

Redesign of the Trivers-Willard Hypothesis Measurement Tool

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Abstract. The Trivers-Willard Hypothesis posits that parents in favorable conditions tend to invest more in male offspring, while those in disadvantaged conditions focus on female offspring under the disadvantaged condition based on the reproductive potential of the next generation. Through a review of previous studies, we find that these series of studies lack a unified measurement to assess parental socioeconomic status and parental investment, which may be the cause of inconsistent results. To solve this problem, our study establishes a cross-culturally applicable measurement framework. By measuring the annual household income, the income distribution ratios and time investment differences between children of different sexes, we aim to validate the Trivers-Willard Hypothesis. Even if there are possible negative results in future studies, our measurement still contributes to enhancing methodological homogeneity in future research.

Keywords: Trivers-Willard Hypothesis, socioeconomic status, parental investment

1. Introduction

In the field of evolutionary psychology, the Trivers-Willard Hypothesis is a theory that explains parental investment strategies in the face of different offspring genders and different parental situations. The hypothesis was proposed by Robert Trivers and Dan Willard in 1973, who hypothesized that parents, in order to maximize their reproductive success, tended to allocate more resources to offspring of a particular sex based on their own status. The central idea of this hypothesis is that when parents are in good shape, they will have a preference for male offspring and will be more inclined to divide resources among their sons [1].

The Trivers-Willard Hypothesis is consistent with the basic principles of natural selection and parental investment theory. From an evolutionary point of view, parents will seek to maximize their genetic replication. The sex of the offspring will have different effects on this goal, and since sons are able to have multiple spouses to produce many offspring, they may be more efficient in terms of reproductive success. Daughters, on the other hand, generally have more stable reproductive outcomes but are unlikely to produce a similar amount to men. As a result, parents in good physical condition should invest more in their sons to take advantage of their potential for high reproductive success, while parents in less physical condition invest more in their daughters to ensure the

reliability of genetic representation. Therefore, the Trivers-Willard Hypothesis showcases an adaptive function.

Although an adaptive function, research on the Trivers-Willard hypothesis has shown mixed results. Findings have shown to support as well as contradict the effects of the Trivers-Willard hypothesis across populations around the world. For example, within the United States, Cleaver and Non [2] found that sex ratio at birth, a comparison between numbers of sons and daughters born from families, does not support the hypothesis. Cleaver and Non [2] highlighted that the ratio was not biased towards females as predicted by the Trivers-Willard hypothesis. In Africa, economically sufficient mothers, an indicator of good physical condition, do not breastfeed their sons more than their daughters, denying the effects of the hypothesis [3]. In Europe, drop out rates for boys are lower in high status families in Finland supporting the hypothesis [4]. However, the sex ratio at birth in Sweden denies the effect [5]. Finally, in Asia, financial spending on education tools such as backpacks in China supports the Trivers-Willard hypothesis [6].

This study proposes that the Trivers-Willard hypothesis's adaptive function should show its effect all over the world regardless of location and culture. We doubt the conclusions reached by the studies mentioned above. We believe that the conclusions are derived from various procedures, resulting in evidence that supports or denies the effects of the adaptive function. For example, within the United States, there are results that support or deny the adaptive function with four different measurement techniques that operationalize the adaptive function. Schnettler [7] used the preference of parental investment to conclude that parental condition influences the investment towards the child's sex, supporting the hypothesis. Hopcroft and Martin [8] found that the sons of high-status families and daughters of low-status families receive more financial spending than the opposite sex, supporting the hypothesis. Keller et al [9]. found that parents with different statuses show no preference in sons vs daughters. This is in addition to Cleaver and Non's [2] findings that low-status families show no preferences for daughters, denying the effect of the hypothesis. Highlighting the low validity of the conclusions reached through the variations in procedural techniques to operationalize the hypothesis.

The variety of operationalizations used to measure the Trivers-Willard hypothesis raises concern for how reliable the conclusions are as an adaptive function for the global population. Even with studies reaching an agreement supporting the hypothesis, the use of multiple distinct measurements makes the conclusion difficult to apply to other samples and populations. Song [6] used backpack color and prices to measure gender and investment, while Veller et al. [10] used a mother's physical condition and offspring investment to determine the effect. Both findings support the effect; however, it is difficult to determine if one procedural technique used in the other study would reach the same conclusion. Suggesting one universal construct would be an accurate measurement of adaptation for the human population.

As mentioned above, a unified and measurement of socioeconomic status (SES) should be defined to solve this problem. According to Trivers and Willard [1], socioeconomic status (SES) is an important factor influencing how human beings allocate resources to the next generation differs by sex.

Socioeconomic status (SES) is defined as a measure of one's combined economic and social status and tends to be positively associated with better health [11]. Three typical indicators of SES encompass parental income, parental education, and occupation [12].

Admittedly, parental education, regarded as a non-negligible indicator, reflects the SES conditions in some aspects. However, its interpretation may vary significantly across cultural contexts. For instance, higher education represents the honor a child brings to the family rather than

interests or only employment demands in East Asia [13]. Besides, returns to higher education are higher in lower-income countries relative to higher-income countries, which will also weaken the effectiveness of parental education [14].

Thus, we finally adopt parental income and occupation as our metrics for SES. Although some subtle biases in the above two variables may also exist, there are already some cross-culturally unified measurement standards for these variables, which will be detailed in the methods section.

The measurement of the parental investment should also be defined. Previous studies defined it with diverse aspect. Freese and Powell [15], for example, identified five core categories: economic, interactional, supervisory, social, and cultural. With these considerations, parental investment can be measured in detail. While some indicators are not commonly available, especially for families in developing countries. For instance, cultural investments are often operationalized as parents' spending on children's extracurricular activities, such as art, music, dance, language, or computer classes, and visits to art, science, or history museums, which may be unimaginable for some rural and disadvantaged areas. Hence, we finally decided to use the parents' financial and time investment.

In conclusion, our study aims to develop more representative measurement tools to explore the relationship between the amount of family resources and parental investment in children of different genders among different countries. In this way, we expect that the Trivers-Willard hypothesis can be supported to be effective in different places. In other words, our hypothesis is that our proposed measurements of socioeconomic status and parental investment will showcase the effect of the Trivers-Willard hypothesis in the population globally.

2. Method

2.1. Research design

This study aims to explore how the annual household income component of a parent's socioeconomic status (SES) affects the difference in financial and time investments between sons and daughters. This study will use stratified sampling to reveal the effect of parental income (SES) on children's preference tendencies. To control for age, children will be split into three different age groups (0-6 years, 7-12 years, 13-18 years).

2.2. Participants

The study will target parents with one son and one daughter in the family, and will sample 500 families (1,000 parents). A stratified sampling strategy will be used to ensure a balanced distribution of three developmental stages: (a) early childhood (children aged 0-6 years, $n \approx 165$ families), (b) middle childhood (7-12 years, $n \approx 165$ families), and (c) adolescence (13-18 years, $n \approx 170$ families). To reduce cultural bias, the questionnaire will be distributed through an international collaborative platform, recruiting participants from four main regions: Asia, Europe, North & South America, Africa, and Oceania. Data were included on the following criteria: (1) parents completing the questionnaire together and (2) families with two children of the opposite sex.

2.3. Measures

2.3.1. Independent variable

The annual household income and International Standard Classification of Occupations (ISCO) of socioeconomic status (SES) will be used as an independent variable in the study measures. Since the currencies used in different regions are different, in order to compare the annual household income more fairly, we convert it to purchasing power parity (PPP) [16] for comparison. Besides, we will transfer ISCO into its corresponding international socioeconomic index (ISEI). This encoding method can convert occupations into a continuous socioeconomic status (SES) score while accounting for cross-cultural differences at the same time [17].

2.3.2. Dependent variable

The dependent variable is the difference in parental investment in sons and daughters, and it consists of two components:

- (1) The income distribution ratio, which is calculated as the percentage of monthly spending per child on education, health care, and extracurricular activities as reported by parents; and
- (2) Time investment differences, using a 7-point Likert scale to assess the "fairness of daily time allocation" (1 = strongly disagree, 7 = strongly agree).

This study will control for demographic effects on the dependent variable through collecting parental demographics (age, sex, and occupation type), child age, stratified by age group (0-6/7-12/13-18 years); as well as parental health status, self-reported using the Happiness Index (1 = very poor to 5 = very good). In addition, the study will add a gender investment gap calculated by the son's expenditure subtracted by the daughter's expenditure. A positive value indicates the parents investing more financially towards the son (son preference) whereas a negative value indicates more financial investment towards the daughter (daughter preference).

2.4. Results

We expect that as the family's annual household income increases, the parents' reported percentage of monthly spending on sons will be higher than on daughters. We also expect more time investment towards the son compared to the daughter, with the disparity of time allocation increasing the higher the annual household income increases.

We expect that as the family's annual household income decreases, the parents' reported percentage of monthly spending on daughters will be higher than on sons. With the disparity of spending between daughters and sons increasing the lower the annual household income. We also expect more time investment towards the daughter compared to the son, with the disparity of time allocation increasing as the annual household income decreases.

3. Discussion

This paper proposes that a consistent measurement of parental income would lead to consistent results of the Trivers-Willard Hypothesis globally. We expect that families with higher annual household income represent high resource acquisition, with the son receiving greater financial and time investment than the daughter. We expect that families with lower annual household income represent low resource acquisition. According to the Trivers-Willard Hypothesis, the daughters of low-status families will receive greater financial and time investment compared to the sons. The expected

results support our hypothesis as sons are expected to receive greater financial investment as well as more time spent with their parents compared to daughters for high-status families. Daughters are expected to receive more financial investment and more time spent with their parents for low-status families. We propose that the expected results of the Trivers-Willard hypothesis have a global reach, as our sample will be taken from all over the world, indicating that income is an accurate measurement of “shape”. The expected results is consistent with the definition of the Trivers-Willard hypothesis [1].

Although past studies have not used annual household income and overall spending to test the hypothesis, some articles used financial spending representing a son's or daughter's investment. We will be comparing our predicted findings to those that have been researched financial cost in the past. Song [6] findings that high status families will spend more money on backpacks for sons and low status families spend more money on backpacks for daughters are consistent with our findings of the Trivers-Willard hypothesis. We expect our measurement of parental income and financial investment to replicate the conclusion reached by Song [6]. We expect families with high income to purchase backpacks of a greater cost for sons than daughters. As well as families with lower income to can purchase higher cost backpacks for their daughters than their sons. By using parental income to represent status and financial investment for backpack purchases, we expect Song's [6] results to replicate.

We expect a replication of Hopcroft and Martin's [8] findings. Their measurement of financial investment includes the number of years the children attend school. With greater financial investment, the more years children attend school. After determining status with parental income, we expect that high-income families' sons receive more years than daughters. We expect that low-income families' daughters receive more years than sons. We expect parental income to represent status and financial investment to represent education and time investment. With the proposed measurements, we expect a replication of Hopcroft and Martin's [8] findings.

Certain studies included parental income as a measurement of status and reached findings that deny the effect of the Trivers-Willard hypothesis. Fujita et al [3]. found that high-income families show no difference in investment towards their sons and daughters. Our study proposes that the measurement of breastfeeding frequencies is not an accurate measurement of investment, as the amount of breastmilk produced can depend on external influences that may affect the mother [18]. Concluding that the mother's investment may be affected by external factors unrelated to her status [18]. Keller et al. [9] found that parental investment shows no effect of the Trivers-Willard hypothesis in the United States. Our study proposes that the measurements they use include factors unrelated to parental investment as breastfeeding and birth weight [18]. These external factors can be influenced by the autonomy of the mothers, unrelated to status.

Certainly, there also exists the possibility that the prediction of our study is inconsistent with the actual situation. The outcome may indicate that investing more in female offspring is not supported in families with a disadvantaged SES. On one hand, this may be attributed to the possibility that the critical quality threshold, where the relative reproductive success advantage shifts from females to males, has been significantly surpassed by the prevailing SES levels of modern society. In other words, in contemporary, relatively affluent contexts, the conditions favoring preferential investment in females for more reproductive returns may no longer apply, which may lead us to further our study in less privileged areas where this threshold might not yet be exceeded. On the other hand, the difference in parental investment by sex may turn out to be more subtle. As Jeremy Freese and Brian Powell [15] have noted, female offspring tend to receive greater investment on socioemotional

capital, like culture, interaction, while male offspring typically receive more economic investment. The drivers underlying this divergent allocation of parental investment require further investigation.

In addition, we can't exclude the possibility that no significant difference in parental investment will be found in the end. On one hand, this may be attributed to the premise of income -- the monetary system. In some extremely underdeveloped regions, their transactions may still rely on the barter system. On the other hand, it could also reflect the limited effect of the Trivers-Willard Hypothesis across diverse contextual conditions.

But nevertheless, as emphasized in the introduction, what matters most is to establish a set of cogent indicators. In this way, even if dichotomous results are found in future studies, many methods, such as meta-analysis, can be applied to explore the Trivers-Willard Hypothesis more comprehensively, while reducing the heterogeneity between studies caused by the measurement.

4. Conclusion

From the predicted results, the Trivers-Willard hypothesis presents a useful tool for predicting child investment based on parental resources. Although past studies incorporated different measurements to determine the direction of parental investment, this study proposes one type of financial measurement to consistently predict parental investment. This provides a consistent implication for gender investment trends based on the available resources that the parents may have. One future direction is to expand the proposed sample towards the extremes of parental socioeconomic status and determine whether the consistency is prevalent within the wealthiest and poorest parents. Nevertheless, this paper proposes that the Trivers-Willard hypothesis can play an important role in projecting children's development trends by measuring the resources that their parents may have.

Acknowledgement

Yuan-Lin Lu and Leyan Xu contributed equally to this work and should be considered co-first authors.

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