Willamette University

Science Collaborative Research Program

Student Presentations

Friday 9/18/2009 – Eaton 209

Science Collaborative Research Program
Research Conference
Friday 09-18-2009

1:30 -1:45 **Jonnie Dunne.** Are you buying what they're selling? Food retailers' perspectives on local food in the Willamette Valley bioregion of Oregon.
(Advisor: Professor Kimberlee Chambers, Earth and Environmental Science)

1:45 – 2:00 **Katy Giombolini.** Growing to feed the needs of the local food movement: can supply meet demand in the productive Willamette Valley?
(Advisor: Professor Kimberlee Chambers, Earth and Environmental Science)

2:00 – 2:20 **Emily Dick and Michael LaDouceur**. Plant-pollinator interactions of *Camassia*: An examination of selfing and the influence of pollinator preferences.
(Advisor: Professor Susan Kephart, Biology)

2:20 – 2:40 **Garrett Potter and Marc Whitehead.** How to trap an atom (in 14 minutes or less).
(Advisor: Professor Michaela Kleinert, Physics)

2:40 – 3:00 **Nikki Lytle and Raquel Bell**. The Microtubule Regulator Stathmin is Required for Axonal Transport in *Drosophila melanogaste r*. *(Advisor: Professor Jason Duncan, Biology)*

3:00 – 3:20 **Leila Mitsunaga and Alia Yasen.** Rapid auditory processing in children at-risk for school failure: Evidence from event-related brain potentials.
(Advisor: Professor Courtney Stevens, Psychology)

3:20 – 3:35 **Autumn McIlraith.** Fast neural specialization for processing single letters: Evidence from event-related brain potentials. *(Advisor: Professor Courtney Stevens, Psychology)*

3:35 – 3:45 BREAK

3:45 – 4:00 **Robert Clarke.** Progress Toward the Stereocontrolled Organocatalytic Synthesis of Thio-Oxacycles. *(Advisor: Professor Andrew Duncan, Chemistry)*

4:00 – 4:15 **Craig Sather.** Progress Towards Stereocontrolled Oxa-Michael Cyclization of Amino Substituted Six-membered Oxacycles. *(Advisor: Professor Andrew Duncan, Chemistry)*

4:15 – 4:30 **Charlotte Osborne**. Stereocontrolled Organocatalytic Synthesis of Oxacycles.
(Advisor: Professor Andrew Duncan, Chemistry)

4:30 – 4:45 **Jeff Collins.** Winter precipitation predicts demographic structure in Yucca brevifolia (Agavaceae). *(Advisor: Professor Chris Smith, Biology)*

4:45 – 5:00 **Tyler Starr.** Hybridization in the Joshua tree (*Yucca brevifolia*).
(Advisor: Professor Chris Smith, Biology)

5:00 – 5:15 **Zach Hutchinson.** Heat does not prevent plasma membrane localization of NtRac1 in cultured guard cell protoplasts of *Nicotiana glauca*. *(Advisor: Professor Gary Tallman, Biology)*

5:15 – 5:35 **Maya Velez and Abe Moland.** Acute Effects of Shoulder Vibration Treatment on Proprioception and Selected Muscle Performance Characteristics in Athletes and Non-athletes.
(Advisor: Professor Junggi Hong, Exercise Science)

Jonnie Dunne. Are you buying what they're selling? Food retailers' perspectives on local food in the Willamette Valley bioregion of Oregon.

(Advisor: Professor Kimberlee Chambers, Earth and Environmental Science)

Local food systems are networks of actors that work to ensure the sustainability of food supplies within communities. Local food has typically been promoted through direct marketing at locations such as farmer's markets and community-supported agriculture (CSAs). Increasingly, grocery stores are sourcing and marketing local foods in response to consumer demands and market potential. Given the frequency with which consumers shop at grocery stores as well as the portion of consumers' food expenditures at these locations, these stores may play a significant role in the success of local agriculture and the shaping of ideology about what is 'local'. We conducted 27 semi-structured interviews with representatives of food retailers in the four major urban centers of the Willamette Valley, Oregon. Our results reveal that grocers perspectives on local food vary significantly from one another as well as in comparison to the published literature on consumers' and producers' ideas of what constitutes local. Grocers also indicated a diversity of reasons for choosing to source and market local foods. Some trends in the variation of responses can be found in how the size and form of ownership of the grocery stores influences the level at which decisions are made. These wide-ranging perspectives illustrate many of the realities of the sustainability of the local food movement, as well as opportunities for change.

Katy Giombolini. Growing to feed the needs of the local food movement: can supply meet demand in the productive Willamette Valley?

(Advisor: Professor Kimberlee Chambers, Earth and Environmental Science)

Eating locally continues to be promoted and discussed as an alternative to growing concerns related to industrialized, global, corporate agriculture. Buying from local famers and producers is seen as a way to eat healthier foods, reduce environmental impacts, and sustain communities. As a result, the number of farmers' markets, home gardens, and community-supported agriculture projects (CSAs) has increased significantly across the United States. Grocers are also capitalizing on consumer interest in fostering relationships with local producers, creating markets for local farmers, and developing in-store materials to promote their local focus. The promotion of the local food movement presents the question: is it possible to feed a community solely from the foods produced locally? The bountiful Willamette Valley growing region, located in western Oregon, is one of the richest agricultural areas in the United States. We conducted a systematic analysis of the United States Department of Agriculture's (USDA) recommended dietary requirements for the estimated 2008 Willamette Valley population and compared these with annual Willamette Valley agricultural production for the years 2004-2008. Our results indicate that current crop production in this highly productive region does not meet the dietary needs of the Willamette Valley inhabitants for any of the USDA's six food groups: grains, vegetables, fruits, dairy, meat and beans, and oils. There is, however, the potential to increase production in many of the USDA food groups in the Willamette Valley, thus increasing the feasibility of the local food movement.

These works were completed as part of the Science Collaborative Research Program and supported with generous funding from the Research Corporation, the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Emily Dick and Michael LaDouceur. Plant-pollinator interactions of *Camassia*: An examination of selfing and the influence of pollinator preferences.

(Advisor: Professor Susan Kephart, Biology)

Few studies have been conducted to see how morphological differences among flowers affect visitation by pollinators and a plant's breeding system. We examined the breeding systems of *C. quamash* and *C. leichtlinii*, selected morphological and developmental differences in their flowers, and the response of pollinators to experimental trait simulation and to natural flowers of both species. We also studied unusual, developmentally altered flowers that appeared to self-pollinate while in bud. We posed the following questions: 1) What floral traits or combinations are preferred by pollinators? 2) Does the pattern of visitation vary with insect taxon or with the availability or type of rewards? 3) Is the rate of autonomous selfing variable between and within species? 4) Are the varied morphologies of *C. quamash* and *C. leichtlinii* flowers associated with differences in selfing rates? We conducted two surveys of breeding systems in *Camassia*. First, we determined the frequency of unusual floral morphs thought to be self-pollinated along 50 m transects. Second, we measured the anther-stigma distances of flowers of both camas species to assess possible spatial effects (herkogamy) in relation to selfing. We found the unusual floral morphs only in *C. leichtlinii*, despite prior observation of similar flowers in *C. quamash*. To study pollinator preferences, we observed visits to artificial *Camassia* flowers supplied with pollen and/or nectar in varied environmental backgrounds. These observations showed that pollinators collectively preferred short height, radial symmetry, and wide petal size in *Camassia*. Our research highlights the value of trait manipulation for understanding plant-pollinator interactions and further reveals important links between herbivory, floral form, and pollinator behavior.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Research Corporation, the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Garrett Potter and Marc Whitehead. How to trap an atom (in 14 minutes or less).

(Advisor: Professor Michaela Kleinert)

This project focused on the design and construction of a Magneto-Optical Trap (MOT) for rubidium atoms. Two diode lasers with slightly different frequencies were used together with an ultra-high vacuum chamber and magnetic fields produced by an Anti-Helmholtz coil to slow (cool) and trap the atoms. During the nine weeks of Summer research, we assembled the complete optics and electronics necessary to cool and trap the atoms. We spent the first month aligning the lasers, shaping their beam profile and adjusting their frequencies. During the second month we built and tested circuits that allow us to maintain trapped atoms for a significant amount of time. We will discuss the construction of the experimental apparatus and the physics behind cooling and trapping of atoms. We will also give an outlook of future experiments which will be performed with this apparatus.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Research Corporation, the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Nikki Lytle and Raquel Bell. The Microtubule Regulator Stathmin is Required for Axonal Transport in *Drosophila melanogaster*.

(Advisor: Professor Jason Duncan, Biology)

Neurons use a microtubule-based transport system to bidirectionally transport proteins, vesicles, and organelles between the cell body and the synaptic terminal through the axon. We investigated two non-complementing mutations in *Drosophila*, *redtape* (*rdtp*) and *B200*, which exhibit phenotypes consistent with defective axonal transport. These phenotypes include a larval crawling behavior in which the posterior body segments flip upward after each peristaltic contraction, due to paralysis of the posterior muscles. In addition, these larvae have reduced levels of components of the microtubule-based transport system, including tubulin and the kinesin motor protein, as well as accumulations of transported components in the longitudinal axons. Although these mutations cause homozygous lethality during the larval stage, a small percentage manage to survive as adults but have significant walking defects and reduced lifespan. We hypothesized that *rdtp* and *B200* disrupt axonal transport through mutation of the *stathmin* gene. *Stathmin* encodes a cytosolic phosphoprotein that regulates microtubule dynamics. To test our hypothesis, we attempted a genetic rescue of *rdtp* and *B200* with a transgenic *stathmin* cDNA under the control of the ubiquitous *tubulin* promoter. Restoring *stathmin* function in *rdtp* and *B200* mutants rescued the homozygous lethality and restored the lifespan of adults to near wildtype levels. As well, exogenous *stathmin* restored the reduced levels of tubulin and kinesin observed in *rdtp* and *B200* mutants. Furthermore, our analysis identified an additional phenotype in these mutants, a 'bang sensitive' seizure phenotype characteristic of mutants that have altered neuronal excitability. Collectively these data demonstrate that *rdtp* and *B200* are alleles in the *stathmin* gene and identify a novel role for stathmin in axonal transport.

Leila Mitsunaga and Alia Yasen. Rapid auditory processing in children at-risk for school failure: Evidence from event-related brain potentials.

(Advisor: Professor Courtney Stevens, Psychology)

Several lines of evidence suggest that deficits in rapid auditory processing could underlie the surface difficulties in language skills faced by many children. However, little is known about the neural systems mediating rapid auditory processing in children, or whether these systems differ in children with language difficulties. In the present study, event-related brain potentials (ERPs) were used to study rapid auditory processing in children using a new child-friendly paradigm. In this paradigm, children were asked to selectively attend to one of two stories presented simultaneously from separate speakers. ERPs were recorded to linguistic and non-linguistic probe stimuli embedded in the attended and unattended channels at interstimulus intervals (ISIs) of 200, 500, or 1000 msec. Data from 76 typically developing 3-8 year old children showed that the ERP amplitude from 100-200 msec post-stimulus onset varied as a function of ISI, suggesting that auditory refractory periods can be measured in very young children, even in a crowded acoustic environment. A comparison of 38 children from high- vs. low-socioeconomic backgrounds showed no difference in ERP refractory period effects as a function of children's socioeconomic background. However, a comparison of 12 children with specific language impairment and 12 matched controls revealed differences in ERP refractory period effects among children with specific language impairment. These data suggest that low-level auditory processing deficits may be part of the complex profile of specific language impairment, but unrelated to a child's socioeconomic status.

Autumn McIlraith. Fast neural specialization for processing single letters: Evidence from event-related brain potentials.

(Advisor: Professor Courtney Stevens, Psychology)

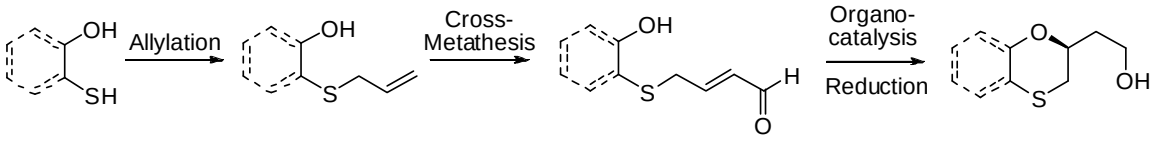
The ability to process written language requires the fast, accurate identification of symbol strings. Previous research with event-related brain potentials (ERPs) reveals that approximately 170 msec after stimulus presentation, neural responses to words versus other classes of visual stimuli are larger over left-hemisphere posterior brain regions. This neural specialization, referred to as the left-lateralized N170 effect, likely reflects early, automatic processing of written words. Previous studies have compared the N170 response to words versus symbol strings, but such tasks are difficult for young children and those with reading disabilities. In the present study, a paradigm was developed for assessing the neural specialization for written language that might be suitable for future studies of children and individuals with reading disabilities. Participants monitored a stream of either single letters or single letter-like stimuli and pressed a button upon seeing a repeat stimulus. ERPs to the letters vs. letter-like stimuli were compared to determine neural specialization. Preliminary data were collected from ten adults. Over left hemisphere sites, the N170 was found to be greater in response to letter stimuli versus letter-like stimuli, while no difference was seen between the two stimulus types over the right hemisphere. This supported the idea that neural specialization for written language could be assessed using single-letter stimuli, and that this distinction is apparent within the first few hundred milliseconds of visual perception. The design of this experiment would make it more easily adaptable for use with special populations, such as young children or individuals with reading disorders.

Robert Clarke. Progress Toward the Stereocontrolled Organocatalytic Synthesis of Thio-Oxacycles.

(Advisor: Professor Andrew Duncan, Chemistry)

Prior work in the Duncan group established that 7-hydroxyhept-2-enal cyclizes under the action of a prolinol-derived organocatalyst to yield the corresponding α-substituted tetrahydropyran derivative in 74% yield and 92% enantiomeric excess. The objective of this research is to expand the molecular scope of this organocatalytic synthetic sequence by creating a substrate library. My work has been concentrated on sulfur-containing oxa-enal substrates. The synthetic sequence I used was initiated by the successful S-allylation of mercapto-ethanol and mercapto-phenol. The following cross-metathesis reactions of the allylated products using the Grubbs II catalyst did yield some of the desired aromatic product, but in low yield (11%). However, the reaction was problematic, causing isomerization and giving many unidentifiable byproducts. To combat these problems, the hydroxyl group was protected by esterification, but this proved not to be helpful. Future research will include exploring different conditions of the cross-metathesis reaction and attempting to characterize the reaction's unknown byproducts. Eventually, once the desired substrates containing the aldehyde are synthesized, those molecules will be reacted with the prolinol-derived organocatalyst, causing it to cyclize with enantioselectivity.

Theoretical Synthetic Sequence:



Craig Sather. Progress Towards Stereocontrolled Oxa-Michael Cyclization of Amino Substituted Six-membered Oxacycles.

(Advisor: Professor Andrew Duncan, Chemistry)

A straightforward synthetic approach to enantioenriched oxacycles will provide a useful tool in synthesizing naturally occurring compounds that contain this functional group. Preliminary work has shown that oxy-Michael cyclization using an asymmetric organocatalyst gives oxacycles in high enantiomeric excess. Substitution of the oxacycles will allow us to build an extensive and diverse library of substituted oxacycles. Synthesizing amine-substituted oxacycles can yield a wide variety of morpholine-derived products; for example, the $GABA_B$ receptor antagonist, SCH-50911, is a morpholine-derived compound with potential applications for antidepressant and anxiolytic use. This research focuses on amine-substituted oxacycles using ethanolamine and 2-aminophenol as building blocks for substrate design. To both starting compounds, mono *N*-allylation and protection of the primary amine followed by a cross-metathesis should afford the proposed substrate for oxa-Michael cyclization by an asymmetric organocatalyst. Double *N*-allylation of ethanolamine was the only product observed rendering it useless for further synthetic steps. Mono *N*-allylation of 2-aminophenol was successful using a catalytic amount of cesium hydroxide followed by subsequent protection of the amine. Cross metathesis yielded no product. Alternative synthetic routes were investigated for future synthetic development leading to the originally planned amine substituted oxacycles.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Research Corporation, the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Charlotte Osborne. Stereocontrolled Organocatalytic Synthesis of Oxacycles.

(Advisor: Professor Andrew Duncan, Chemistry)

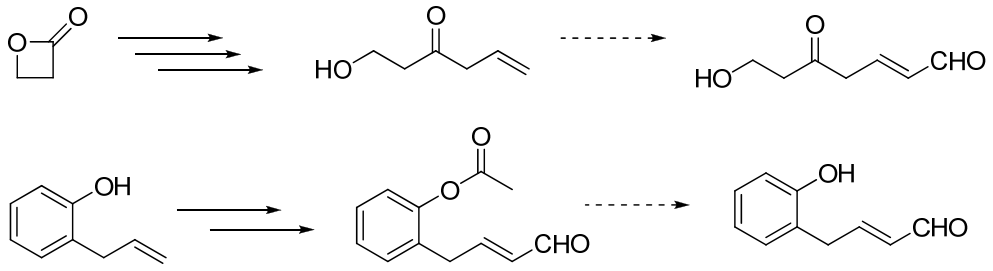
The formation of oxygenated heterocycles and their derivatives is a vital step in the total synthesis of many natural organic compounds; their structural importance in numerous synthetic schemes warrants further study of their formation. Preliminary studies have established that it is possible to enantioselectively form oxacycles from hydroxy α,β-unsaturated enals via an intramolecular oxa-Michael cyclization, using a proline-derived organocatalyst.

Ongoing studies expand the substrate scope by synthesizing hydroxy enals containing various substitutions (Figure 1). A keto-substituted hydroxy enal was synthesized by a ring-opening reaction of β-propiolactone to obtain a hydroxy ester, which was reacted to form a Weinreb amide. This amide was allylated so the resulting compound could be combined with crotonaldehyde in a cross metathesis reaction to form the desired keto-substituted hydroxy enal. The intended Grignard allylation reaction did not progress satisfactorily with an unprotected alcohol, so a TBS protecting group was used.

Synthesis of an aromatic hydroxy enal began with 2-allylphenol. A cross metathesis reaction was attempted, but the intended product was not obtained. The addition of an acetyl group satisfactorily protected the phenol during the cross metathesis, but could not be removed to give the desired substrate.

Future studies will explore an alternative scheme for the synthesis of the keto-substituted hydroxy end, starting from 1,3-dithiane. Once synthesized, the target substrate will be subjected to the cyclization conditions to form the keto-substituted oxacycle.

Figure 1. Substrate Synthetic Scheme



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Jeff Collins. Winter precipitation predicts demographic structure in Yucca brevifolia (Agavaceae).

(Advisor: Professor Chris Smith, Biology)

Global climate change is expected to cause range changes and local extinctions, especially in species that are unable to migrate or adapt. Previous studies have predicted that Joshua trees (*Yucca brevifolia),* an integral part of the Mojave Desert ecosystem, are at great risk of local extinctions across much of their range. However, these predictions are based on ecological niche modeling (ENM), which may not accurately estimate the fundamental niche of some species. Long-lived plants such as the Joshua tree can exist as relict populations in areas that were once suitable habitat, but now can support only established trees. Such relict populations cause ENM to overestimate future range. Incorporating information about demography may improve predictions. To determine whether some populations of Joshua trees are experiencing population decline, we performed demographic surveys at eight sites in southern California. We assigned each tree to one of seven size classes, and performed stepwise linear regression to correlate median size class with elevation, February precipitation, annual precipitation, and July maximum temperature. The regression revealed a statistically significant correlation ($R^2 = 0.258$, $p = 0.032$) between median age class and February precipitation. This correlation suggests that Joshua trees exist as relict populations where rainfall has decreased in recent history. If this is indeed the case, previous predictions of future Joshua tree range likely include large areas where Joshua trees will not be able to survive. To maximize the survival of Joshua trees, therefore, it is essential to incorporate knowledge about population ecology into future ENM studies.

Tyler Starr. Hybridization in the Joshua tree (*Yucca brevifolia*).

(Advisor: Professor Chris Smith, Biology)

The Joshua tree / yucca moth association, is a classic example of an obligate pollination mutualism; the Joshua tree relies on the yucca moth as its exclusive pollinator, while the yucca moth depends on the tree's developing seeds as food for her larvae. There are two morphologically distinct Joshua tree varieties, each pollinated by a different species of moth. The two tree varieties and associated pollinator moths exist in separate populations, with the exception of a small contact zone in Tikaboo Valley, Nevada, where both tree varieties and moth species occur. In this contact zone, moths have been seen visiting their non-native hosts, and individual trees that seem to be morphologically intermediate between the two varieties, while rare, have been observed. These two observations suggest that hybridization could be occurring between the two Joshua tree varieties. We use vegetative and preliminary floral morphological measurements to detect the presence of morphological intermediates within the contact zone, indicative of possible hybridization. Although vegetative morphology does not indicate statistically significant evidence of hybridization, preliminary floral data suggest that morphological intermediates may be present in the contact zone.

This work was completed as part of the Science Collaborative Research Program and supported with generous funding from the Research Corporation, the Mary Stuart Rogers Foundation and the M.J. Murdock Charitable Trust.

Zach Hutchinson. Heat does not prevent plasma membrane localization of NtRac1 in cultured guard cell protoplasts of *Nicotiana glauca*.

(Advisor: Professor Gary Tallman, Biology)

The plant hormone auxin is required for virtually every major plant developmental process, including cell growth and division. At 32°C, cultured guard cell protoplasts (GCP) of *Nicotiana glauca* contain at least one functional auxin signaling pathway mediated by a Rac GTPase. At 38°C, GCP develop an insensitivity to auxin marked by limited cell growth and the inability to divide. In their active state, Rac GTPases must be bound to GTP and associate with the plasma membrane in order to forward the auxin signal downstream. We hypothesized that heat would prevent the plasma membrane localization of Rac GTPases in GCP. To visualize the location of the Rac GTPases at higher temperatures, GCP were transformed in three ways: (1) with *35s-mgfp5-NtRac1-CA*, which produces a constitutively active form of NtRac1; (2) with *35s-mgfp5-NtRac1-WT*, which produces the wild-type auxin-activated form; or (3) with *35s-mgfp5-NtRac1-T20N*, which produces an inactive GTPase due to a dominant-negative mutation in the gene. Transformed GCP were cultured at the permissive temperature of 32ºC or at 38ºC in darkness. After 48 hours at 38°C in an auxin-containing media, 57 ± 23% (mean ± SE) of GCP transformed with *35s-mgfp5-NtRac1-CA* exhibited plasma membrane localization. None showed perinuclear localization; in 43 ± 23%, NtRac1-CA was localized elsewhere. Under the same conditions, 67 ± 14% of GCP transformed with *35s-mgfp5-NtRac1-WT* showed plasma membrane localization. None showed perinuclear localization; in 33 ± 14 %, NtRac1-WT was localized elsewhere. In GCP transformed similarly but cultured in media lacking auxin, 51 ± 24% exhibited plasma membrane localization, 4 ± 4% perinuclear localization, and 45 ± 21% localization elsewhere. After 48 hours at 38°C in an auxin-containing media, no GCP transformed with *35s-mgfp5-NtRac1-T20N* exhibited plasma membrane localization; 43 ± 10% showed perinuclear localization, and 57 ± 12% were localized elsewhere. Similar trends were seen after 48 hours in the 32°C control experiments for GCP transformed with *35s-mgfp5-NtRac1-CA* and *35s-mgfp5-NtRac1-WT* in an auxin-containing media. However, 46 ± 8% of GCP transformed with 3*5s-mgfp5-NtRac1-T20N* showed plasma membrane localization, 18 ± 6% perinuclear localization, and 36 ± 6% were localized elsewhere. Because GCP grow and divide at 32°C, it is possible that enlarged vacuoles were pushing the cytoplasm outward, obscuring results for the 48 h *35s-mgfp5-NtRac1-T20N* treatments. These data suggest that heat does not prevent plasma membrane localization of NtRac1 in GCP and that heat disrupts the auxin pathway somewhere downstream of NtRac1.

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Maya Velez and Abe Moland. Acute Effects of Shoulder Vibration Treatment on Proprioception and Selected Muscle Performance Characteristics in Athletes and Non-athletes.

(Advisor: Professor Junggi Hong, Exercise Science)

Functional changes following the exposure to whole-body vibration (WBV) treatment has been attributed to adaptations in the neuromuscular system. However the lack of standardization in protocols and studies makes it difficult to gain a complete understanding of the underlying mechanism. In the present study we examined the acute effect of shoulder vibration treatment on proprioception and selected muscle performance characteristics (peak torque, time to peak torque, and power). Forty young individuals (18 athletes and 22 non-athletes) with no history of upper body injuries were randomly assigned to an experimental or control group. The experimental group received shoulder vibration treatment (3 bouts of 1-minute with 30 Hz and 5 mm). During the treatment session, the subjects held the push-up position on the vibration platform with the elbow extended. The control group performed the same position as the experimental subjects. To assess shoulder proprioception, active and passive joint position sense were measured on both internal and external rotation of the shoulder. The muscle performance variables (peak torque, time to peak torque, and power) were measured using isokinetic dynamometer with the velocity of 60 deg/sec. After three bouts of 1-minute vibration treatment, the athletes in the experimental group demonstrated a significant improvement in the joint position sense and peak torque ($p<0.05$). However the non-athletes in the experimental group didn't show any changes either on joint position sense or muscle function following the treatment. Our findings suggest that short bouts of vibration treatment appear to have an effect on both shoulder proprioception and muscle strength in athletes.

Key words: whole body vibration, neurological adaptation, proprioception, peak torque

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