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Introduction

For over 50 years Lafayette Instrument Company has provided laboratory equipment at the very foundation of scientific literature in the fields of Motor Behavior, Psychology, Physiology, Animal Behavior, Neuroscience and others. This is Lafayette Instrument Company's first guide specifically designed to assist researchers and educators in the selection of products that are most appropriate for their needs. We gratefully acknowledge the support of our many friends in the scientific community in the preparation of this and future publications.

The following review is an excerpt from the seminar, *"Motor Learning/Control Equipment Workshop"* presented by Dale G. Pease, Ph.D., in 1997 at Lafayette Instrument Company. Dr. Pease is the former Chair of the Department of Health and Human Performance at the University of Houston, Houston, Texas.

About the Author

Dale G. Pease, Ph.D.

Education

B.S. in Health, Physical Education & Recreation, 1961, Brockport State University of New York, Brockport, New York

M.S. in Physical Education (Administration emphasis), 1965, University of Colorado, Boulder, Colorado,
Dr. Fred Murphy, Major Professor

Ph.D. in Movement Science Program, Motor Learning/Sport Psychology Program, 1975, Florida State University, Tallahassee, Florida,
Dr. Robert N. Singer, Major Professor

Certifications

National Certification of "Sports Psychology Consultant" from the Association for the Advancement of Applied Sport Psychology, 1991 (Recertified 1999).

United States Olympic Committee Sport Psychology Registry for 1996-2000 quadrennium.

Honors

Awarded Fellow Status, American Alliance for Health, Physical Education, Recreation and Dance, 1983.

Elected to Executive Board for Association for the Advancement of Applied Sport Psychology, 1996.

Chair for Sport Psychology Academy, National Association for Sport and Physical Education, 1999.

College of Education Alumni Service Award, 1999.

Texas Scholar 2000, awarded by Texas Association for Health, Physical Education, Recreation and Dance, Austin, TX 1999.

Retrospective Overview

The term *motor behavior* is used when no distinct importance between motor learning, motor control and performance is necessary (Sage 1984). The first identified subarea of the motor domains was motor development. In the 1930s studies associated with growth, maturation and motor variables were conducted. In the mid-1960s motor learning emerged as a field of study followed by motor control and sport psychology – all providing different approaches for studying the processes and behavioral outcomes involved in human movement.

During the late 1800s and early 1900s there were studies involving vision and hand movements to targets, accuracy of limb positioning, force reproducibility, transfer of learning, training for sending Morse Code and learning/performance plateaus.

From the 1920s to the 1940s, studies involved strength, steadiness, body configuration, learning typing skills, retention of movement patterns, arm and hand movements, time and motion studies, and others.

During World War II studies focused on the selection and training of people to perform military tasks – "compatibility of human and machine." These covered, for example, gunnery, vehicle control, pilot training and the role of motor performance factors such as fatigue, etc.

Studies involving the development of human-machine interaction studies continued after World War II. This resulted in the development of fields of study labeled "human factors," "ergonomics," "engineering psychology," "cybernetics" and others.

In the mid-60s psychologists' interest in "motor" declined, while interest by people trained in physical education, movement education, kinesiology and sport science greatly increased. This movement was led by Dr. Franklin Henry in the Department of Physical Education at the University of California, Berkley. Doctoral programs studying movement were created primarily in physical education departments. National organizations were founded to promote communication among motor behavior scientists (e.g., North American Society for the Psychology of Sport and Physical Activity). Motor learning textbooks by Cratty, Singer and others were published. Research in motor behavior crossed the whole spectrum, ranging from neural control of muscle-spindle mechanisms to the role of sensory feedback and motor memory to application of research in the teaching and coaching of motor skills.

Today distinct areas of study have emerged within motor behavior, such as motor learning, motor control, motor development and sport psychology. These studies continue to look at the underlying processes (e.g., neural mechanisms, cognitive processes, etc.) that contribute to learning, control and performance. However, developing within each area of study is the integration of research methodologies from physical biology, neuropsychology, biomechanics, psychophysiology, experimental and applied psychology, physical education and kinesiology.

Future training of motor skills instructors must incorporate a strong task orientation, i.e., a focus on the effects of variables on the performance of motor skills.

Application:

1. Training teacher/coaches in movement activities
2. Retraining people for industrial job needs
3. Job placement and performance predictions
4. Effect of work environments (ergonomics)

Graduate programs with a focus on research must emphasize a process orientation, that is, what are the underlying mental and neural events that support or produce movement?

Application:

1. Injury and rehabilitation
2. Development of robotics
3. Neurological diseases
4. Effects of aging
5. Motor development in children (e.g., clumsiness)

Academic Programs in United States' Universities Today

Over the last 10 to 15 years, we have seen several changes in the academic programs at different universities. The traditional physical education programs have changed the names of their departments, academic degrees and the content of the degree programs to address current trends.

In some states in the U.S., you cannot major in education at the undergraduate level. You must major in a discipline. Therefore, in the case of physical education, the science-based discipline has to be identified. The required course work is in exercise physiology, kinesiology (biomechanics), motor learning and development, sport psychology and others.

In Texas, physical education was defined as a professional certification. The label chosen by most universities and colleges for the discipline was Kinesiology, which is "the study of human movement." Degrees from the baccalaureate to the doctoral level have been renamed Kinesiology. Departments have also been renamed with labels such as Human Performance, Kinesiology, Sport Science, etc.

At the University of Houston there are more than 500 majors of which approximately 30 percent are in teaching certification programs. The remainder are in options such as exercise science (e.g., pre-physical therapy or occupational therapy, cardiac rehabilitation, corporate fitness, etc.) and sports administration.

All undergraduate students are required to take a motor learning course.

Motor Learning

Motor learning is the area of study focusing on the acquisition of skilled movements as a result of practice. When testing for this, one must establish the purpose of the learning experience. Is it to determine the efficiency of the initial learning, the retention of the acquired skill or for the purpose of transfer? This last one involves using the same learned skill in a new and different situation.

Lafayette Instrument Company manufactures products that can test different types of tasks. The examiner can test the individual's response to different demands when trying to perform a task at high and consistent levels or at different stages of the learning process. Characteristics of the learner, such as age, previous experiences and strength must be taken into consideration since they can have an influence in the acquisition of the desired skill. The environment in which this person must learn and perform this task will have a critical influence in the process as well.

Based on the factors described above, the examiner can determine the most effective teaching methodology. Examples of these are guided learning, trial and error, use of modeling, visualization and forms of feedback. Although such simple equipment as balls, darts and

hula-hoops can make excellent tools to study the motor learning phenomenon, our focus is on laboratory equipment produced by Lafayette Instrument Company.

Some desired features for any product used in the motor learning area are:

- User Friendly
- Provides a novel learning experience
- Provides performance curves in 10-20 trials
- Challenging and motivational to the learner
- Fits within a distinct classification category
- Durable
- Efficient data collection and analysis

Motor Control

Motor control is the area of study dealing with the understanding of the neural, physical and behavioral aspects of moving (Schmidt 1988). In the effort to find relations between movement behaviors and neurological processes researchers often use movement kinetics to understand the control factors. Movement kinematics is the measure of locations of various parts of the body during movement, the angles of various joints and the time relations between movement in one joint and movement in another.

The following methods can be used to measure kinematics:

- Cinematography
- Potentiometers
- Accelerators
- Force platforms
- Electromyography (EMG) recordings
- Electroencephalogram (EEG) recordings
- Reaction time
- Movement time
- Performance time
- Biofeedback systems

Lafayette Instrument Company produces and markets analog and computerized Physiological Recording and Biofeedback systems that can be used in these methods.

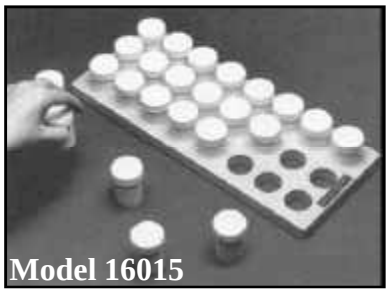
Equipment Selection

The products manufactured and sold by Lafayette Instrument Company will allow researchers to measure the following psychomotor parameters:

- Perception
- Gross Motor Balance
- Strength
- Gross Motor Dexterity
- Fine Motor Dexterity
- Reaction Time
- Motor Memory
- Hand-Eye Coordination
- Physiological Recording and Data Acquisition
- Effect of Drugs on the Central Nervous System
- Functions of the Visual System

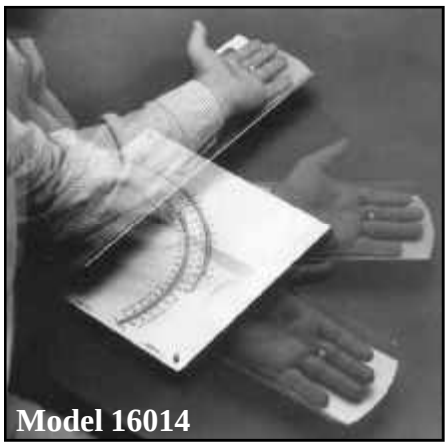
1. Perception

Evaluations help determine an individual's ability to discriminate weight, force, time and spatial relationships.


Model 16015

Product(s) Recommended:

Discrimination Weights	Model 16015
Stopwatches	
Single event	Model 00033A
Single split	Model 00034A
Kinesthesiometer	Model 16014
Hand Dynamometer	Model 78010


Model 16014

Model 00033A

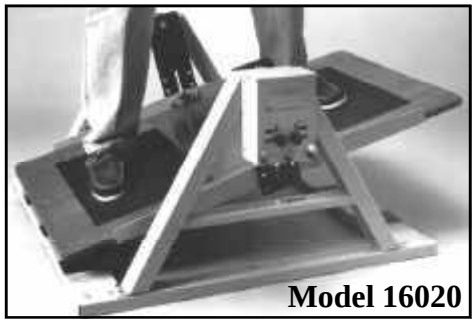
Model 00034A

2. Motor Balance

Evaluations measure gross motor balance ability. The task is a continuous skill, self-paced, requiring some form of balancing ability. Examples of learning concepts tested include mass vs. distributed practice, visual cueing, modeling, goal setting, reward systems and social facilitation.

Product(s) Recommended:

Stability Platform	Model 16020
Stability Platform w/ Infrared Control	Model 16020IR/PS

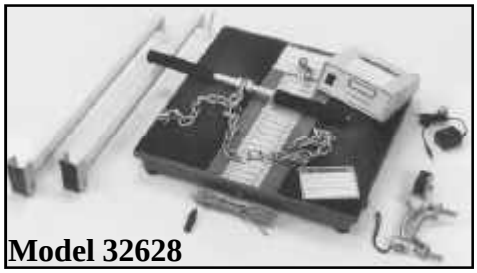

Model 16020

3. Strength

Evaluations measure lift-load capability and the ability to perform physically demanding tasks. It also measures fitness as it pertains to the ability to perform handling and other tasks requiring arm, shoulder and back strength.

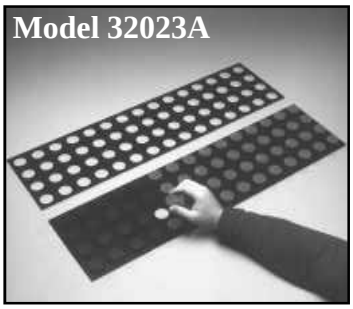
Product(s) Recommended:

Hand Dynamometer	Model 78010
Jackson Strength Evaluation System	Model 32628



4. Motor Dexterity

Evaluations measure the capacity for simple but rapid eye-hand-finger movement and assesses quick movement in handling simple tools and production materials without differentiating size and shape. Examples of motor learning concepts that can be tested include effect of stress on performance, effects of personality factors on performance, attention allocation, and motivational factors (e.g., goal setting).



Product(s) Recommended:

Minnesota Manual Dexterity Test	Model 32023
Complete Minnesota Dexterity Test	Model 32023A

5. Fine Motor Dexterity

Evaluations measure the ability to perform fine motor tasks such as finger dexterity as necessary in manufacturing assembly tasks. The test is self paced and discrete in its primary form. Motor learning concepts that can be tested are similar to those tested with gross motor dexterity.

Product(s) Recommended:

Purdue Pegboard Test	Model 32020
Grooved Pegboard	Model 32025

6. Reaction Time

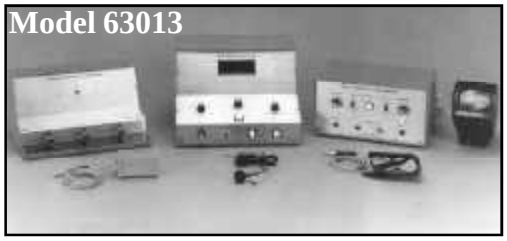
Evaluations measure two types of reaction time:

Simple Reaction Time is the time from the initiation of a suddenly presented stimulus to the beginning of the response (pressing a hand or foot pedal). This response involves the higher centers of the brain, not just reflex reaction. This is a measure of mental events such as stimulus processing, decision making and response programming.

Product(s) Recommended:

Reaction/Movement Timer	Model 63017
Foot Switchpad	Model 63510A

Discriminate Reaction Time is a task in which a number of stimuli are presented and the subject responds to a predetermined stimulus. Cognitive processing is an important aspect of this task. The importance of this task is that often a number of stimuli are present in the environment and one must first determine to which stimulus to respond.

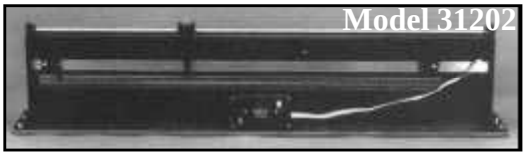


Product(s) Recommended:

Deluxe Multi-Choice Reaction Time Apparatus	Model 63013

7. Motor Memory

Motor memory is the persistence of the acquired capability for responding (Schmidt 1988). Testing motor memory involves perception, encoding and retrieval of stored kinesthetic information. Research has shown that the ability to effectively process movement locations and/or distances for recall purposes has important application for predicted performance in numerous physical tasks.

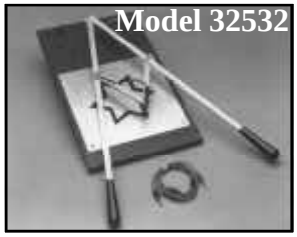


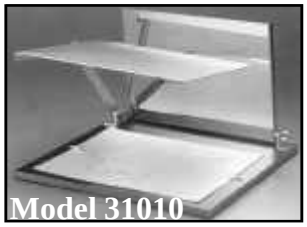
Product(s) Recommended:

Linear Movement Apparatus	Model 31202

8. Hand-Eye Coordination

Hand-eye coordination involves the effective movement integration of hands, arms and legs when guided by vision. Examples of tests of hand-eye coordination involve aiming (dart throwing), tracking (rotary pursuit), and tracing (mirror tracer, and two arm-coordination test). Successful pilots, dentists, dental technicians and hand tool tradesman have been found to perform these hand-eye coordination tests with an above average level of achievement. This test equipment requiring hand-eye coordination can also be used to test numerous motor learning concepts such as speed/ accuracy, visual imagery, overpractice effects and teaching methods.





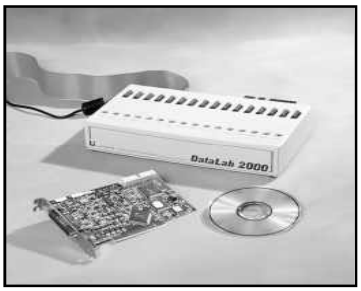
Product(s) Recommended:

Standard Rotary Pursuit	Model 30010A
Photoelectric Rotary Pursuit Apparatus	Model 30014A
Two-Arm Coordination Test	Model 32532
Standard Mirror Tracer	Model 31010
Automatic Scoring Mirror Tracer	Model 58024

9. Physiological Recording and Data Acquisition

Electromyography (EMG) recordings are used in motor learning/control to determine what changes are occurring when learning and what occurs when stress or tension is added. They are also used to fractionate reaction time and control muscle tension (stress management; biofeedback).

Physiological recording systems must be able to:

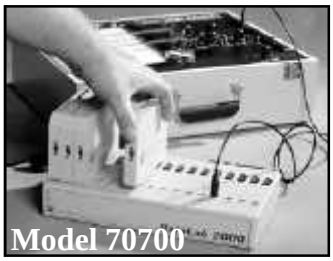


- Measure temporal patterning
- Measure intensity of contraction (amplitudes)
- Provide average over trials, providing a more reliable pattern

Electroencephalography (EEG) is the measurement of electrical potentials from brain functions.

- Alpha 8-12 Hz – associated with relaxed, but alert state.
- Beta 18-30 Hz – active mental state.
- Theta 5-7 Hz – relaxed, drowsy state.

EEG is used in motor learning, motor control and sport psychology to evaluate attentional changes based on hemispheric asymmetry and change in electrical activity prior to and during performance. For example:


Model 70700

- Changes in alpha activity during preparatory period (3-5 sec.) in rifle shooters.
- Alpha patterns change as performance improves in beginners.
- Demands of task change EEG responses (it is suggested that different tasks have an EEG signature of their own).
- Relationship with emotional responses.


Model 76107

Product(s) Recommended:

DataLab 2000 Model 70700
Minigraph (Inking or Thermal) Model 76107
IMG/TMG

10. Effects of Drugs on the Central Nervous System

Critical Flicker Fusion (CFF) helps scientists study brain damage, anxiety, fatigue, neurosis of Alzheimer's disease, epilepsy and the effects of aging. It plays an important role in considerations of the information capacity of the visual system and the development of models of the visual system.


Model 12021

Product(s) Recommended:

Flicker Fusion Model 12021

11. Functions of the Visual System

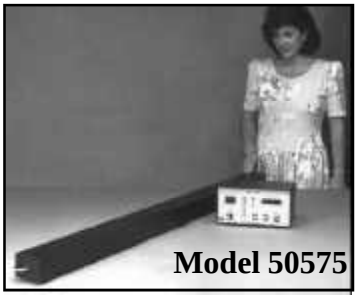
As an index of both the efficiency and integrity of the visual system, CFF and Flicker are valuable measurements in studying functions of the visual system, pathologies of the nervous system and development of visual capacities.


Model 12021

Product(s) Recommended:

Flicker Fusion Model 12021

12. Anticipation Time



Anticipation time is a measure of one's perception of motion and visual estimation of speed. It involves a subject responding to a moving stimulus so that the subject's response coincides with the arrival of the stimulus.

Product(s) Recommended:

Bassin Anticipation Timer Model 50575
Modified Bassin Timer Model 31201

Conclusion

As research and education in motor behavior progresses, new areas of study will certainly evolve. New instrumentation will meet the needs and requirements of professionals in industry and demand for greater interfacing of basic equipment with computers and software programs that provide tools for data collection, storage and statistical analysis will grow. We will also see the development of comprehensive motor learning laboratories that use only computer hardware and software. Even the use of virtual reality for motor behavior training will be of great value.

In the future, equipment for field use will be used more often than laboratory equipment to evaluate individuals while performing a task.

Lafayette Instrument Company has made a firm commitment to stay ahead of these new applications by providing professionals in this field with the right type of equipment for their needs.

Suggested Reading and References

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