Global Journal of Medical Research: a
Neurology & Nervous System
Volume 24 Issue 1 Version 1.0 Year 2024
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4618 & Print ISSN: 0975-5888

# Performing the Garcia Score for Accuracy and Reliability

By Brock R. Yager, BS, Sasha A. Kondrasov, BS, Jack Jestus, BS, Sidish Venkataraman, MD, Nicholas J. Contillo, BS, Nathan P. McMullen, MS, Stephanie A. Coffman, MD, Fatima Ryalat, MD, Zhidan Xiang, PhD, Debra I. Diz, PhD & Stacey Q. Wolfe, MD

*Wake Forest University School of Medicine*

*Abstract-* Reliable, sensitive, and accurate tests are needed to assess animal models of brain injury. The Garcia score is a neurobehavioral measure that has been used in many murine studies. However, despite its widespread use, there are no detailed video descriptions of the steps to properly perform and grade the Garcia test on rats. Consequently, there has been significant variation in its performance and reliability, calling for greater standardization. The Garcia score is comprised of six measures: spontaneous activity, symmetry in the four limbs, forepaw outstretching, climbing, body sensation, and response to vibrissae touch. Each component is scored with a minimum of zero or one and a maximum of three, with the highest total score of 18. This report systematically and clearly describes how each component of the Garcia score is performed and graded with an accompanying video illustration.

*Keywords:* *garcia score, behavioral, brain injury.*

*GJMR-A Classification:* *LCC: RC394.B7*

*Strictly as per the compliance and regulations of:*

# Performing the Garcia Score for Accuracy and Reliability

## Performing the Garcia Score

Brock R. Yager, BS [α], Sasha A. Kondrasov, BS [σ], Jack Jestus, BS [ρ], Sidish Venkataraman, MD [ω], Nicholas J. Contillo, BS [¥], Nathan P. McMullen, MS [§], Stephanie A. Coffman, MD [χ], Fatima Ryalat, MD [ν], Zhidan Xiang, PhD [Θ], Debra I. Diz, PhD [ζ] & Stacey Q. Wolfe, MD [£]

*Abstract-* **Reliable, sensitive, and accurate tests are needed to assess animal models of brain injury. The Garcia score is a neurobehavioral measure that has been used in many murine studies. However, despite its widespread use, there are no detailed video descriptions of the steps to properly perform and grade the Garcia test on rats. Consequently, there has been significant variation in its performance and reliability, calling for greater standardization. The Garcia score is comprised of six measures: spontaneous activity, symmetry in the four limbs, forepaw outstretching, climbing, body sensation, and response to vibrissae touch. Each component is scored with a minimum of zero or one and a maximum of three, with the highest total score of 18. This report systematically and clearly describes how each component of the Garcia score is performed and graded with an accompanying video illustration. The purpose of this report is to assist researchers in implementing the Garcia test and to help standardize the use of this measure across studies.**

*Keywords: garcia score, behavioral, brain injury.*

## I. Introduction

Behavioral testing is a critical element of assessing brain function. Reliable, sensitive, and accurate tests are needed to assess animal models of brain injury. The Garcia score is a neurobehavioral measure that has been used in many murine studies [1]. However, despite its widespread use, there are no detailed video descriptions of the steps to properly perform and grade the Garcia test on rats. Consequently, there has been significant variation in its performance and reliability. This video-illustrated article enumerates the Garcia score's methodology in clear detail to assist researchers and help standardize its use across studies. The methodology described has been tested and validated repeatedly in clinical experiments completed by experienced technicians in our lab.

*Author α: Student Researcher, Department of Neurological Surgery, Wake Forest University School of Medicine, Winston-Salem, NC, USA. e-mail: byager@wakehealth.edu*
*Author σ: Student Researcher, Department of Neurological Surgery, Wake Forest University School of Medicine, Winston-Salem, NC, USA. e-mail: skondras@wakehealth.edu*
*Author ω: MD, Resident, Department of Neurological Surgery, Wake Forest University School of Medicine, Winston-Salem, NC, USA. e-mail: svenkata@wakehealth.edu*
*Author Θ: PhD, Research Associate, Department of Neurological Surgery, Wake Forest University School of Medicine, Winston-Salem, NC, USA. e-mail: zxiang@wakehealth.edu*
*Author ζ: PhD, Professor, Hypertension and Vascular Research Center, Wake Forest University School of Medicine, Winston-Salem, NC, USA. e-mail: ddiz@wakehealth.edu*
*Corresponding Author £: MD, FAANS, Professor, Department of Neurological Surgery, Wake Forest University School of Medicine, Winston-Salem, NC, USA. e-mail: sqwolfe@wakehealth.edu*

## II. General Overview

The Garcia score is comprised of six measures: spontaneous activity, symmetry in the four limbs, forepaw outstretching, climbing, body sensation, and response to vibrissae touch. Each component is scored with a minimum of zero or one and a maximum of three. The overall score is the sum of the scores for each component—the highest possible is 18. (Table 1) A higher score indicates that the animal is closer to baseline or "normal" behavior. A lower score indicates greater neurobehavioral deficit. The following is a detailed description of each component of the Garcia test and how it is scored. Spontaneous activity is often performed first to avoid changes from testing fatigue, but the remaining components can be completed in any order. The explanations center around a rat model, but this is also valid (and commonly used) for murine models. A video is provided to demonstrate the performance and grading of this test.
Video link: https://drive.google.com/file/d/1-UEtnk7twwyEz0_oHy5lcKGASFCdqsiV/view?usp=sharing

## III. Acclimation

A period of time prior to beginning the Garcia test is necessary to allow the rats to acclimate to the rat handler and their surroundings. This involves bringing the rat into the room in which the testing takes place and letting it relax in its cage, then placing it on the testing table, and holding and interacting with it. This allows the rat to become accustomed to its handler and environment, in turn ensuring that performance on the Garcia test is not impacted by external factors that may have otherwise agitated the rat if acclimation had not been achieved. The length of the acclimation period may vary and is complete only when the rat becomes

calm, indicated by grooming itself while held by the handler and cessation of frantic or agitated movement. At this time, the rat is ready for the Garcia test.

## IV. Spontaneous Activity

Place the rat in its cage for the beginning of the Garcia test, to perform spontaneous activity first (0:04 in video). The goal is to observe the rat approach all four walls of the cage within a 5-minute time span. Typically, an awake rat will do this within a few seconds. If the rat approaches all four walls or corners, it will be scored a 3. If it explores one or two walls, it will receive a 2. If it does not explore any and/or circles in place, it will receive a score of 1. A score of 0 is given to a rat that does not move.

## V. Symmetry in the Four Limbs

Symmetry in the four limbs is another component of the Garcia score which measures coordination and strength in each limb without an applied stimulus (0:46). The rat is suspended by its tail and its spontaneous movements are observed for at least 30 seconds. A rat will receive a 3 if it extends and moves each of its limbs equally. This can be observed if you begin by noting a side preference and subsequently examining each limb as the rat moves. The rat will receive a 2 if one paw extends but is markedly slower or more strained than the contralateral side. If there is essentially no movement on one side with minimal twitching, the rat will receive a 1. A score of 0 is given if the rat cannot move its limbs. A helpful tip for this test is to allow proper time between assessments to accurately assess symmetry.

## VI. Forepaw Outstretching

Forepaw outstretching is another component of the Garcia test which measures strength and coordination in the forepaws (1:19). The rat is suspended slightly by the tail so that the forepaws are still contacting the table, but the hind paws are not. The technician pushes the rat forward so that the rat may begin walking on their forepaws three separate times. The rat will receive a score of 3 if both forelimbs are outstretched and the rat walks symmetrically. A score of 2 is if one side outstretches less than the other, or if there is some deviation in walking. The rat will receive a 1 if a forelimb significantly lacks the ability to help the rat move forward, but still twitches to some degree. A score of 0 is given if one forelimb does not move. To ensure accuracy, an important tip is to avoid applying an unequal force in any direction so that symmetry between the forepaws can be assessed.

## VII. Climbing

Climbing is another component of the Garcia test which tests strength and balance (1:53). This necessitates a grid wall. The rat is placed on the center of the grid and allowed to climb to the top while the technician holds the grid upright in such a manner that it is perpendicular to the table. This is completed for three trials. The rat will receive a 3 if it reaches the top of the grid in three trials with symmetric gripping power. It will receive a 2 if it reaches the top in three trials with asymmetric gripping power; for example, the rat may move towards the right while climbing to the top. The rat will receive a 1 if it tends to circle or move downwards instead of climbing upwards. A score of 0 is given if the rat fails to move. A helpful tip for this test is to standardize the grid wall in its position and incline because data can be skewed profoundly without consistency among serial testing.

## VIII. Body Proprioception

Body proprioception is another component of the Garcia test which measures coordination and strength in each limb without an applied stimulus (2:32). It is similar to testing symmetry in the movement of limbs, but tests whether the rat will respond to an applied stimulus to each side of its lower body. If the rat responds to each side equally, it will receive a 3. It will be given a 2 if it reacts more slowly to one side. The rat will receive a 1 if it does not react to one side. It is also important for this test to allow proper time between assessments to accurately assess symmetry in response to the applied stimulus.

## IX. Response to Vibrissae Touch

Vibrissae touch is the remaining component of the Garcia test which tests symmetry in motor response to a stimulus applied to the whiskers (3:00). It entails slightly elevating the rat by its tail about 1-2 inches off the table in such a way that the hindlimbs are suspended but the forelimbs are still contacting the table. Once the rat is no longer moving, the technician slowly approaches one side sweeping a probe caudally to cranially along the whiskers. This procedure is repeated on the contralateral side. A response from the rat is any blinking, startling, or turning its head ipsilateral to the stimulus. The rat will receive a score of 3 if it responds equally to the stimulus on both sides. A score of 2 is given if there is a slower response on one side. It will receive a 1 if there is no response on one side. This test is technically the most challenging, and observing the reaction can be difficult due to its subtlety. Being mindful of the positioning and ensuring that the rat is calm and facing directly opposite from the technician while still achieving an easily visualized side-profile will provide the most consistent and efficient results.

## X. Conclusion

The Garcia score is a widely used, validated, multi-component measure of neurobehavior in rodent

models of cerebral injury. This article systematically and clearly explains and illustrates the proper performance and grading of this test so that researchers can implement and standardize this measure across studies.

*Conflict of Interest*

None

*Author's Contributions*

Brock Yager*

*GROUP 1:* Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data

*GROUP 2:* Drafting the work, Revising the work critically for important intellectual content

*GROUP 3:* Final approval of the version to be published

*GROUP 4:* Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Sasha Kondrasov*

*GROUP 1:* Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data

*GROUP 2:* Drafting the work, Revising the work critically for important intellectual content

*GROUP 3:* Final approval of the version to be published

*GROUP 4:* Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

*Brock Yager and Sasha Kondrasov contributed equally to the work of this study.

Sidish Venkataraman, MD

*GROUP 1:* Acquisition of data

*GROUP 2:* Revising the work critically for important intellectual content

*GROUP 3:* Final approval of the version to be published

*GROUP 4:* Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Zhidan Xiang, PhD

*GROUP 1:* Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data

*GROUP 2:* Drafting the work, Revising the work critically for important intellectual content

*GROUP 3:* Final approval of the version to be published

*GROUP 4:* Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Debra I. Diz, PhD

*GROUP 1:* Acquisition of data

*GROUP 2:* Revising the work critically for important intellectual content

*GROUP 3:* Final approval of the version to be published

*GROUP 4:* Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

Stacey Q. Wolfe, MD, FAANS

*GROUP 1:* Conception of the work, Design of the work, Acquisition of data, Analysis of data, Interpretation of data

*GROUP 2:* Drafting the work, Revising the work critically for important intellectual content

*GROUP 3:* Final approval of the version to be published

*GROUP 4:* Agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved

## Acknowledgements

The authors thank Wayne Graham for his laboratory and animal expertise.

## References Références Referencias

1. Garcia Julio H, Wagner Simone, Liu Kai-Feng, Hu Xiao-jiang. Neurological Deficit and Extent of Neuronal Necrosis Attributable to Middle Cerebral Artery Occlusion in Rats. Stroke 1995; 26: 627-635.

*Table 1:* Garcia Score Grading System – Brief description of how each component of the Garcia test is scored.

| | Spontaneous Activity | Symmetry in the Four Limbs | Forepaw Outstretching | Climbing | Body Proprioception | Response to Vibrissae Touch |
|---|---|---|---|---|---|---|
| 3 | Explores all four walls/corners | Extends and moves all limbs equally | Both forelimbs outstretched, walking symmetrically | Reaches top with symmetric gripping power | Responds to each side equally | Responds to each side equally |
| 2 | Explores one or two walls | One forelimb extends but slower/ strained | One forelimb outstretches less, or some deviation in walking | Reaches top with asymmetric gripping power | Reacts more slowly to one side | Reacts more slowly to one side |
| 1 | Moves but does not explore any walls | No movement on one side, minimal twitching | One forelimb lacking movement but twitches | Circles or moves downward | Does not react to one side | Does not react to one side |
| 0 | Does not move | Does not move forelimbs | Does not move one forelimb | Fails to move | N/A | N/A |

*Abbreviations: none*