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The Positivism Paradigm of Research

Yoon Soo Park, PhD, Lars Konge, MD, PhD, and Anthony R. Artino Jr, PhD

Abstract

Research paradigms guide scientific discoveries through their assumptions and principles. Understanding paradigm-specific assumptions helps illuminate the quality of findings that support scientific studies and identify gaps in generating sound evidence. This article focuses on the research paradigm of *positivism*, examining its definition, history, and assumptions (ontology, epistemology, axiology, methodology,

and rigor). Positivism is aligned with the hypothetico-deductive model of science that builds on verifying a priori hypotheses and experimentation by operationalizing variables and measures; results from hypothesis testing are used to inform and advance science. Studies aligned with positivism generally focus on identifying explanatory associations or causal relationships through quantitative approaches, where empirically based

findings from large sample sizes are favored—in this regard, generalizable inferences, replication of findings, and controlled experimentation have been principles guiding positivist science. Criteria for evaluating the quality of positivist research are discussed. An example from health professions education is provided to guide positivist thinking in study design and implementation.

Editor's Note: This article is part of a collection of Invited Commentaries exploring the Philosophy of Science.

Scientific research, the systematic quest for knowledge, can be considered through different *research paradigms* that make assumptions about how the world operates.¹ These research paradigms are the philosophies of science,² which guide the way science is conducted by shaping the following core elements: ontology (how reality is viewed), epistemology (how the nature of knowledge is conceived), axiology (the role and values of the research process), methodology (how the paradigm defines processes associated with conducting science), and rigor (the criteria used to justify the quality of research in the paradigm).^{3,4}

In this article, we focus on the research paradigm of *positivism*—its definition,

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historic formation, components, and assumptions. Understanding paradigm-specific assumptions is important, as they provide deeper understanding of how science is operationalized and of components that promote legitimate problems, solutions, and criteria for evidence.^{1,5,6} We present examples of positivist research and applications that facilitate understanding of this research paradigm, including its use in health professions education and in scientific research more broadly. We conclude with a case study of how a clinician–educator working with the positivist paradigm might approach a specific case.

The Hypothetico-Deductive Model of Science

Positivism is aligned with the *hypothetico-deductive model* of science. As such, identifying the structure and basis of positivism through the hypothetico-deductive lens is a useful place to start.⁷ The hypothetico-deductive method is a circular process that begins with theory from the literature to (1) build testable *hypotheses*, (2) design an experiment through *operationalizing* variables (i.e., identifying variables to manipulate and measure through group assignments), and (3) conduct an empirical study based on *experimentation*. Ultimately, the findings from such a study are used to help inform *theory* and contribute to the literature, thereby completing the circular process (theory → hypothesis → operationalizing variables → experimentation → theory). Findings from the empirical study can

help strengthen or refine theory; for example, a hypothesis that confirms the effectiveness of an instructional approach to a new group of learners can help inform and refine theory.^{8–10}

Positivism: Definition and History

Definition and components of positivism

Positivism relies on the hypothetico-deductive method to verify a priori hypotheses that are often stated quantitatively, where functional relationships can be derived between causal and explanatory factors (independent variables) and outcomes (dependent variables).⁸ Positivist research, however, does not always rely on quantitative methods. For example, an experimental study examining the effects of an intervention through qualitative analysis fits within the positivist paradigm.¹¹

Box 1 lists definitions of key terms associated with positivism. Box 2 provides a list of useful materials for further reading.

A primary goal of positivist inquiry is to generate explanatory associations or causal relationships that ultimately lead to prediction and control of the phenomena in question.^{12,13} In the purest view, positivism is rooted in the following principles as categorized by Mill in the classic text, *A System of Logic*:¹⁴

Box 1

Key Terms and Definitions Related to Understanding the Research Paradigm of Positivism

Dependent variable: Measures of interest (outcomes) in the study; unlike independent variables, dependent variables can only be measured, not manipulated.

Dualism: Separation of researcher and participants in study design and data collection to minimize bias.

Effect size: Quantified metric reflecting the impact of an intervention, expressed in standardized units to allow comparison across studies.

Functional relationship: Association between a study's independent and dependent variables, often expressed quantitatively, through direct or indirect effects (e.g., increase in independent variables also increases the dependent variable). Functional relationships can also be causal, where the impact of independent variables causes the results of the outcome to change.

Hypothesis: A statement or idea derived from theory or literature that can be tested through experimentation.

Hypothetico-deductive model: Scientific model based on forming a testable hypothesis and developing an empirical study to confirm or reject the hypothesis.

Independent variable: Factors that influence outcomes of the study; independent variables can be manipulated (e.g., assigning study participants to treatment or control groups) or measured.

Internal validity: Evidence and inference supporting the "causal" relationship between the independent and dependent variables.

Laws of nature: Synthesis of scientific discoveries and theories that form the foundation of how nature operates; examples include our scientific understanding of how time and space operate, through scientific findings in physics.

Objectivity: Absence of bias due to researcher influences, flaws in experimental design, or outliers in data.

1. **Goals of science:** Social and natural sciences should focus on discovery of laws that facilitate explanation and prediction.
2. **Methodology:** Social and natural sciences should use the same methodology based on the hypothetico-deductive model of science (theory, hypothesis, operationalization, experimentation).
3. **Laws of nature:** Basic laws of nature, formed through replication and syntheses of scientific discoveries and theories, assert the existence of a single true and identifiable reality.
4. **Evidence for law:** Laws of nature are derived from empirical data.
5. **Sampling and inference:** Larger samples are favorable over smaller, idiosyncratic samples; larger samples reveal generalizable tendencies, causes, and the nature of reality.

Based on these principles, positivism seeks to discover laws of nature, expressing them through descriptions of theory. These theories focus on

explanation and prediction based on the hypothetico-deductive model.

Within this focus is the notion that large sample sizes are valued over smaller samples (i.e., objective data collected across a large sample are superior to data gathered through smaller samples). Larger samples improve consistency in data and representation of the population characteristics, facilitating better generalizations regarding the causes of phenomena in nature. What is more, to make stronger claims regarding generalizations, replication of findings is also valued through systemic and controlled experiments.¹⁵ In this way, positivist research focuses on verifying theories.¹⁶

History of positivism

The history of positivism dates back to the Enlightenment period of the 17th and 18th centuries, inspired by philosophers Descartes and Locke. The scientific community at the time promoted a movement away from medieval notions of totalitarianism based on royal decrees. During the Enlightenment, philosophers and scholars valued

individual thinking and the worldview of objective knowledge. Reflecting this history, the development of positivism is characterized by a move away from social elites (e.g., royalty) defined by truth via decree, and toward scholars discovering objective, evidence-based truth through well-described experimentation.

Examples of scientists who contributed to positivist views include Copernicus and Galileo, both of whom challenged and redefined laws of nature through experimentation and the collection of data to make explanations and causal inferences. To date, positivist thinking still dominates modern research in clinical and basic sciences, as evidenced by international standards for science in leading journals and professional organizations.⁷ As such, positivist thinking influences the advances in science and the approach that clinicians take to scholarly understanding.⁸

Philosophical Foundations of the Positivist Paradigm

Ontology: Nature of reality

The positivist paradigm is based in the assumption that a single tangible reality exists—one that can be understood, identified, and measured. This allows explanation and prediction in a causal framework to operate naturally, as causal inferences rely on (1) temporal precedence (i.e., for X to cause Y, X must precede Y in time), (2) association (i.e., X and Y are correlated), and (3) lack of confounders (i.e., no other factors besides the identified factors affect the outcome; X is the only cause of Y within the space identified).^{7,17}

Epistemology: Nature of knowledge

Positivists contend that knowledge can and must be developed objectively, without the values of the researchers or participants influencing its development. Knowledge, when appropriately developed, is truth—that is, it is certain, congruent with reality, and accurate. To appropriately develop truth, absolute separation must exist between the research participant and the researcher. To achieve this separation, positivists operate in *dualism* and *objectivity*.^{16,18} In other words, positivist thinking asserts that participants and researchers can actually be separated (dualism). Moreover, by following strict protocols,

Box 2

Additional Resources on Understanding the Research Paradigm of Positivism

- Creswell JW. *Research Design: Qualitative & Quantitative Approaches*. Thousand Oaks, CA: Sage; 1994.
 - Bunniss S, Kelly DR. Research paradigms in medical education. *Med Educ*. 2010;44:358–366.
 - Hoyle RH, Harris MK, Judd CM. *Research Methods in Social Relations*. New York, NY: Wadsworth; 2009.
 - Ponterotto JG. Qualitative research in counseling psychology: A primer on research paradigms and philosophy of science. *J Coun Psych*. 2005;52:126–136.
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the 2 entities are separated to reduce bias in the study (objectivity).

Axiology: Values of the research process

Positivism relies heavily on objectivity and so dismisses the importance of individuals' subjective experiences and values—be they the experiences and values of research participants or of researchers. These subjective experiences and values are seen as unimportant in positivist thinking. This requires the researcher to stay objective and not interact with participants during data collection. Further, it requires the researcher to not be involved in the experiment in any meaningful way. In some domains, such objectivity can be implemented in rather straightforward ways. For example, one can imagine an experimental physicist conducting research in a vacuum, where no external factors beyond the systems being studied are part of the experiment. This objectivity is more difficult to realize in other domains. For instance, positivism can be applied to social science research—albeit with a bit more difficulty—since it requires the use of rigid and strict study protocols that result in as little researcher bias as possible.

Methodology: How to conduct scientific research

Positivist methodology emphasizes engaging in research in settings where variables can be controlled and manipulated.¹⁹ In the social sciences, this requires that the researcher creates somewhat artificial environments where other extraneous factors, beyond the study variables, are minimized. In the purest form of positivism, the sole focus of the

study is to examine the explanatory or causal relationships between variables in the study, as is done in the natural sciences. As such, experimental designs are favored in the positivist paradigm, including quasi-experimental designs.¹⁷ Results from experiments are used to confirm or refine theories, which, in turn, can lead to new hypotheses and questions for new studies.

Rigor: Criteria for evaluating quality of research

A key goal in positivist experimentation is to isolate and control the influence of all factors so that only the key variables of interest are studied (e.g., only X could have caused Y). In this regard, positivist researchers are most interested in the study's *internal validity*—how well the study design and evidence gathered support claims for causal inference. Internal validity that focuses on causality should not be confused with *assessment validity* that deals with how well a particular construct (e.g., educational assessment, psychological measure) is measured.

Rigor in the positivist paradigm—particularly quantitatively oriented social science research—is evaluated based on the degree to which the researcher has been able to minimize threats to internal validity.²⁰ Such threats include, for example: (1) maturation: naturally occurring changes in participants over time, (2) history: events that take place during research that influence results, (3) instrumentation: measurement issues that reflect how well the construct

is measured (i.e., assessment validity), (4) statistical regression: tendency for scores to regress toward the mean in follow-up measurements, (5) testing effect: effect of testing on subsequent measurements, (6) selection: preexisting differences in participants, (7) mortality: participant attrition, and (8) interaction of selection and maturation: differences between groups that cause changes in the groups at different rates. Studies conducted in the positivist paradigm pay careful attention to these threats to internal validity and work to generate study designs that allow the associated confounders to be controlled.²¹

It is a deeply rooted assumption that quantitative foundations using statistical inference to estimate the effects of a given experiment are key to the rigor of the positivist research paradigm. This quantitative focus requires sufficient sample size and power to detect meaningful effect sizes based on appropriate statistical tests. While other research paradigms may not place heavy emphasis on large sample sizes, the use of and reliance on statistical principles requires that the positivist researcher carefully consider study designs that determine a priori hypothesized effect sizes. That is, before the study, the researcher must determine the anticipated size of the difference between the control and treatment groups that will be considered meaningful.²¹ Larger sample sizes reduce uncertainty in statistical results and yield

Box 3

Sample Case^a

Lee was a resident assigned to monitor a post-op patient. The patient had a periodically low respiratory rate and lower-than-normal pulse and blood pressure. Narcan was ordered on an "as needed" basis, to be given in doses of 0.2 mg intravenously. In checking the patient's vitals, Lee decided it was time to administer an intravenous (IV) dose of Narcan.

Once Lee injected the vial of Narcan into the IV port, Lee noticed it was labeled "2 milligrams per 1 milliliter (ml)"—the entire vial should not have been injected. Feeling panicky, Lee reported the mistake to an attending and rushed back to the patient's side to monitor the vital signs. Lee was surprised to find that the patient's vitals had come up to normal rates, and the patient was actually much more alert. When Lee reported this change to the attending surgeon and anesthesiologist, they told Lee to continue to monitor the patient closely, remarking that it may have been just what the patient needed.

Lee felt hugely relieved, but was still overwhelmed and very upset. In most cases, giving 10 times a normal dose of any medication could have led to extremely serious consequences, and even death. Still, Lee managed to remain outwardly composed, and took the time to complete an incident report. At the end of the day, when Lee finally sat down to rest, the incident played over and over again. Lee did not sleep.

^aThis sample case is used throughout the Philosophy of Science Invited Commentaries to illustrate each research paradigm.

stronger confidence in findings; this is a fundamental law of inferential statistics.

Case Study: Lee's Experiment

In Box 3, we present a scenario in which a resident ("Lee") injects 10 times the normal medication dose. In this final section, we use this sample case to prompt an application of a positivist paradigm to design an experiment that uses theory, articulates and tests a hypothesis, operationalizes variables, and informs theory.

After the experience of administering an incorrect medication dosage under pressure, Lee decides to examine this issue further. Lee chooses to design a study investigating how to improve training to correct medication dosage using different curricular interventions (mastery-based simulation versus traditional curriculum). Below are steps Lee would follow to engage in a positivist educational research study.

Theory-based hypothesis

Lee approaches the program director with a proposal to design a mastery-based simulation curriculum that trains residents under pressure to apply correct doses of Narcan (Naloxone), specific to patient age and race/ethnicity. Lee hypothesizes that using a mastery-based simulation curriculum approach can improve trainees' ability to identify and administer correct medication doses under pressure, relative to traditional instruction she received through direct patient contact (non-simulation-based training).

Operationalizing variables

Under the supervision of the program director, Lee recruits 2 groups of learners—an experimental (intervention) group who receive the mastery-based simulation training for applying correct medication doses under pressure, and a control group of learners who are trained under the traditional curriculum.²¹ All other learning conditions are comparable. Lee designs a simulation-based assessment to compare the 2 groups of learners following their training. Measures that define outcomes (e.g., correct medication dose, duration of medication application) are identified. The literature informs the effect sizes that Lee uses to signal

significant improvement in outcomes, which allows calculating the required sample size and power for recruiting learners.

Experimentation

Following appropriate ethical approval, Lee measures outcomes before experimentation in both groups. After the intervention, Lee measures outcomes again, then compares pre- and postintervention outcomes between the 2 groups from the simulation assessment.

Results to inform theory

Lee makes a statistical comparison between the outcomes of the 2 groups and the findings reported to confirm (verify) the hypothesis. If Lee identifies that mastery-based simulation training is more effective than a traditional curriculum in improving application of correct medication doses, then this result contributes to mastery-based learning theory. Specific nuances of the study findings (e.g., type of mastery-learning condition or instruction) can help refine the mastery-based learning theory.

Conclusions

This article provides the definition, assumptions, and application examples of research that can be conducted in a positivist paradigm, summarized as follows:

- Scientific research in a positivist paradigm focuses on explanation and prediction.
- The hypothetico-deductive model of science is used to facilitate the research process, taking a theory-verification approach.
- Research operates in a dualistic and objective world, where the researcher does not interact with study participants to minimize bias.
- Theories of nature depend on empirical data, with larger samples used to make generalizations.

While different research paradigms provide their unique value in advancing science, positivism has been a dominant form of research in basic and clinical science for over 150 years.^{6,8,22} As such, understanding positivism and its language is important for researchers

hoping to conduct research in interdisciplinary fields such as medical education.

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