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**PIANO TECHNIQUE AS A
MANIFESTATION OF MOTOR
CONTROL AND LEARNING:
AN INVESTIGATION FROM THE
PERSPECTIVES OF THE MOTOR
AND ACTION SYSTEMS THEORIES**

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*At liquidas avium voces imitaries ore
ante fuit multo quam levia carmina cantu
concelebrare homines possent aurisque iuvare.
et zephyri, cava per calamorum, sibila primum
agrestis docuere cava inflare cicutas.
inde minutatim dulcis didicere querellas,
tibia quas fundit digitis pulsata canentum,
avia per nemora ac silvas saltusque reperta,
per loca pastorum deserta atque otia dia.
[sic unumquicquid paulatim protrahit aetas
in medium ratioque in luminis erigit oras.]
haec animos ollis mulcebant atque iuvabant
cum satiate cibi; nam tum sunt omnia cordi.*

- Titus Lucretius Carus (c.98 - c.55 B.C.), *De Rerum Naturam*, Liber V [1379-1391]

SUMMARY

TITLE: Piano technique as a manifestation of motor control and learning: an investigation from the perspectives of the motor and action systems theories

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Many reasons can be cited for resorting to motor behaviour science in psychology as a departure point for investigating piano technique. This study compares the merits of the motor and action systems approaches to motor control and learning in order to assess which approach could be most valuable in addressing problems of piano playing.

The study commences with an investigation into the traditional motor systems perspective of motor control. Discussions are rather general and multi-faceted in order to enhance understanding of action theorists' criticisms of the motor view - an approach also necessitated by the lack of research involving piano playing.

Three stages of human information-processing and the way they are influenced by interference are examined. In the final, i.e. response-programming stage, movements can only be launched in discrete bursts; this, however, does not influence fluency and continuity in piano playing, because a response can consist of many subsidiary movements controlled by a motor program. In the response-execution stage following information-processing, movements are organized with a powerful underlying temporal structure. Only one such structure can be sustained by the motor program at a time, explaining the difficulty of executing polyrhythms in piano playing. The generalized motor program concept can account for certain easily coordinated technical constructs in piano playing. Also, grounds exist for postulating that rhythm and timing in piano playing are regulated by an internal clock.

Following discussions on the relative importance of three types of intrinsic feedback for piano playing and the pointing out of techniques for giving extrinsic feedback, Adams's closed-loop theory and Schmidt's schema theories for motor learning under the motor systems approach are critically examined. Methods are described for applying schema theory concepts to musical instrument practice. Motor memory, apparently, is not well understood.

Action theorists regard the motor systems application of the computer metaphor to human motor

behaviour and the motor programming notion as incorrect. The concept of functionally-defined actions consisting of postures and movements, which in themselves are actions, is presented. The ecological view, based on Gibson, that human information-pickup from the environment is direct, without elaborate central processing, is discussed. Apparent common denominators between two prominent "methods" for piano playing and action systems theory are pointed out.

Most aspects of action systems theory still need to be tested; much uncertainty is also prevalent on action learning.

Under the motor systems approach, various scientifically-based premises exist for structuring piano practice, applying to *inter alia* massed vs. distributed practice, blocked vs. random practice, variability in practice, slow practising of rapid passages, and practising "in rhythms". If action theory is correct in that the motor programming notion is wrong, most of these premises could lose their scientifically-based claims to validity; so will schema theory. Unfortunately, action theory apparently cannot offer any scientifically verified alternatives yet.

Much more research will be necessary for either choosing a particular theory or establishing a fusion between theories as a basis for piano-technical learning.

SAMEVATTING

TITEL: Klaviertegniek as a manifestasie van motoriese beheer en leer: 'n ondersoek vanuit die perspektiewe van die *motor systems*- en *action systems*-teorieë

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Verskeie redes kan aangevoer word vir die keuse van *motor behaviour science* in die psigologie as vertrekpunt vir 'n ondersoek na klaviertegniek. Hierdie studie vergelyk die *motor systems*- en die *action systems*-benaderings tot motoriese beheer en leer ten einde te bepaal watter benadering van die meeste nut sal wees vir 'n ondersoek na klaviertegniese vraagstukke.

Eerstens word die tradisionele *motor systems*-perspektief van motoriese beheer ondersoek. Besprekings is van 'n betreklik algemene aard en dek verskeie fasette om begrip van die *action*-teoretici se kritiek van die *motor*-perspektief te bevorder. Hierdie benadering word voorts genoodsaak deur 'n tekort aan navorsing met betrekking tot klavierspel.

Drie fases van menslike inligtingverwerking en die invloed daarop van interferensie word ondersoek. Tydens die laaste -, of responsprogrammeringsfase, kan bewegings slegs in diskrete sarsies geïnisieer word. Vloeiendheid en kontinuïteit in klavierspel word egter nie geraak nie aangesien 'n bewegingsrespons uit verskeie ondergeskikte bewegings, beheer deur 'n motoriese program, kan bestaan. Gedurende die responsuitvoeringsfase na inligtingsverwerking word bewegings georganiseer met 'n sterk onderliggende tydstruktuur. Slegs een tydstruktuur kan op 'n keer deur die motoriese stelsel hanteer word, wat verklaar waarom dit moeilik is om poli-ritmes in klavierspel uit te voer. Die veralgemeende motoriese program kan bepaalde maklik-uitvoerbare tegniese konstruksies in klavierspel verklaar. Gronde bestaan vir die stelling dat ritme en tydsberekening in klavierspel deur 'n interne klok gereguleer word.

Die relatiewe belangrikheid vir klavierspel van drie tipes intrinsieke terugvoer word bespreek en tegnieke vir ekstrinsieke terugvoer word uitgewys. Hierna word Adams se geslotelus-teorie en Schmidt se *schema*-teorie vir motoriese leer in die konteks van die *motor systems*-benadering krities ondersoek. Wysies vir die toepassing van *schema*-konsepte ten opsigte van musiekinstrument-oefening word uitgelig. Klaarblyklik is nie veel bekend oor die motoriese geheue nie.

Action-teoretici beskou die *motor systems*-toepassing van die rekenaarmetafoor op die mens as

onjuis. Voorts ontken hulle die bestaan van motoriese programme. Die konsep van funksioneel-gedefinieerde *actions* bestaande uit *postures* en *movements*, wat *actions* in eie reg is, word uitgelig. Gibson se ekologiese perspektief dat die mens direk inligting uit die omgewing opneem, sonder uitgebreide inligtingverwerking, word bespreek. Faktore in gemeen tussen twee "metodes" vir klavierspel en *action systems*-teorie word uitgewys.

Die meeste aspekte van *action systems*-teorie moet nog aan toetsing onderwerp word; heelwat onsekerheid bestaan ook rondom *action* motoriese leer.

Die *motor systems*-benadering huisves verskeie wetenskaplik-gebaseerde veronderstellings waarvolgens klavieroefen gestruktureer kan word; hierdie veronderstellings het onder andere betrekking op *massed* vs. verspreide oefen, *blocked* vs. willekeurige oefen, veranderlikheid in oefen, stadige oefen van vinnige passasies en oefen in "ritmes". As *action*-teorie korrek is omtrent die verkeerdheid van die *motor*-benadering, kan die wetenskaplik-teoretiese verantwoordbaarheid van die meeste veronderstellings daarmee heen wees. Ongelukkig kan *action*-teorie klaarblyklik nie wetenskaplik-bewese alternatiewe verskaf nie ten spyte van bepaalde belowende insigte.

Heelwat meer navorsing word benodig ten einde 'n bepaalde teorie of samesmelting van teorieë te kies as 'n grondslag vir klaviertegniese leer.

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