<table>
<thead>
<tr>
<th>Title</th>
<th>Classification of Experimental Methods in Sport Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Author(s)</td>
<td>Polster, Harald</td>
</tr>
<tr>
<td>Citation</td>
<td>Hitotsubashi journal of arts and sciences, 36(1): 49-57</td>
</tr>
<tr>
<td>Issue Date</td>
<td>1995-12</td>
</tr>
<tr>
<td>Type</td>
<td>Departmental Bulletin Paper</td>
</tr>
<tr>
<td>Text Version</td>
<td>publisher</td>
</tr>
<tr>
<td>URL</td>
<td><a href="http://doi.org/10.15057/11685">http://doi.org/10.15057/11685</a></td>
</tr>
</tbody>
</table>
CLASSIFICATION OF EXPERIMENTAL METHODS IN SPORT SCIENCE*

HARALD POLSTER

I. Fundamental Methodology

Experimental methods are to be found in the hierarchy of empirical research methodologies in an exposed position. This is due in part to the high standardisation claim, which is connected in particular with the experimental methods employed. In accordance with SPRUNG/SPRUNG 1984 (p. 247) the following hierarchy of research methodology has developed, not excluding interim forms (Figure 1).

**FIG. 1 HIERARCHICAL SYSTEM OF METHODOLOGY**

Nonstandardised methodologies do not require comprehensive means for control and variation in regarding to the subject of the investigation. The surrounding circumstances and investigative means are selected, less systematically, but rather situationally. Such procedures are advisable in the case of exploratory investigations, if the experimental approach to a phenomenon is still unclear. The application of nonstandardised methods requires a high degree of experience on the part of the investigator, because the danger of misinterpretation exists.

**Example 1**
An investigation of swimmers to determine anxiety and linked pedagogical influence is planned. In the

* I would like to express my gratitude to Mr. Ronald Siani for reading this paper and his valuable assistance in English.
first step might be queried beginners in swimming to their positive as well as negative experiences informally. Conclusions from these findings could lead to certain educational situations, which might be further transformed into pedagogical consequences.

Quasi-experimental methodologies are already subject to standardisation. They are found to be half way between correlation studies and real experiments (LEWIN 1986, p. 50). In comparison with experimental methods, the limiting conditions of quasi-experiments exist as follows:

- The quasi-experimental methodology makes possible the manipulation of independent variables, but does not allow for the randomised assignment of the experimental subject.

Example 2
A long-term test to compare pupils' physical state and health. Two school classes with pupils of the same age are to be selected. Class A follows a special endurance program. Class B participates in normal sports curriculum. The physical abilities of both classes might be compared to disease related absence from school. A random distribution of the test persons is not conceivable in this case.

- The independent variables are only subsequently reconstructable or exist in occurring form.

Example 3
Competitive athletes are divided in two homogeneous groups depending on their sprint performances. The sprint performances (dependent variable) of these two groups are examined with the aid of training documents. Training age and training volume of the athletes are treated as independent variables. The examination can result only in a retrospective view.

- Quasi-experimental methodologies can aid in analysing independent variables concerning standardised instructions, but variations of conditions can not be performed.

Example 4
The development of coordinative performances of two experimental groups should be compared by means of motor tests. As part of a longitudinal study the experimental subjects in Group A and Group B perform several test sequences over a two year period. Interpretation of the results is possible only in the form of a deductive explanation.

Experimental methodologies are workable through inductive variation and control of the independent variables accordingly to the phenomenon to be examined. Causal relevance between independent and dependent variables can also be analysed. "An experiment requires both, a random selection of experimental subjects for the experimental and the control group, as well as the manipulation (variation, change) of the independent variables." (LEWIN 1986, p. 50)

Example 5
The pupils of two school classes are distributed in regard to their mental attention performance in two randomised homogeneous sport curriculum groups. Group A performs a special psychomotor program to enhance concentration (experimental group). Group B performs the normal sport curriculum (control group). In this case the experiment is directed at the influence of psychomotor performances (independent variable) on the general mental attention in teaching (dependent variable).

The reality of the research process requires decisions regarding methodology which are dependent on expenditure-benefits-points of view. In so far the practice of sport-methodical research follows, considering their multiple indicative object areas, frequently a synergetical
approach of methods. Figure 2 shows the central position of the experimental method in the framework of anthropological research. The experimental method occupies the rank of the methodical optimum.

II. Classification

The dissemination of experimental methods combined with the diversity of forms has led to the classification of experimental types. According to their preferred criteria, several authors were stimulated to draw up different classifications. PARTHEY/WAHL 1966 (p. 183 ff.), HENNIG 1978 (p. 74 ff.), FRIEDRICH/ HENNIG 1980 (p. 634 ff.) and SPRUNG/SPRUNG 1984 (p. 260 ff.) describe such models. The classifications are not undisputed and even their experimental values have been evaluated differently. However, the methodological arrangements of the experiments, linked with future claims of the sport-methodical research, make systematisation inevitable. From the above, in part extremely complicated models, the following simplified classification types can be deduced.

- **Function type:** Experiments can be arranged decisively according to the main task. Consequently the goal and purpose determine the character of the experiment.

- **Conditional type:** Experiments are in different degrees close to the reality. This is by no means a criterion to determine the quality or importance of an experiment or its practical conclusiveness.

- **Period type:** Experiments are always conducted within a time frame. Although the time component is frequently neglected when interpreting variable effects, its consideration is very significant.

This systematic approach is derived from the most inhomogeneity of the experimental methods within any type. Nevertheless for a certain experimental method a thorough criteria of the two other types can be correctly assumed. Additionally, this is logical, because each experiment in essence is definable by its goal function, realisation conditions and time dimensions. (Table 1.)

It should be clear, that a general type of sport-methodical experiment does not exist.
TABLE 1 CLASSIFICATION OF EXPERIMENTAL METHODS

<table>
<thead>
<tr>
<th>FUNCTION TYPE</th>
<th>CONDITIONAL TYPE</th>
<th>PERIOD TYPE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exploration Experiment</td>
<td>Model Experiment</td>
<td>Short-term Experiment</td>
</tr>
<tr>
<td>Test Experiment</td>
<td>Laboratory Experiment</td>
<td>Long-term Experiment</td>
</tr>
<tr>
<td>Decision Experiment</td>
<td>Field Experiment</td>
<td>Time Series Experiment</td>
</tr>
<tr>
<td>Demonstration Experiment</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Likewise, all terms, such as for example, education experiment, training experiment, teaching experiment express application purposes exclusively. The specifications of sport-methodical applications, explained in the following section, should support the promotion of understanding and aid in the development of experimental methods in sport science.

III. Principal Methods

Despite further possibilities of classification, the following principal methods are described from a pragmatic sports point of view.

Function types

Exploration experiments are useful approaches to a principal investigation. They should serve to provide details for the hypothesises as well as for the planning of tests (variables, indicators). Because they help elicit preliminary information regarding the existing conditions in the field of investigation occasionally they are denoted as orientation experiments.

Example 6
The application of explorative experiments is advisable where a single phenomenon is to be studied which is part of a complex whole, for instance, a certain single player position on a sports team. Explorative experiments are valuable even in inventing new sports techniques (compositional sports) or in the development of new sports equipment (apparatus sports).

Test experiments exist in such matters, if the influences on the investigation are verifiable most extensively. Moreover the investigative plan still must be specified. In this sense testing experiments likewise serve as preparatory steps to the principal investigation. From their results, more practical and organisational particularities are to be expected, such as the correction of temporal terms, method modifications according to actual requirements and the lowering or intensification of variable influences.

Example 7
Test experiments in sport are recommended, especially if newly constructed methods or the unification of different investigation techniques as parts of multiple research projects have to be taken into consideration. Similarly it is appropriate to test experimental procedures beforehand by running investigations with different random samples: male and female experimental subjects, competitive and handicapped athletes, younger and elderly test persons.

Decision experiments are associated with the so-called critical experiments, where the results are used to verify or falsify hypothesises (SPRUNG/SPRUNG 1984, p. 261). They are
accepted among the experimental profiles as such with supreme generalised benefits. If the goal of the experiment lies in choosing a certain investigative method (construction, calibration, standardisation), one is speaking of a method experiment. The development of such diagnostic procedures reflects one of the broadest experimental fields in this research area.

Example 8
The high claim, linked to decision experiments, demands well-founded planning and representative random samples for sport-methodical applications. In the methodology of physical education there are multiple investigation methods which should meet these experimental criteria. Testing experiments of greater relevance for sports might be directed at the introduction of new teaching methods for physical education, a change of load rhythms in competitive sports or the proof of effectiveness in reference to different training means. Also experiments, to reduce learning time or the choice of different learning step sequences, are typical decision experiments in sport science. Concerning these forms the term learning experiment is frequently used.

Demonstration experiments display the effects of previously explored rules for teaching purposes. In this frame work predications have a solely didactic function. Demonstration experiments are multi-purpose, extremely conclusive and effective for pedagogical work.

Example 9
Demonstration experiments are of immeasurable importance in the field of sport. They include simple technique demonstrations under different realisation conditions (strength level, tactical variants, partner influences, etc.) as well as the consequences of different materials and equipment for athletic performance. For these kinds of experiments different performance levels of ergometer tests are very characteristic and easy to administer.

Conditional types

Model experiments can be characterised as being further from reality. Nevertheless they have a high heuristic value, because intellectual sharpness and depth are required regarding phenomena which are still less investigated. On this field more and more computer-aided scenarios serve as stimulus material. For sport-scientific problems especially strategic features are of interest. This contents motor task classes, requiring relatively high dynamic and cognitive influence of the motor activity. In this regard DÖRNER 1986 created the idea of operative intelligence.

Example 10
Model experiments can be very helpful in thinking about risk induced performances or critical load situations. They enable simulations of action conditions (e.g. computer-aided speed simulator), which are linked in the real case with dangerous risk. Model experiments are consequently capable of finding conclusions in sport, being part of difficult field situations.

Laboratory experiments can be described by systematic investigation requirements, the possibility for isolation and control variables and the measurability of effects (WARWITZ 1976, p. 25). Disturbing influences can be eliminated completely. This kind of artificial experiments exist in a larger distance to the reality of acting. Conclusions regarding the real event, made after completing a laboratory experiment, depend on the degree of that artificial and natural conditions are matched.
Example 11
Sport-methodical lab experiments treating superficially biological questions elicit fewer problems, because they can approach the natural stimulus conditions very closely. In terms of a treadmill laboratory experiment, course profiles and height conditions can be simulated. Extended complications appear if the athletic activities tend to be more complex. The individual technique of a duel athlete or a sports game player might be biomechanically analysed under lab conditions. Nevertheless the results have to be qualified, because influences, such as, opponents, team members or tactical sequences cannot be simulated easily or must be excluded in laboratory experiments.

In these cases sport-methodical research is chiefly a synthesis between laboratory and field experimental methods.

Field experiments are executed under equal conditions according to the sports activity existing outside the experimental situation. The investigation conditions leave "the natural game and sport situation in the field of their social and motivational relations..." Interesting factors solely are selected (WARWITZ 1976, p. 25). In contrast to the laboratory experiment, relevant situations are chosen. This leads to the difficult problem of "situation taxonomy", even for sport-methodical research (SPRUNG/SPRUNG 1984, p. 263). Likewise the insignificant possibilities of condition control have to be critically evaluated in field experiments. A perfect example of sport-methodical field experiments might be characterised as training and teaching experiments. They clearly describe, without presenting experimental types themselves, the natural characteristic of an experiment. They consider the goals of athletic training and motor exercising in a comprehensive way, in a way that other types of sport-methodical experiments can not do. Training and teaching experiments are bound to the motor activity directly. The aims of motor activity and experiment become a unit.

Example 12
For sport-methodical field experiments the unchanged social and daily circumstances are significant, like exercise groups, training places or time schedules. Field experiments in competitive sport are drafted to test new training conceptions, to examine changed training proportions or to compare current performance level with prognosis values (STARK/KRUG 1979, LEHNERT/STARK 1982). The pedagogical means and process, including the relationships between teaching and learning, are in the centre of experiments in school sport research (THIESS 1980).

Period types

Short-term experiments lie in conceptual proximity to status and characteristic diagnostics. They seek to analyse actual conditions or their development within a small time unit. Along with this fact, the analysis of changes precedes the status measurements, increasing the difficulties in defining the features of the experimental period types (JÄGER 1988, p. 156 f). In the case of short-term experiments, one starts from the position that time variables are relatively stable within the experiment. With regard to training, exercising and teaching, it seems that short-term experiments are less relevant to sport-methodical research (HIRTZ 1983, p. 448). Nevertheless they are remarkable for sports methodology in two aspects.

Example 13
• Short-term investigations are important for the investigation of single phenomena under high differentiated condition variations; for example single and complex reaction tests, motor memory perform-
ances under error corrections, adaptability of biologic indicators caused by different loads.

- Multiple evidence of complex phenomena at one time supports the clarification of structural relationships; for example the physiological, motor, verbal indications of emotional situations in sport or the simultaneous application of several biomechanical investigation methods for technique objectivations.

From that point of view it is obvious that short-term experiments attain their full validity principally under exploration and laboratory conditions.

**Long-term experiments** are aimed at the diagnostic process. They uncover changes on the basis of longitudinal comparisons (JÄGER 1988, p. 157). Long-term experiments refer to quantitative and qualitative changes over a limited time period. They should be utilised particularly if experimental influences are more extensive rather than intense, or if changes are expected only after a longer period. Long-term experiments are calculated with a time variable and they mostly used under field conditions. The pedagogical long-term experiment represents an important method in the sport-methodical research. (HIRTZ 1983, p. 451). All longitudinal studies over several years mention that method. Thereby a subdivision of the time period into logical and reasonable stages is recommended.

**Example 14**
Suggestions for an optimum of experimental periods are hard to find. They depend on changeable variables, the basic conditions of the test subjects and the intensity of the experimental influence. However, one can start from the principle that experiments which are performed to measure changes in motor features and their structural regulations, should require a minimum of 2–3 months.

**Time series experiments** are based on recording periodic sequences of investigation data, marking process. One presumes that the data exists in dependence over the time series. The measurements of the variables are repeated chiefly in equal periods. Also other factual, reasonable time extents are possible, for example training and teaching stages or load cycles in competitive sports. BORTZ 1984 (p. 44) distinguishes three types of models for time series analyses:

- Regularity of a time series (prediction models).
- Changeability of a time series (intervention models).
- Influenciability by other time series (transfer function models).

**Example 15**
Time series experiments are relatively seldom used in sport science, although they could have large heuristic value for performance prognostics or the determination of intervention effects after load stimuli. The significance of time series experiments concerning progression measurements in motor learning process is pointed out by PÖHLMANN 1990. Experimental attempts, focusing the process diagnostics, should follow such kinds of sequence-analytical testing designs.

Mathematical statistics offer different methods for the analysis of longer (at least 50 measuring points) and shorter time series. Finally, the sport-methodical research is also influenced by the application of modern testing designs. The theory of progression measurement provides the methodological framework for process diagnostics.
IV. Specification of Sport-Methodical Experiments

With the formation of sport-methodical experiments we must consider specific conditions. These specifications are stamped decisively from the field of utilisation. The primary experimental fields can be distinguished between school, rehabilitation, mass and competitive sports. The realisation conditions for sport-methodical experiments differ in part considerably. They describe the originality of the experimental field, without being an element of the experimental situation in each case. Such distinctions can exist in following features:

- The means and methods of the athletic activity.
- The goal and motivation structure of the test persons.
- The representation and size of the random sample.
- The pedagogical and didactic influence on the test persons.
- The age and athletic performance level.
- The external execution conditions for an experiment.

Particularities of sport-methodical experiments emerge also from the high complexity of sport-methodical questions. Taking into account the above mentioned requirements, it is always advantageous to limit the constitutional factors of experimental effects to a suitably low number. Rather than maximum data, the relevance strength and representation of data are essentially for the solution of the theoretical problem (HENNIG 1978, p. 63).

- The sport-methodical experiment should therefore be as simple and visible as possible.

The actual conditions in a sport-methodical experiment should display a high degree of similarity to the athletic reality. This demand can be met without problem, if the sport-methodical experiment is tied to training or the exercise process. However, according to laboratory or even model experiments, one should also aspire to reflect always the essentials of athletic reality.

- Preceding a sport-methodical experiment therefore requires thorough analyses of claims and conditions concerning the athletic activity.

Athletic performances, which form the basis of sport-methodical experiments, determine not only biological just as in each case psychical and social functions. This factorial unit justifies the particular contribution of sport-methodical experiments even for other human scientific disciplines. The experimental approach in the sport-methodical research therefore must focus on the high degree of human variability, as well as the influence of athletic activity, which help to form the human personality.

- Sport-methodical experiments should therefore require a multidimensional interpretative frame work for the theoretical, diagnostic and practical sport claims.

The performance and social behaviour of sport participants are always influenced by actual and historical circumstances of the society. Motor movements, in part, can be adventure oriented for the individual in an intense way. In this sense, overstepping of individual performance limits is meaningful. Sports experimentation can be attached by risks very quickly, being on one hand the subject of scientific interest and requiring the maintenance of human values on the other hand (POLSTER 1985).
Therefore sport-methodical experiments should calculate experimental risks without infringing on ethical, social or health values.

Summing up should be worked out the meaning of sport-methodical experiments for human sciences. Daily variety of motor movements form the basis of human existence. Sport-methodical experiments assume a central position in the methodical inventory. They can deliver valuable contributions to the disclosure of human strengths in the future. To achieve this stage of development, transforming the treatment of experiments into an ordinary actuality in sport science is necessary.

Hitotsubashi University

REFERENCES

Friedrich, W./Hennig, W.: Der sozialwissenschaftliche Forschungsprozeß. Deutscher Verlag
der Wissenschaften. -Berlin 1980. -837 S.
-Berlin 1987. -184 S.
Hirtz, P.: Das Langzeitexperiment-wichtige Methode der sportwissenschaftlichen Forschung.
Lehnert, A./Stark, G.: Empfehlungen zur Durchführung von Trainingsexperimenten in der
-13 S.
Deutscher Verlag der Wissenschaften. -Berlin 1966. -262 S.
Pöhlmann, R.: Testtheorie und Testpraxis im Bereich der Sportmotorik. Theorie und Praxis
Sprung, L./Srung, H.: Grundlagen der Methodologie und Methodik der Psychologie. Deut-
scher Verlag der Wissenschaften-Berlin 1984. -452 S.
Stark, G./Krug, J.: Das Experiment als eine Untersuchungsmethode der Theorie und Method-
dik des Trainings. -In: Lehner, A. (Ges.-Ltg.): Planung, Organisation und Untersuchungs-
meide der Leistungssportforschung. Forschungsinstitut für Körperformultur und Sport.
Thiess, G.: Zu Problemen bei der Anlage pädagogischer Experimente in der körperlichen
Bildung und Erziehung in der Schule. In: Theorie und Praxis der Körperformultur. -Berlin 29