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Article

Beyond the P-Value: The Significance of Inconclusive Results and the Role of the IIRF in Advancing Scientific Inquiry

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Abstract: In scientific research, there is a noticeable lack of specific studies focused on inconclusive results, in contrast to the abundance of studies dedicated to conclusive or positive outcomes. While conclusive results offer definitive answers, inconclusive results, often viewed less favorably, do not provide such clarity. However, they play a vital role in the scientific process by identifying gaps and inspiring future research. This paper introduces the pioneering Integrated Inconclusive Results Framework, a significant development that addresses the challenges associated with inconclusive results. The Framework aims to shift the perception of inconclusive results from setbacks to crucial components of scientific progress, ultimately enhancing scientific inquiry's rigor, transparency, and overall quality. The paper delves into the historical treatment of inconclusive results, causes, and strategies for handling them, offering insights into utilizing them to inspire and guide future research, thereby strengthening the scientific community and instilling confidence and reassurance in the direction of scientific research.

Keywords: inconclusive results; null findings; statistical significance; research methodology; publication bias

1. Introduction to Inconclusive Results and Findings

Bias in publication practices has resulted in a lack of representation of inconclusive studies in published research, creating a skewed scientific record and potentially distorting the perceived strength of specific findings (Dickersin, 1990). However, there is a growing recognition of the significance of reporting and interpreting inconclusive results to ensure the integrity and reliability of scientific knowledge (Chalmers & Glasziou, 2009). Scientific research results are generally categorized as conclusive or inconclusive based on their clarity and support for the initial hypotheses (Greenland, 2017; Ioannidis, 2005). Statistically, non-significant results can be either informative, showing that it is doubtful that a treatment has a significant effect, or inconclusive, indicating uncertainty about the relative effects of the treatments compared. Inconclusive results, also known as negative findings, typically stem from research that does not achieve statistical significance (Evola, 2024). This suggests that the available data do not validate the original hypothesis for that particular measure, and there is insufficient evidence to conclude that the treatment had any real impact. These results are characterized by their inability to draw a clear conclusion for various reasons, such as insufficient statistical power, conflicting data, or methodological limitations (Ioannidis, 2005).

2. Historical Context

Historically, the scientific community has always favored publishing positive or significant findings over inconclusive or null results, known as publication bias (Rosenthal, 1979) - although inconclusive findings in academic research have always been part of the evolution of the scientific method and its associated challenges. The adaptation of the statistical significance threshold ($p < 0.05$)

in the mid-20th century further marginalized inconclusive results, leading to the dismissal of studies that did not meet this criterion. With increasing awareness of publication bias and the limitations of the p-value approach, there is a growing recognition of the importance of reporting all results, including inconclusive ones. Initiatives like the Open Science Movement have played a critical role in advocating for greater transparency and reproducibility in research, emphasizing the significance of publishing all research findings, including inconclusive ones (Nosek et al., 2015). Journals like the Journal of Articles in Support of the Null Hypothesis have emerged to address this gap and promote a more balanced representation of research outcomes (Kaiser, 2018).

Early Scientific Endeavors (17th-19th Centuries)

During the Scientific Revolution and Enlightenment, incomplete results were expected in early experiments due to the absence of standardized methodologies and advanced technology. Early chemists and physicists, for example, frequently struggled to obtain definitive findings while exploring chemical reactions or the properties of light. These challenges began to be addressed with the development of the scientific method, which emphasized hypothesis testing, observation, and repeatability (Shapin, 1996).

20th Century: Rise of Experimental Science

Throughout the 20th century, as scientific disciplines advanced, there was an increasing awareness of the importance of inconclusive findings. In fields such as psychology, early research encountered challenges with methodology. For instance, the well-known Hawthorne studies of the 1920s and 1930s examined worker productivity and produced inconclusive results due to many uncontrolled variables (Roethlisberger & Dickson, 1939). These studies underscored the necessity for more meticulous experimental controls. Medical research in the mid-20th century also witnessed numerous clinical trials with inconclusive results, often due to small sample sizes and insufficient study designs. The Thalidomide tragedy in the 1960s, in which an anti-nausea drug led to congenital disabilities, emphasized the importance of rigorous and conclusive clinical testing (McBride, 1961). This incident resulted in more stringent regulatory standards for drug testing.

Late 20th to Early 21st Century: Technological Advancements and Methodological Refinement

Significant technological advancements facilitated more precise and large-scale studies in the latter part of the 20th century. However, inconclusive results remained prevalent, particularly in intricate fields such as genetics and epidemiology. Despite achieving significant milestones, the Human Genome Project initially generated numerous inconclusive findings about the connections between particular genes and diseases, leading to additional research and more sophisticated analytical techniques (Collins et al., 2003). In psychology and social sciences, the replication crisis in the early 21st century revealed that numerous well-established findings could not be replicated, often due to small effect sizes and methodological shortcomings. This crisis prompted a call for elevated levels of transparency, data sharing, and replication endeavors (Open Science Collaboration, 2015).

Current Era

In today's scientific process, inconclusive findings are essential to enhance research methodologies and practices. For example, the focus on reproducibility and open science seeks to minimize inconclusive results by advocating for stringent study designs, preregistration of studies, and comprehensive data reporting (Munafò et al., 2017).

3. Causes of Inconclusive Results

According to Bernalov et al. (2019), no experiment can conclusively prove the absence of an effect. Instead, experiments help estimate the magnitude and variability of an effect: when variability is high, results may be inconclusive, but when variability is low, results may suggest a meaningful effect. Inconclusive results are characterized by their inability to support or refute research hypotheses definitively. When a study fails to meet the threshold for statistical significance (typically $p < 0.05$), the results can be deemed inconclusive. This means the data do not provide strong enough evidence to support or refute the hypothesis (Evola, 2024). They often stem from methodological

limitations, such as small sample sizes, measurement errors, or unforeseen variability in data (Ioannidis, 2005; Greenland, 2017).

Insufficient Sample Size: An inadequate sample size is one of the most common causes of inconclusive results. Studies with too few participants may lack the statistical power to detect significant effects, leading to ambiguous outcomes (Button et al., 2013).

Measurement Errors: Errors in data collection methods, whether through faulty instruments, biased measures, or human error, can lead to results that are difficult to interpret (Altman & Bland, 1994).

Variability in Data: High variability or noise within the data can obscure actual effects, making it challenging to draw clear conclusions. This variability can stem from uncontrolled environmental factors, heterogeneous samples, or inherent biological variability (Nuzzo, 2014).

Methodological Limitations: Flaws in study design, such as lack of randomization, inadequate control groups, or poor operational definitions of variables, can result in inconclusive findings. These limitations hinder the ability to isolate and identify the effect of the variables of interest (Shadish et al., 2002).

Theoretical Ambiguity: Inconclusive results can also arise from unclear or competing theoretical frameworks that make it difficult to interpret findings consistently. When multiple theories can explain the same data, results may appear inconclusive (Meehl, 1967).

4. Impact of Inclusive Findings

Despite their perceived drawbacks, inconclusive results are critical indicators of the complexity and uncertainty inherent in scientific inquiry (Ioannidis, 2005; Greenland, 2017).

4.1. Impact on Some Selected Field Research

A study by Temple & Ellenberg (2000) and Pocock & Stone (2016) investigating the effectiveness of a new drug for treating a specific illness did not uncover statistically significant differences between the treatment and control groups. Despite the inconclusive findings, the study has stimulated further research into varying dosages, specific patient subgroups, and the underlying mechanisms of action. This ongoing process enhances treatment protocols and shapes future approaches to drug development (Ioannidis, 2005).

4.2. Impact on General Research

The impact of inconclusive results on scientific progress is multifaceted. On the one hand, they can delay the advancement of knowledge by failing to provide clear answers. However, they can also stimulate further investigation, encourage methodological improvements, and foster a culture of transparency and reproducibility in research (Baker, 2016). For instance, inconclusive results in clinical trials can prompt researchers to re-evaluate study designs, reconsider endpoints, and explore alternative hypotheses, ultimately leading to more effective treatments and interventions (Chalmers & Glasziou, 2009).

4.3. Impact on Researcher's Confidence

The presence of inconclusive research results can significantly impact the confidence of researchers and the scientific community. On one hand, such results can reduce confidence by failing to provide clear answers, leading to frustration and a potential loss of funding or support (Fanelli, 2012). On the other hand, when appropriately contextualized and reported, inconclusive results can improve scientific rigor by highlighting the limitations of current methods and encouraging more robust and innovative approaches in future research (Ioannidis, 2016). Embracing inconclusive results promotes a culture of transparency and openness, which is crucial for the self-correcting nature of science. By acknowledging and reporting all outcomes, researchers can build a more reliable and comprehensive body of knowledge, ultimately enhancing the credibility and reliability of scientific findings (Nosek & Bar-Anan, 2012). While researchers aim for clear-cut outcomes to validate

theories or interventions, inconclusive findings can challenge existing beliefs and prompt critical re-evaluation. This process is integral to the scientific method, fostering a culture of rigorous inquiry and intellectual humility (Fanelli, 2012). The presence of inconclusive results underscores the complexity and variability inherent in scientific investigations. Instead of dismissing inconclusive findings as failures, researchers increasingly recognize their value in refining methodologies, identifying limitations, and guiding future research directions (Baker, 2016). This reflective approach enhances the robustness of scientific inquiry and promotes transparency and credibility within the research community (Chalmers & Glasziou, 2009).

4.4. *Impact on Researchers' Psychology*

The inconclusive results can significantly impact researchers, leading to various psychological effects. These effects may include frustration and disappointment when researchers' hypotheses are not confirmed, thus affecting their morale and motivation (Fanelli, 2012). In fields where the publication of positive results is prioritized, researchers may encounter challenges regarding career advancement or securing funding opportunities due to the perceived lack of impactful findings (Dwan et al., 2008). However, developing resilience and adapting to inconclusive outcomes can foster perseverance and innovation in research practices (Baker, 2016).

5. Handling of Inconclusive Results

Effective management can be achieved through transparent reporting, wherein researchers accurately communicate inconclusive findings to prevent publication bias and offer a comprehensive view of research outcomes (Baker, 2016). Conducting additional exploratory or subgroup analyses can help identify potential patterns within inconclusive data, guiding future research directions (Chalmers & Glasziou, 2009). Improving study designs, refining measurement tools, and enhancing statistical methods are essential for mitigating factors contributing to inconclusive results (Greenland, 2017). Furthermore, integrating inconclusive results from multiple studies through meta-analysis or systematic reviews can provide a more nuanced understanding of complex phenomena (Ioannidis, 2005). In his article "5 Tips for Dealing with Non-Significant Results," Brock (2019) further provides strategies to avoid unpublishable outcomes resulting from inconclusive results. These include:

- Conducting an equivalence test: When a non-significant result is inconclusive, it could indicate that the null hypothesis is true (there is no effect) or that the data are inconclusive. Performing an equivalence test can help distinguish between these possibilities. While it cannot prove any effect, it can indicate that any existing effect is likely of negligible practical or theoretical significance.
- Collaborating with other researchers and collecting more data to address the issue of underpowered studies.
- Using directional tests to enhance statistical power by tweaking research designs.
- Implementing sequential analyses to improve data collection efficiency.

6. Integrated Inconclusive Results Framework (IIRF)

The paper proposes the Integrated Inconclusive Results Framework (IIRF) from the preceding discussions and relevant literature. This framework (Table 1) offers a systematic approach to managing and capitalizing on inconclusive findings in scientific research effectively. The primary goal of IIRF is to change the perception of inconclusive results from being considered setbacks to being recognized as pivotal elements that propel scientific advancement.

The proposed five components of the IIRF:

- 1) **Transparent Reporting Protocol:** Establish guidelines for accurately reporting inconclusive findings with the same rigor as conclusive results. Encourage journals to adopt these

- guidelines, promoting the publication of inconclusive results to prevent publication bias and provide a holistic view of research outcomes (Baker, 2016).
- 2) **Exploratory Analysis Toolkit:** Develop tools and methodologies for conducting additional exploratory analyses on inconclusive data, including subgroup analyses and pattern recognition techniques. Train researchers to utilize these tools effectively to uncover potential trends and guide future research directions (Chalmers & Glasziou, 2009).
 - 3) **Methodological Improvement Initiative:** Focus on improving study designs, refining measurement tools, and enhancing statistical methods to reduce the occurrence of inconclusive results due to methodological flaws (Greenland, 2017). Collaborate with research institutions to implement these improvements systematically.
 - 4) **Meta-Analysis Integration Platform:** Create a platform for integrating inconclusive results from multiple studies through meta-analysis and systematic reviews. Encourage collaboration among researchers to contribute their data to this platform for a more nuanced understanding of complex phenomena (Ioannidis, 2005).
 - 5) **Psychological Support Program:** Implement a support program for researchers dealing with the psychological impact of inconclusive results, providing counseling, resilience training, and career development resources (Fanelli, 2012). Promote a culture that values inconclusive results as integral to the scientific process to enhance researcher morale and motivation.

Table 1. Integrated Inconclusive Results Framework (IIRF).

Components	Description	Key Activities	Expected Outcomes
Transparent Reporting Protocol (TRP)	Establish guidelines for accurate reporting of inconclusive findings.	- Develop reporting standards. - Promote adoption by journals. - Train researchers on reporting guidelines.	To reduce publication bias. Provide a comprehensive view of research outcomes and increased acceptance of inconclusive results.
Exploratory Analysis Toolkit (EAT)	Provide tools for additional exploratory analyses to identify patterns within inconclusive data.	- Create and disseminate analysis tools. - Offer training sessions. - Encourage exploratory research.	Helped identify new research directions. Enhanced understanding of inconclusive data.
Methodological Improvement Initiative (MII)	Improve study designs, measurement tools, and statistical methods to reduce inconclusive results.	- Conduct workshops on methodological improvements. - Develop best practice guidelines. - Collaborate with institutions.	Higher quality research designs and reduces methodological errors, i.e., fewer inconclusive results.
Meta-Analysis Integration Platform (MAIP)	Create a platform for integrating inconclusive results from multiple studies through meta-analysis.	- Develop an online platform. - Facilitate data sharing and collaboration. - Conduct meta-analyses.	Enable comprehensive understanding of research topics: improved data synthesis and enhanced research reliability.
Psychological Support Program (PSP)	Provide support for researchers dealing with the psychological impact of inconclusive results.	- Offer counseling services. - Develop resilience training programs. - Provide career development resources.	Improved researcher's morale and motivation. Reduced stigma around inconclusive results and increased researcher resilience.

Credit: Author, 2024.

6.1. Plausible Demonstration and Use of IIRF

The following presents a possible scenario to illustrate the practical application and effectiveness of the IIRF in various research contexts. By promoting transparent reporting, encouraging exploratory analysis, improving methodological rigor, and integrating findings through meta

Possibility One: Exploratory Analysis Toolkit (EAT) in Educational Research

A study examining the impact of a new teaching method on student performance produced varied results, with no clear evidence supporting the superiority of the new method over traditional approaches. Using the EAT component of the IIRF, the researcher conducted additional exploratory analyses, including subgroup analyses based on student demographics and learning styles. These analyses revealed that the new teaching method was particularly effective for students with specific learning disabilities, a pattern not evident in the initial analysis. This insight influenced future research and curriculum development, highlighting the value of exploratory analysis in uncovering meaningful trends within inconclusive data (Chalmers & Glasziou, 2009).

Possibility Two: Methodological Improvement Initiative (MII) in Health Research

In a long-term study investigating the impact of a dietary intervention on heart disease risk, researchers faced inconclusive results due to significant variability in participants' adherence to the diet. By incorporating the Methodology Improvement Initiative (MII) component of the Improved Investigation and Research Framework (IIRF), the research team could enhance their study design by implementing more stringent measures of dietary adherence, refining randomization techniques, and better controlling for confounding variables. These methodological enhancements have the potential to substantially decrease data variability and bolster the reliability of findings in future studies, ultimately yielding more substantial evidence of the intervention's effectiveness (Greenland, 2017).

Possibility Three: Meta-Analysis Integration Platform (MAIP) in Environmental Science

Research on the impact of climate change on biodiversity has often produced inconclusive results due to the complexity and variability of ecological systems. The MAIP component of the IIRF has enabled researchers to integrate data from multiple studies through meta-analysis. This method has allowed researchers to synthesize inconclusive findings across various contexts and species, providing a more nuanced understanding of the broader trends and patterns in biodiversity changes. The comprehensive insights gained from this meta-analysis have informed conservation strategies and policy decisions, underscoring the value of aggregating inconclusive results to enhance scientific understanding (Ioannidis, 2005).

Possibility Four: Psychological Support Program (PSP) in Academic Research

A group of early-career researchers conducting exploratory studies in social psychology frequently encountered inconclusive results, leading to frustration and decreased motivation. Implementing the PSP component of the IIRF provided researchers with access to counseling services, resilience training, and career development resources. This support helped them navigate the emotional challenges of inconclusive findings, fostering a more positive and resilient research culture. Thus, it demonstrated the importance of psychological support in maintaining research productivity and morale (Fanelli, 2012).

6.2. Implementation of IIRF

Academic institutions, research organizations, and funding bodies promote an environment where all research findings, including inconclusive ones, are highly regarded by embracing the Integrated Inconclusive Results Framework (IIRF). Implementing the IIRF offers numerous practical benefits for researchers, institutions, and journals, transforming the perception and utilization of inconclusive results. Its adoption can foster more transparent, rigorous, and comprehensive scientific inquiry across diverse research settings.

For Researchers: Enhanced Research Quality and Integrity

Transparent Reporting Protocol: TRP encourages researchers to report all findings comprehensively, reducing the bias toward publishing only positive results. This practice enhances the integrity of scientific reporting and provides a complete picture of research outcomes, facilitating more informed future studies (Baker, 2016).

Exploratory Analysis Toolkit: Provides researchers with advanced tools and methodologies to delve deeper into inconclusive data. By conducting additional analyses, researchers can uncover hidden patterns and generate new hypotheses, thereby increasing the value of their research efforts (Chalmers & Glasziou, 2009).

Methodological Improvement Initiative: This initiative offers resources and guidelines to refine study designs, measurement tools, and statistical methods. This leads to more robust and reliable research, reducing the incidence of inconclusive results due to methodological flaws (Greenland, 2017).

Psychological Support Program: This program helps researchers cope with emotional and professional challenges arising from inconclusive findings. Providing counseling, resilience training, and career development resources fosters a supportive environment that values all research outcomes (Fanelli, 2012).

For Institutions: Promotion of a Culture of Transparency and Rigour

Institutional Adoption of TRP: Encourages academic and research institutions to implement policies that mandate the comprehensive reporting of all research findings, including inconclusive ones. This policy shift promotes transparency and reduces publication bias within the institution (Nosek et al., 2015).

Training and Workshops: Institutions can organize training sessions and workshops to educate researchers on effectively utilizing the EAT and MII components. This continuous professional development ensures researchers have the latest tools and methodologies to handle inconclusive data.

Support Structures for Researchers: Implementing the PSP within institutions can enhance researcher well-being, reduce burnout, and maintain high motivation and productivity levels. This support is particularly beneficial for early-career researchers who may be more affected by inconclusive results (Fanelli, 2012).

Collaborative Platforms: Institutions can facilitate data sharing and collaboration by integrating the MAIP. This platform allows researchers to contribute to and benefit from meta-analyses and systematic reviews, fostering a collaborative research environment that enhances understanding of complex phenomena (Ioannidis, 2005).

For Journals: Commitment to Comprehensive and Unbiased Reporting

Adopting TRP Guidelines: Journals can adopt the TRP guidelines to ensure that all submitted manuscripts, regardless of the conclusiveness of their results, are given fair consideration. This practice reduces publication bias and encourages a more accurate representation of scientific inquiry in published literature (Rosenthal, 1979).

Publishing Inconclusive Results: Journals can create special sections or issues dedicated to inconclusive or negative results, similar to the Journal of Articles in Support of the Null Hypothesis. This initiative provides a platform for essential but often overlooked findings, contributing to a balanced scientific record (Kaiser, 2018).

Encouraging Exploratory Analyses: By encouraging authors to include exploratory analyses in their submissions, journals can help uncover valuable insights from inconclusive data. This practice aligns with the EAT component and enhances the robustness of published research (Chalmers & Glasziou, 2009).

Peer Review Training: Journals can train reviewers to evaluate inconclusive results critically and constructively. This training ensures that reviewers recognize the value of all research outcomes and provide feedback that supports transparent and rigorous scientific reporting.

6.3. Limitations of IIRF

Implementing the Integrated Inconclusive Results Framework (IIRF) is of great value to the scientific community in effectively managing and utilizing inconclusive results. However, its effectiveness in scientific research may be hindered by certain limitations. One significant challenge is the potential resistance from the scientific community and academic journals to adopt new reporting standards for inconclusive results, as current biases favor positive findings (Nosek et al.,

2015). Additionally, various research disciplines may require customization of the IIRF, necessitating additional resources and effort (Ioannidis, 2016). The success of components such as the Exploratory Analysis Toolkit and the Methodological Improvement Initiative depends on access to high-quality data and statistical expertise, which may not be universally available to researchers (Button et al., 2013). Furthermore, the effectiveness of the Psychological Support Program relies on institutional support and researchers' willingness to seek assistance, which varies significantly (Fanelli, 2012). Lastly, the Meta-Analysis Integration Platform faces challenges related to data privacy, intellectual property rights, and collaborative efforts, which are essential for its success (Dickersin, 1990). Overcoming these limitations will require ongoing effort, collaboration, and adaptation to advance scientific knowledge effectively.

7. Conclusion

The Implications and Implementation of IIRF carry significant benefits for researchers, institutions, and journals, with far-reaching implications. By promoting transparency, enhancing methodological rigor, and providing emotional and professional support to researchers, the IIRF fosters a more robust and reliable scientific process across various research environments. It can enrich our understanding of complex phenomena, advancing scientific knowledge. In medical research, it can improve the reliability of studies and contribute to better clinical practices and policy decisions. In the social sciences, particularly in educational research, the IIRF has the potential to guide the analysis and reporting of studies on new teaching methods or interventions. For environmental research, transparent reporting and methodological improvements can enhance the quality of studies. In psychology, the IIRF supports reporting and analyzing inconclusive results in behavioral studies, promoting a comprehensive understanding of human behavior. The PSP, for example, provides a framework to assist researchers in navigating the challenges of inconclusive findings, helping them maintain their motivation to explore complex psychological phenomena.

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