigger impact on lower SES

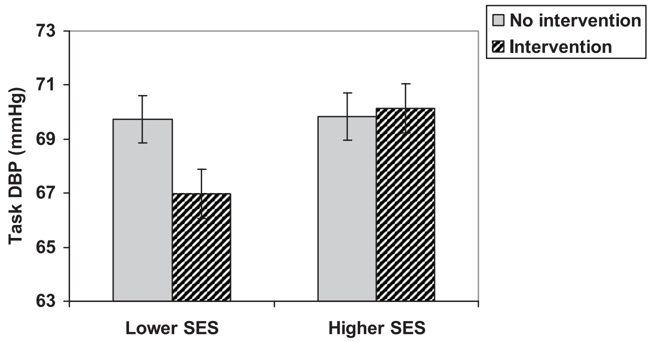


Figure 2. Average diastolic blood pressure (DBP) during each condition (intervention, no intervention) by socioeconomic status (SES) group (lower, higher). Task means are adjusted for baseline values and task order. Error bars represent standard error of the mean.

adolescents. To do this, we conducted a one-way ANCOVA of the effect of type of intervention on task scores (controlling for baseline and task order) among lower SES adolescents. A significant effect of type of intervention was found for SBP reactivity, $F(1,52) = 4.68$, $p < .05$ ($\eta^2 = 0.083$). Lower SES adolescents who received the resource intervention had lower SBP reactivity than those who received control. A significant effect of type of intervention was also found for DBP reactivity, $F(1,52) = 6.57$, $p < .05$ ($\eta^2 = 0.112$). Lower SES adolescents who received the resource intervention had lower DBP reactivity than adolescents who received control. The effect for HR reactivity was not statistically significant, $F(1,49) = 3.10$, $p = .08$ ($\eta^2 = 0.060$), although the trend was in the same direction as SBP and DBP (Figure 3).

### Role of Academic Background

One possibility is that adolescents' school achievement affected how they responded to the acute stressor or to the intervention. We tested this possibility by controlling for participants' grade point average (GPA) in all analyses described above. Significant findings were not changed by controlling for GPA, suggesting that the effects of intervention on acute stressor reactivity were not confounded by academic background.

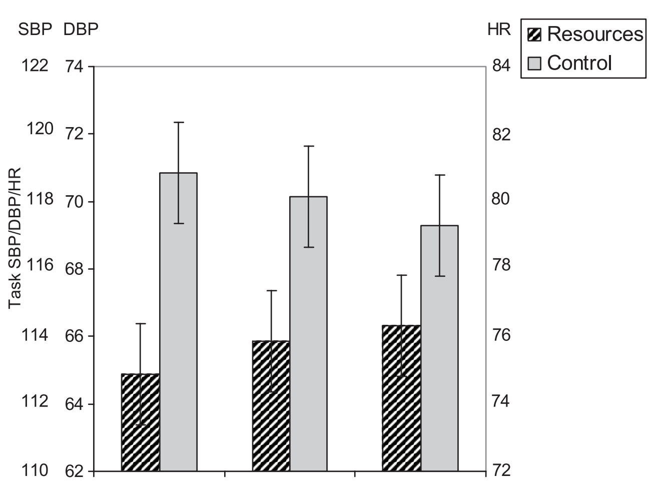


Figure 3. Average systolic blood pressure (SBP), diastolic blood pressure (DBP), and heart rate (HR) during each type of intervention (control, resources) among lower socioeconomic status (SES) adolescents. SBP and DBP are depicted in mm Hg; HR is depicted in beat/minute. Task means are adjusted for baseline values and task order. Error bars represent standard error of the mean.

## DISCUSSION

This study provided preliminary evidence that a laboratory manipulation of SES-associated psychosocial factors reduced physiological responses to stress among lower SES, but not higher SES, adolescents. This finding fits with previous observational research documenting that psychosocial factors such as control and social resources are more strongly related to physical health in low, compared with high, SES individuals (20,39). The present study extends previous research by using a novel approach that highlights the potential value of experimentally manipulating pathways between SES and physiological markers to better understand the mechanisms underlying SES and health relationships.

The intervention condition accounted for approximately 20% of the variance in SBP and DBP reactivity among lower SES adolescents, suggesting an effect size whose magnitude may be important. When the magnitude of BP changes during intervention (approximately 3 mm Hg) were compared with other laboratory manipulations, such as providing social support during acute stressors, the degree of change was comparable to the finding in one study (40), although smaller in magnitude than the finding in others (41–43).

Why did the psychosocial intervention work best among lower SES adolescents? Psychosocial interventions may be most effective among individuals who generally lack these qualities in their daily lives. If lower SES adolescents typically deal with stressors without much control and with few informational resources, they may be more responsive to the opportunity to approach a stressful situation with enhanced control or resources. Conversely, if higher SES adolescents already believe that they possess the control and resources needed to deal with a stressor, they may not benefit from being given additional control or resources. However, it should be noted that this study investigated only one type of resources (information from another person to help with a task); it is possible that high SES adolescents would benefit from other types of resources more than low SES adolescents.

Resources in terms of informational hints provided by another person was a more effective intervention for reducing physiological reactivity in lower SES adolescents than control. Some researchers have argued for the primacy of resources, particularly among those lacking them, and for the importance of resources in the stress process (24). Similarly, others have argued that addressing health inequalities must begin with addressing disparities in resources, rather than psychological perceptions (10). Moreover, our findings are consistent with other literature documenting the effects of resources on biological and health outcomes. When resources are defined in terms of support networks, tangible or instrumental support resources (having someone to help with concrete tasks) have been associated with greater sensitivity of immune cells to the effects of cortisol among adults undergoing a chronic stressor (30). Providing tangible support (concrete suggestions for dealing with stressful situations) also reduced BP reactivity in adolescent boys (33). As well, emotional support resources have been found to be beneficial to physiological outcomes among older adults with low income (39). Resources defined as material possessions also have been related to health and well-being. A lack of resources (financial strain) was found to be a significant pathway between low SES and poor physical functioning (44). In a different realm, experimental studies in public policy have found that providing low SES families with financial resources (vouchers to move into higher SES neighborhoods or housing relocation programs) resulted in children being more likely to graduate from high school, less likely to exhibit behavioral problems, less likely to have substance abuse problems, and less likely to suffer physical health problems (45).

How might this type of resource intervention reduce physiological reactivity in lower SES adolescents? We speculate that social resources in terms of providing assistance with a stressor could operate through a number of different pathways. The hints given could have modeled effective coping for how best to approach the stressor. Previous research has shown that social resources are associated with more active coping, particularly during high stress (46,47). Social resources may also help by making the acute situation less stressful because the individual now has information from another person to help perform the task well. In addition, social resources may reduce the effort required for the task, as previous research has found that task effort explained the relationship between instrumental support and acute stress reactivity in boys (33). It is also possible that the provision of resources changed subjective perceptions, such as perceived control. For example, providing social modeling about how to complete a task may increase participants' self-efficacy (48). However, we note that one study, albeit in a very different context, did not find effects of providing parents with material resources (wage supplements and child care subsidies) on children's perceived efficacy and perceived competence, despite beneficial effects on other psychological outcomes such as social behaviors (49,50). Although resources and control likely overlap, there may be situations in which resources can produce changes in health via pathways other than control, and vice versa. These explanations are speculative, as the present study did not empirically test pathways between resources or control; future studies are needed that rigorously assess the viability of the pathways proposed above.

There are a number of reasons why control may not have been effective in the context of this study. Control was only given during the acute stressor. Some researchers have argued that control is best when it is perceived as stable and applied to longer-term stressors (51). In addition, being given control may increase adolescents' sense of responsibility and self-blame during stressful situations (20). Finally, control may work best when it involves being able to terminate a stressor, as animal studies have shown (52). In our study, we gave control in terms of decisions about task parameters, but we did not allow participants to end the task, as this would have made it difficult to fairly compare the intervention and no intervention conditions. Thus, it may be that control did not work well in our study because it did not include being able to end the stressor.

We view this study as a first step in, and merely one example of, documenting the possibility of doing experimental manipulations that influence the relationship between SES and physiological markers of health. Our goal was to illustrate a potential new approach to investigating SES-health pathways, rather than providing definitive conclusions about mechanisms. The present study was limited in its definitions of resources and control, given that our starting point was physiological reactivity during a standard acute-stress reactivity paradigm; hence, our definitions of resources and control were constrained by the nature of the stressor. For example, although low SES individuals likely lack a number of different types of resources (e.g., financial and material goods, community services), the present study focused on a knowledge-based definition of resources that could be manipulated in the context of acute stressor reactivity tasks, such as public speaking. Future studies are needed that test different conceptualizations of resources to determine if there are specific deficits in resources among low SES individuals that are most responsive to intervention. The present study tested a control intervention against a resources intervention, when in reality the two may be linked, and resources may help bolster perceptions of control. This study represents a first example of a novel approach to experimentally manipulate SES-health relationships. Future studies should be cautious about artificially dichotomizing intervention approaches until the pathways are better understood.

The present study provided preliminary evidence that an intervention consisting of informational hints to lower SES adolescents reduced physiological reactivity to an acute stressor. However, these conclusions must be weighed cautiously, as real-world effects of resources likely occur at multiple levels (environment, person, situation), and may interact with one another to affect health. For example, although low SES environments may have fewer available resources for a community, certain individuals within that community may have found ways to bolster their resources through other sources; hence, the effects of environmental resources may vary depending on the person's characteristics. Future studies should explore the nature of these complex relationships between resources at multiple levels and effects on health. Finally, future studies are needed to test the extent to which this study's findings are generalizable to physiological responses to situations in the larger social world, and to apply this study's findings to large-scale observational and public policy studies on SES and health.

Other limitations include ethnic composition across the two SES groups differing, which was unavoidable given the overlap between SES and ethnicity in the US. However, we tested for and found no ethnicity differences in physiological reactivity. Second, the within-subjects design meant that adolescents participated in two different types of acute stressors. We attempted to control for confounds related to this design by equating the dimensions of each stressor (e.g., both involving speech and interaction with the experimenter), counterbalancing type of task across interventions, and controlling for type of task in all analyses.

In addition, this study dichotomized participants into lower and higher SES groups. The within-subjects design necessitated a repeated-measures analytical approach, and our use of ANCOVA required categorical independent variables. Although this dichotomization is artificial, one would expect that it would increase random error, and in doing so, reduce statistical power for detecting associations. Nonetheless, the lack of truly distinct SES groups limits the extent to which one can generalize the reactivity differences in this study to real-world differences in poor versus wealthy families.

Finally, because our study objectively manipulated control and resources, we did not design subjective measures to assess changes in perceptions of control or resources. This constitutes a limitation of the present study. We showed that the control (but not resource) manipulation did change subjective perceptions of powerlessness, and that the control and resources interventions were equivalent in participants' perceptions of their ability to cope during the stressor, thus providing some indirect evidence of the credibility of the intervention approaches. Nonetheless, it would be important for future studies to directly assess constructs, such as perceived control and self-efficacy.

Experimental designs, such as the present study employed, are important for testing mechanisms in a controlled environment and for establishing causality. In this study, we focused on the ability of psychosocial manipulations to change acute stressor reactivity. In children, cardiovascular reactivity predicts changes in resting BP several years later (53,54). There is also some evidence in adults that cardiovascular reactivity to laboratory stressors predicts health outcomes such as hypertension and coronary heart disease years later (55–58). If lower SES adolescents experience episodes of acute-stress reactivity more frequently in their daily lives, over time the accumulation of these episodes may put these adolescents at risk for poorer cardiovascular health later in life. If so, social resources intervention could have beneficial implications for longer-term physiological health among lower SES adolescents, although we must caution that this link to health is inferential.

In conclusion, the present study demonstrated that a resource intervention of informational hints from another person reduced the physiological responses to acute stress among lower SES adolescents. Studies that manipulate psychosocial factors are important both for understanding the psychological characteristics that mediate SES-health relationships and for informing intervention approaches. In addition to targeting societal-level factors such as access to health care, targeting psychosocial factors may serve as a promising individual-level approach to reducing the detrimental health consequences of living in a low SES environment. The present study suggests a novel approach to pursuing this research and provides preliminary evidence that informational social resources are one potentially malleable pathway between lower SES and physiological response to stress.

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