# Popper and Feyerabend on Ad-Hoc Modifications and Confirmation

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# Project Information

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- Feldbacher-Escamilla, Christian J. (2011a). "Neue Technik und ad-hoc-Hypothesen vom wissenschaftstheoretischen Standpunkt". In: *Tagungsband der Nachwuchstagungen für Junge Philosophie in Darmstadt*. Ed. by Alpsancar, Suzana and Denker, Kai. Marburg: Tectum, pp. 197–219.

## Talk(s):

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- Feldbacher-Escamilla, Christian J. (2011b-09-11/2011-09-15). *Popper on a Problem of Theories of Confirmation Regarding Ad-hoc Modifications*. Conference. Presentation (contributed). XXII. Deutscher Kongress für Philosophie. LMU Munich: German Society for Philosophy (DGPhil).
- Feldbacher-Escamilla, Christian J. (2011c-06-02/2011-06-04). *Zur wissenschaftstheoretischen Bewertung von ad-hoc-Hypothesen: Ad-hoc-Modifikationen im Rahmen des Falsifikationismus*. Conference. Presentation (contributed). 9th Conference of the Austrian Society for Philosophy (ÖGP): Crossing Borders. University of Vienna: ÖGP.

# Project Information

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# Introduction

Example:

1. Frustration induces aggression (cf. Dollard et al. 1970).
2. $c_1, \ldots, c_n$ are frustrated but not aggressive.
3. Frustration induces aggression in all non-$c_1$, ..., non-$c_n$-cases.

The problem under discussion: 3 is an ad-hoc modification of 1 because of 2.

# Contents

# Ad-hoc Modifications: Characterization

# Against Method

Feyerabend's main argument (cf. Feyerabend 1993, chpt.1):

1. If there is success in science, then some scientists act against the scientific rules proposed in philosophy of science, especially by Carnap, Popper et al.
2. All scientists should try to promote scientific success!
3. Hence: Some scientists should act against the scientific rules proposed in philosophy of science!

# Against Method

Feyerabend tries mainly to argue in favour of thesis 1.

His strategy:

- Try to make case studies which are accepted by most scientists as cases of scientific success (for the sake of the argument assume that there is scientific success)!
- Show that in such a case at least one important scientist acted against the scientific rules of philosophy of science, especially those of Carnap, Popper et al.!
- Try to show this by showing that the scientist acted in accordance with a so-called *counterrule*!

Example of such a counterrule:

'Use always hypotheses which are hardly testable!'

# Against Method

Feyerabend discusses the following counterrules:

- *Counterrule to induction*
- *Counterrule to consistency*
- *Counterrule to accuracy*
- *Counterrule to ad-hoc modifications*

Feyerabend speaks of:

- Ad-hoc hypotheses: "New explanations are formulated by such hypotheses. Independent data is missing." (cf. Feyerabend 1993, p.77)
- Theories which are ad-hoc: Theories which are not ad-hoc "exceed the known data widely." (cf. Feyerabend 1983, p.120)
- Ad-hoc approximations and ad-hoc adaptions (cf. Feyerabend 1993, p.155)

We'll concentrate on ad-hoc theories only!

# Scientific Research Programmes

- One goal of PoS is the reconstruction of scientific theories.
- For this purpose the expression ‘scientific research programme’, introduced by Imre Lakatos (Lakatos 1980), seems to be very fruitful.
- Without taking care of the important methodological part (i.e. a set of normative statements) it holds that:

**Definition**

$T$ is a scientific research programme iff there are $C$, $H_1, \ldots, H_n$ and $T_1, \ldots, T_n$ such that:

- $T_1, \ldots, T_n$ are theories, and:
- $T_1 = Cn(C \cup H_1)$ and $\ldots$ and $T_n = Cn(C \cup H_n)$, and:
- $T = \langle T_1, \ldots, T_n \rangle$.

Feyerabend accepts Lakatos’ proposal to discuss scientific theories in the framework of scientific research programmes (cf. Feyerabend 1993, chpt.16).

# Scientific Research Programmes

Example: *Newtonian Mechanics* used for an explanation of some phenomenon of motion and its causes:

- Core $C$: the three Newtonian axioms about forces
- Periphery $H_1, \ldots, H_n$: special laws of forces and hypotheses about initial conditions. For instance the law of gravitation $\in H_1$, Hook's law $\in H_2$ and $H_1 \subset H_2$ etc. (for an overview cf. Schurz 2008, sect.5.2).

How to apply a methodology—e.g. the falsificationistic methodology of Popper—within the framework of a scientific research programme $T$? Lakatos:

1. Try to test the initial conditions of the periphery of $T$
2. Try to test the CP-clauses of the periphery of $T$
3. Reject the core of $T$

# Scientific Research Programmes

Falsificationism exemplified within the framework of *Newtonian Mechanics*:
Goal: Calculation of mercury's orbit

- Given: $C$, $H_1, \ldots, H_n$
- Additional hypotheses $H_{n+1}$:
  - Spatio-temporal coordinates and mass of mercury at $t_0$ etc.
  - CP-clause: There are exactly $i$ forces in the solar system.

Problem: calculation $\neq$ measurement (mercury perihelion)

- ☑ Initial conditions
- ☐ CP-clause
- ☑ $C$

Therefore $H'_{n+1}$: there are exactly $i+1$ forces in the solar system.
Problem: calculation $\neq$ measurement
Checklist like above
Therefore $H''_{n+1}$: there are exactly $i+2$ forces in the solar system. ⟳

# Scientific Research Programmes

Assuming the thesis, as Lakatos argues for, that $C$ is not refutable in the described way, the following so-called second conventionalist problem holds (cf. Duhem 1991, chpt.10, §4) and (Andersson 1988, sect.7.1):

**Proposition**

*For most of the developed scientific research programmes $T$, all time frames $t$ and all theories $T_1$ of $T$, it holds: If $T_1$ of $T$ counts at $t$ as falsified, then there is a $T_2$ of $T$ such that $T_2$ is a modification of $T_1$ and $T$ counts at $t$ not as falsified.*

As far as $T_1$ and $T_2$ of $T$ have the same core $C$ of $T$, this means that one can most of the time "rescue" $C$ by modification.

To apply, e.g., falsificationist methodology adequately, one has to exclude some kinds of modifications.

# Ad-hoc modifications

Which kinds of modifications of the periphery of a scientific research programme should be excluded as unscientific or illegitimate?

The view that *in general* ad-hoc modifications of the periphery of a scientific research programme should be excluded is *widely* accepted.

But what is characteristic for ad-hoc modifications?

Popper proposes that we should call all those modifications 'ad-hoc' that decrease the empirical content of a theory (cf. Popper 2002b, sect.20).

Feyerabend follows in his main argumentation this proposal (cf. Feyerabend 1993, chpt.8 and chpt.9).

# Ad-hoc modifications

Let us begin with an auxiliary definition:

**Definition (Comparability)**

Let $T_1$ and $T_2$ be two sets of sentences of a scientific research programme $T$. Then it holds: $T_1$ and $T_2$ of $T$ are comparable with respect to their content iff

- $content(T_2, T) \subseteq content(T_1, T)$, or:
- $content(T_1, T) \subset content(T_2, T)$.

# Ad-hoc modifications

Now let us come to Popper's proposal:

**Definition (Ad-hoc modification)**

Let $T_1$ and $T_2$ be two theories of the scientific research programme $T$. Then it holds:

- If $T_1$ and $T_2$ of $T$ are comparable with respect to their content, then $T_2$ is an ad-hoc modification of $T_1$ in $T$ iff $content(T_2, T) \subseteq content(T_1, T)$.

Popper's characterization has the following features:

1. *content* $\Uparrow$ leads to an increasing amount of explanations.
2. If *content* $\Uparrow$ and *content* is the empirical content of a theory, then the theory gets increasingly falsifiable.

# Ad-hoc Modifications: A problem and a solution

# Ad-hoc modifications: a problem

But Popper's characterization is subject to the following problem:

**Proposition (Objection, (Grünbaum 1976))**

*For all consistent theories $T_1$ and $T_2$ of a scientific research programme $T$, all sentences $E$ and all time frames $t$ it holds: If*

1. *$T_1$ counts at $t$ as falsified with the help of $E$ (i.e. $\neg E \in T_1$), and:*
2. *$T_2$ explains $E$ (i.e. $E \in T_2$), and:*
3. *content is the empirical, testability or logical content of a theory;*

*then $T_2$ is no ad-hoc modification of $T_1$ in $T$.*

The first two conditions are satisfied in usual cases of modification:

1. $T_1$ is modified, because it counts as falsified at $t$ with the help of $E$.
2. $T_2$ does the job that was not done by $T_1$, namely to explain $E$.

# Ad-hoc modifications: a solution

Although usual contents of theories are not adequate for Popper's proposal, one can find within his works a quite suitable content definition: the so-called empirical problem content of a theory (cf. a similar characterization in Popper 1993, chpt.9).

**Definition**

$empProb(T_1, T) = empCont(T_1, T) \cup \{A$ : There is a $B$ such that $B \in empCont(T_1, T)$ and $A = \neg B\}$.

As one can easily demonstrate, the result of Adolf Grünbaum does not hold for the empirical problem content of a theory.

# Ad-hoc modifications: a solution

Even better; there is another feature of this characterization:

3. Single-case modifications are eliminated.

Let us return to our initial example of the frustration aggression theory:

$C$: Any core of a psychological research programme $T$

$H_1$: $Frustr(x) \Rightarrow Aggres(x)$

$E$: $Frustr(c_1)$ & $\neg Aggres(c_1), \ldots, Frustr(c_n)$ & $\neg Aggres(c_n)$

Dr. Cheap:

$H_2$: $Frustr(x) \& \ x \neq c_1 \& \ldots \& x \neq c_n \Rightarrow Aggres(x)$

Dr. Hardwork:

$H_2'$: $Frustr(x) \ \& \neg Depres(x) \Rightarrow Aggres(x)$

$empProb(Cn(C \cup H_2), T) \subset empProb(Cn(C \cup H_1, T))$ and hence $T_2 = Cn(H_2 \cup C)$ is an ad-hoc modification of $T_1 = Cn(H_1 \cup C)$. Nothing similar holds for $T_2' = Cn(H_2' \cup C)$ with respect to $T_1$.

# A side note: Popper vs. confirmation

Popper claims that theories of confirmation are in favour of ad-hoc modifications:

> *"Those who identify confirmation with probability must believe that a high degree of probability is desirable. They implicitly accept the rule: 'Always choose the most probable hypothesis!' Now it can be easily shown that this rule is equivalent to the following rule: 'Always choose the hypothesis which goes as little beyond the evidence as possible!' And this, in turn, can be shown to be equivalent, not only to 'Always accept the hypothesis with the lowest content (within the limits of your task, for example, your task of predicting)!', but also to 'Always choose the hypothesis which has the highest degree of ad hoc character (within the limits of your task)!'*
> *(cf. Popper 2002a, p.287)*

# A side note: Popper vs. confirmation

And in fact, the following theorem holds in usual theories of confirmation:

**Proposition**

- *Let $p$ be a probability function and let $T_1$ and $T_2$ be two theories of a scientific research programme $T$ such that $T_1 \subseteq T_2$, and:*
- *Let $E$ be a set of observational sentences satisfying the condition $E \subseteq T_1$ (which is accepted as true by the scientific community at a specific point in time).*

*Then it holds that $confirm(T_2, E, p) \leq confirm(T_1, E, p)$.*

According to this theorem the slogan regarding theory construction would be: stick with your empirical theories to the empirical data!

# A side note: Popper vs. confirmation

According to Popper, bold conjectures are in general better than conjectures that stick to the data.

This is due to the fact that bold conjectures are better testable than the other ones.

For this reason we should *in general* favour $T_2$ against $T_1$.

There is a solution to this problem of confirmation theories: use also bold conjectures about your data basis for theory evaluation!

# A side note: Popper vs. confirmation: A Bayesian Solution

A solution within usual Bayesian accounts to this problem regarding ad-hoc modifications (cf. Howson and Urbach 1989, chpt.4:j.3) is this: First, define ad-hoc modification as follows; "$t$ will be judged adversely and pejoratively labelled ad hoc, if $p(t, e) \leq 0.5$, where $e$ is the new evidence that refuted the predecessor of $t$." Second, as far as in such cases it must not be the case that $confirm(t, e, p) > 0$, it does not follow from theories of confirmation (e.g. both of Carnap $1950^a$ and $1950^b$) to use ad-hoc modifications.

# A side note: Popper vs. confirmation: A Popperian Solut.

The following theorem relitavizes Popper's claim:

## Proposition

- *Let $p$ be a probability function and let $T_1$ and $T_2$ be two theories of a scientific research programme $T$ such that $T_1 \subseteq T_2$, and:*
- *Let $E$ be a set of observational sentences satisfying the condition $E \subseteq T_1$ (which is accepted as true by the scientific community at a specific point in time), and:*
- *Let $E^*$ be a set of observational sentences such that $T_2 = Cn(T_1 \cup E^*)$.*

*Then it holds that: $confirm(T_1, E \cup E^*, p) \leq confirm(T_2, E \cup E^*, p)$*

Interpreting $E^*$ as bold conjectures with respect to $T_1$ one can take this proposition as a Popperian solution to the problem of ad-hoc modification. The slogan would be: Apply also in the process of theory evaluation the method of bold conjectures.

# A side note: Popper vs. confirmation: Proofs I

- Proof of Popper's objection (for Carnap 1950[b], assuming $E$, $T_1$ and $T_2$ being finitely axiomatizable by $e$, $t_1$ and $t_2$ respectively):
  1. $E \subseteq T_1 \subseteq T_2$ (assumption)
  2. $confirm(t_2, e, p) > confirm(t_1, e, p)$ (assumption, ip)
  3. $\frac{p(t_2 \& e)}{p(e)} - p(t_2) > \frac{p(t_1 \& e)}{p(e)} - p(t_1)$ (2, Def. Carnap 1950[b])
  4. $p(t_2 \& e) - p(t_2) \cdot p(e) > p(t_1 \& e) - p(t_1) \cdot p(e)$ (3)
  5. $p(t_2) - p(t_2) \cdot p(e) > p(t_1) - p(t_1) \cdot p(e)$ (1, 4)
  6. $p(t_1) \geq p(t_2)$ (1)
  7. $r \geq 0$ and $p(t_1) = p(t_2) + r$ (6, var-cond✓)
  8. $p(t_2) - p(t_2) \cdot p(e) > p(t_2) + r - p(t_2) \cdot p(e) - r \cdot p(e)$ (5, 7)
  9. $0 > r - p(e) \cdot r$ (8)
  10. Reductio (that is: $\exists x \exists y (x > 0 \;\&\; 0 \leq y \leq 1 \;\&\; 0 > x - y \cdot x)$) (7,9)

# A side note: Popper vs. confirmation: Proofs II

- Proof of the Popperian solution (for Carnap 1950[b], assuming $E$, $E^*$, $T_1$ and $T_2$ being finitely axiomatizable by $e$, $e^*$, $t_1$ and $t_2$ respectively):

1. $E \subseteq T_1 = T_2 \setminus E^*$ (assumption)
2. $confirm(t_1, e\&e^*, p) > confirm(t_2, e\&e^*, p)$ (assumption, ip)
3. $\frac{p(t_1\&e\&e^*)}{p(e\&e^*)} - p(t_1) > \frac{p(t_2\&e\&e^*)}{p(e\&e^*)} - p(t_2)$ (2, Def. Carnap 1950[b])
4. $p(t_2) - p(t_1) \cdot p(e\&e^*) > p(t_2) - p(t_2) \cdot p(e\&e^*)$ (1, 3)
5. $p(t_1) < p(t_2)$ (4)
6. $p(t_1) \geq p(t_2)$ (1)
7. Reductio (5, 6)

# Feyerabend's rule = Standard rule

# Back to Feyerabend!

Which case is according to Feyerabend a relevant case of a *counterrule* on ad-hoc modifications?

Feyerabend: Galileo Galilei; this case is usually, especially by Popper, regarded as a case of scientific success. But, so Feyerabend, Galilei used ad-hoc modifications.

Let us demonstrate Feyerabend's reconstruction with the help of an example:

- Copernicus: The earth rotates and circles the sun.
- The tower argument was seen as evidence against Copernicus.
- Galileo's principles of relativity and idleness are in favour of Copernicus' claim.
- Galileo's later observation by the help of his telescope provide independent evidence for Copernicus' claim.

Let us reconstruct this line of argumentation within our terminology!

# Case study: Galilei

Galilei investigated in *De motu* (a manuscript of 1590) motions of bodies with the following properties:

| Homogene | World centre | Centre of Gravity | *Against Method* |
|---|---|---|---|
| 0 | 0 | 0 | |
| 0 | 0 | 1 | |
| 0 | 1 | 0 | |
| 0 | 1 | 1 | |
| 1 | 0 | 0 | |
| 1 | 0 | 1 | p. 122 |
| 1 | 1 | 0 | |
| 1 | 1 | 1 | p. 121 |

Galilei presupposed the following two principles:

1. principle: bodies in mixed motion (non-natural and non-forced externally) are finite in motion.
2. principle: bodies in mixed motion have some inner force (impetus).

# Case study: Galilei

But this principles were incompatible with the view that the earth is not static:

First argument against the rotation of the earth:

1. 1. principle (cf. Feyerabend 1983, p. 121 and p. 123)
2. The earth is in mixed motion. (Assumption)
3. The earth's motion is finite. (out of 1 and 2)
4. If the earth rotates, then its motion is infinite. (cf. daily raising of the stars: (cf. Feyerabend 1983, p. 123))
5. Hence: The earth does not rotate. (out of 4 and 3)

# Case study: Galilei

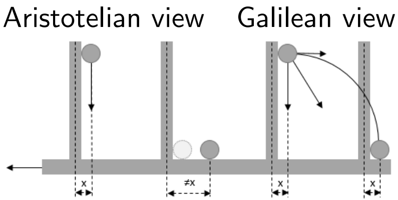
Second argument against the rotation of the earth:

1. 2. principle (cf. Feyerabend 1983, p. 121f)
2. For all bodies it holds that: if there is an impetus in the body, then the body's motion is a motion where no observer takes part.
   (property of the impetus: (cf. Feyerabend 1983, p. 123))
3. We observe only relative motion.
   (Galileo's *principle of relativity*: (cf. Feyerabend 1983, p. 115))
4. Every stone, falling down from a tower is in mixed motion.
   (mixing of linear and circular motion: (cf. Galilei 1982, p. 148))
5. Hence: We observe the motion of such a stone. (out of 4, 1, 2 and 3)
6. Hence: The earth does not rotate.
   (out of 5 and the premises of the tower argument)

# Case study: Galilei

The tower argument (cf. Feyerabend 1993, p. 58f):

1. If the earth rotates or circles the sun, then the trajectory of a stone falling from a tower is arched.
2. The trajectory of a stone falling from a tower is linear (not arched).
3. Hence: The earth does not rotate or circle the sun.



# Case study: Galilei

For this reason both principles were given up by Galilei: In the *Discorsi* (1635 lat., 1636 ital.) Galilei formulates the hypothesis of an infinite horizontal (mixed) motion (vs. 1. principle), and already in the *Dialogue* (1632) he seems to give up both principles (cf. Feyerabend 1983, p. 123):

1* principle: 'There are bodies in infinite mixed motion.' (vs. 1. principle), and:

2* principle: 'There are bodies in mixed motion without impetus.' (vs. 2. principle)

# Case study: Galilei

Our definitions allow us the reconstruct these modifications as ad-hoc ones:

1. The $1^*$. principle is the negation of the 1. principle, and:
2. The $2^*$. principle is the negation of the 2. principle.
3. So the problem content of the modification does not exceed the problem content of the original assumptions.
4. So the modification is ad-hoc.

# Back to Feyerabend again!

By this Feyerabend has provided an example where a scientist was successful by using ad-hoc modifications.

So, acting in accordance with the counterrule:

'Use always ad-hoc modifications!'

is sometimes successful.

# Back to Feyerabend again!

Feyerabend's view on ad-hoc modifications coincides with that of PoS:

- Some philosophers of science regard ad-hoc modifications as outside their scope, since they are relevant for theory construction, but not for the justification of theories (cf. Andersson 1991).
- Most philosophers of science think that ad-hoc modifications should not become regular, but they accept such modifications for the purpose of giving up a progressive scientific research programme too early (cf. (Lakatos 1980), (Schurz 2008), (Bunge 1967) et al.). Even Popper speaks of "degrees of ad-hocness" and makes no qualitative claim that abandons strictly ad-hoc modifications.
- The solution to the problem of theories of confirmation (namely that according to them one should follow Feyerabend's counterrule) suggests to use ad-hoc modifications in similar cases as Feyerabend discussed, namely to develop the techniques for grasping data and by this confirm or disconfirm the bold conjectures about the data.

# Conclusion

To conclude: There seems to be no counterrule to Feyerabend's counterrule:

'Use never ad-hoc modifications!'

held widely in philosophy of science.

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