

# **THE SCIENCE, PHYSICS, AND BIOMECHANICS OF BASEBALL PITCHING**

**THE SCIENCE OF BASEBALL PITCHING  
VOLUME 1**

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**An e-book**

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## ACKNOWLEDGEMENTS

### Baseball, Cricket, Tennis, and Javelin Throwing

People might ask *What does Brent Rushall know about baseball pitching?* That is a fair question. It is true that I have not spent much of my academic career devoted to studying this intriguing sport. Apart from a few years of academic involvement at Indiana University in the mid-1960s, where I was fortunate enough to have the time and resources to write the first computer program that analyzed baseball pitching and cricket bowling movements (Pyke & Rushall, 1969), as much of my time has been spent studying and watching cricket, tennis, and javelin throwing as that spent on baseball.

In a few sports science settings, it has been the custom to gather coaches of like sports together to talk about mechanics, conditioning, and coaching with the hope that innovations in one sport will be transferred to and adapted by similar sports. More than a decade ago, this approach was initiated at the Victorian Institute of Sport (Melbourne, Australia) by the Director of Coaching Development, Mr. Peter Spence, himself a very successful cricket coach. This cross-fertilization of ideas was successful there and is what I bring to this baseball book.

Unfortunately, many individuals will consider only baseball pitching "*things*", not willing to look "*outside the box*". There are procedures followed in baseball that have been tried and found wanting in cricket and other high-velocity throwing sports. One example is marginally weighted implements that according to pitching gurus increase pitching strength and velocity. In the early 1960's, attempts to have some top Australian tennis players wear weighted wristbands to improve hitting power nearly cost the Australians the Davis Cup. When the weighted bands were removed, the players continually hit the ball with an obvious degradation in precision and velocity. Recent research has shown that a similar effect occurs with weighted bats; hitting is affected adversely. In those early years, a variety of studies were published that showed skills and performances did not benefit from marginally weight-changed implements. Weighted baseballs are popular in baseball circles. However, the "*science*" behind their use is flawed. Those flaws are addressed directly in Topic 3 of this book. Many other conflicts and similarities between baseball, cricket, and tennis will not be mentioned here. Suffice it to say there are many common factors between human performances that require repetitious maximally-explosive (high-velocity) movements that require skilled precision in functional outcomes. The underlying science is common to sports that demand tasks of that type. That science needs to be considered and accommodated in baseball pitching.

Not only is there a need for evaluating current baseball pitching practices and procedures, but there is a pressing need to implement the principles of sports science that have mushroomed over the past 30 years. There is such an extent of scientific (refereed) research that is appropriate for consideration when contemplating baseball pitching, that now it is possible to talk definitively about what is correct and incorrect in the sport. Much of my writing covers those principles of physics and human movement which are no longer argued, and therefore should be adapted to this baseball role. Unfortunately, the evidence that has emerged does not justify or endorse a considerable number of accepted procedures used in the coaching and development of pitchers. This book strikes out with the tenet that evidence should be supported, and beliefs and myths discarded in the light of that evidence.

The biomechanics content of this book has been largely reproduced and supplemented with specific factors governing high-velocity throwing activities in the book *Momentum Pitching* (Rushall, 2009a). That book also contains specific details about the teaching content of

*Momentum Pitching* and serves as a valuable adjunct to this first volume in *The Science of Baseball Pitching* series (Rushall 2009b, 2009c, 2009d).

The value of this book that covers the science, physics, and biomechanics of pitching, will be determined best by pitchers and coaches who try those principles. Being evidence-based, theoretical arguments without evidence will not suffice to dispel any of its content. Readers, pitchers, and coaches should now demand evidence of what to do, not the often published opinions and beliefs of those of influence.

As I look at what is included in this volume, I reflect back on the good fortune I have had in my sporting and academic careers. Often, I have been in the right place at the right time to be exposed to and associated with some of the greatest coaches and sports scientists of all time. My academic training and profession has steered me in a very fruitful and productive career path. Each day I wonder how I could have been so lucky.

My wife Jane, as always, has provided steadfast support in my work in this project. She has endured many, many hours of listening to explanations of why balls curve and dip, pitchers pitch well and poorly, and why athletes are injured when those injuries could have been prevented. As has been the case with my other books and publications, I could not have produced what you see in these pages without her indulgence and love.

Pitch well.

Brent S. Rushall, Ph.D.,R.Psy.

January, 2009

## PREFACE

There are many reasons for writing a book. I believe that baseball players, and in particular pitchers, deserve effective and sound coaching. Baseball is a sport that is steeped in beliefs, many bordering on mysticism, while other postulations reek of misinformation. Other individuals in baseball offer coaching advice and sport analyses in the form of infomercials founded on false premises. One of their strongest motives is profit. With these forces at work in baseball coaching, parents who foot the bills for a son's "*special*" training; colleges that spend state, student, and donated monies on players' scholarships and sporting opportunities; and professional organizations that pay extraordinary amounts with the view to being "*winner*s", all deserve that their monies buy better than folk-tale ridden coaching explanations and erroneous practices. This book is an attempt to present known facts and practices with the intention of combating the very weak coaching knowledge and effectiveness in baseball pitching.

The content of this book is more expansive and extensive than other baseball books. Human performance, and pitching in particular, does not involve activities that can be described in a few simple terms or factors. A good coach needs to understand the functioning of the human brain, body, and mechanics; the aerodynamics of a ball in flight; and the procedures that can be used to produce the best human performance possible when throwing a baseball in a particular manner at a defined target. This book is one of a series based on the content of the extraordinarily large original Mills and Rushall (2006) book.

### Baseball Science

It is unfortunate that exercise physiology has gained the strongest foothold in sport and exercise science. Most college departments associated with human movement studies, feature more units of study and laboratory experiences in exercise physiology and its prerequisite sciences (e.g., anatomy, general physiology, biochemistry, etc.) than most other sport sciences (biomechanics, motor learning, sport psychology) combined. When a sport is only viewed through one scientific perspective, the truth about performance will never be known. That is because an exercising human concomitantly employs psychological, biomechanical, and physiological factors in any movement. There is no human exercise where these three basic movement sciences do not occur together, although how each one is emphasized and used varies between exercise endeavors. That most writings on improving baseball pitching have focused on physiological factors is understandable but regrettable, because it has led to incomplete and therefore, erroneous practices. This series of e-books, of which this is the first, attempt to cover all the applied-science bases of pitching performance should be evaluated against the understanding that an analysis of a "*whole*" pitcher is better than one of only discussing a player as a collection of muscles and blood. Exercise physiology is important, but no more so than biomechanics, physics, and psychology. Unless the activities of a pitcher are interpreted from the three major fields of sport science, a correct evaluation and prescription will not be made for any pitcher. The complexity and extent of the sections of this book are meant to give the coach sufficient background to make balanced and correct decisions about the science, physics, and biomechanics of the performances of pitchers so they or their sponsors will "*get their money's worth*".

Some aspects of sport science are not included in this series of e-books. There would be great value in discussing the growth and development differences between pre-pubertal children, post-pubertal adolescents, and mature adults and explaining how those differences modify what is known about psychology, physiology, and biomechanics. A decision was made not to include growth and development as it pertains to pitching. The e-book series is already very extensive

and to add yet another long volume would make it completely unwieldy while probably taxing the patience and energies of the author and overwhelming most readers. Although I have done my best to present content extensively, I do not claim the evidence-based knowledge of this book is all that needs to be known to be a successful baseball pitcher or pitching coach. It should go a very long way to helping individuals to achieve prominence in those two vocations but it is not all that one requires for complete success.

Since multiple sport sciences are presented as e-books, there is likely to be considerable topic repetition throughout the series. For example, strength, power, and speed can be viewed from neural, biomechanical, and physiological viewpoints. Consequently, those topics will be repeated but in terms of the scientific discipline being discussed. Repetition of topics occurs frequently throughout the series as do cross-references to topics and principles.

The book is divided into three parts, every one focusing on a scientific or practical discipline. The basic unit of the book is the topic. I chose that name to break away from the more common term "*chapter*". Topics are not chapters in a story. They are considerations of defined topics that can stand alone based on their knowledge and explanatory content.

One thing this book does not have is content recipes. You will not find prescriptions of how many pitches to perform, what grips to use to apply the resultant force for delivering a curveball, etc. I believe that individualizing the coaching of pitching is a fundamental need for effective coaching. To satisfy that belief, this book presents most of the building-block knowledge that a coach needs to make informed decisions about actual activity principles for each pitcher. With that approach, each pitcher should improve along his coach-recommended and justified path that has included him in the decision-making process. Armed with extensive knowledge contained in the e-book series that looks at a pitcher with a "*full-picture concept*", including his mechanics, psychology, and physical state, a player should be stimulated to improve in more than a very restricted domain. The extra areas of knowledge that are unique to these publications should promote the expansion of considerations for programming the coaching of pitchers as well as looking for more avenues to develop a player's full potential.

### **Current Baseball Knowledge**

Dick Mills has shared with me questions raised by readers of the original book, *The Science and Art of Baseball Pitching* (Mills & Rushall, 2006). One asked why is it that *Momentum Pitching* (Rushall, 2007), which is the outcome of a rigorous scientific evaluation of baseball pitching, is supposed to be right and all/most others partially or totally wrong? That is a fair question and can only be answered with opinions that I have developed over more than 50 years involvement in applied sport science. Below are some points I consider pertinent to this question. These points were included in an actual response to a request from Dick Mills (personal communication, December 18, 2008).

*It would take pages and pages of negative opinions and data-based observations to describe the propensity of people/coaches who trust belief-based coaching principles as opposed to evidence-based (fact-based) principles of human movement/behavior. I have yet to read a baseball guru correctly relating principles of physics, principles of human behavior, principles of applied physics (biomechanics), and/or principles of the physiology of exercise. Our "Big book" attempts to shoot down many misconceptions and much misinformation concerning baseball skills and specifically pitching.*

*It is my opinion that the Internet has fostered the amount and frequency of misinformation in most sports. A client of mine, Dr. Frank Zatko, asked: "I wonder if our sport tends to pass*

*down non-scientific coaching errors that just become part of the foundation of the sport?" The lore of baseball/pitching is perpetuated and consists mostly of dogma rather than fact. Such is caused by the waning prevalence of critical thinking that is so obvious in our high school and university graduates. Actually, I have adopted the tenet for sport explanations: "If it sounds reasonable it must be wrong". Too many experts are flat wrong about areas in which they claim to have qualifications. This societal tendency to promote and increase destructive information (in sports) is addressed in my article concerning the Second Law of Thermodynamics [<http://coachsci.sdsu.edu/csa/thermo/thermo.htm>; and is reproduced in part as topic1 in this book].*

*Much of the Coaching Science Abstracts (<http://coachsci.sdsu.edu/index.htm>) is a record of truths (i.e., the results of acceptable scientific published research articles) and to dispel sporting/baseball dogma. Unfortunately, I have not recorded all the baseball/pitching-specific works that dispel much of baseball dogma (for example the ASMI study which shows that throwing a football is unlike and potentially injurious to pitching).*

*This answer to your client's question is wishy-washy at best but the problem pervades all facets of modern living/education. Was not that impression obviously reinforced by the lack of knowledge and understanding of history, geography, and behavior demonstrated by most candidates for national offices in the recent election? Yet millions of people championed such individuals!*

*A large proportion of this nation (often reported as being in excess of 80%) believes in some form/representation of a god. The arguments to "prove" such an existence are illogical/false and yet the movement is growing in this country. If that can occur across the varieties of American sub-cultures, the same phenomenon can also occur in other societal interests, such as baseball pitching. [I am not disputing the right of individuals to believe what they wish, just the existence of what is dogmatically proposed.] It should not amaze one that young pitchers are taught incorrect beliefs and that such beliefs are then perpetuated throughout the experiences that follow in life. Little League (the baseball equivalent of "Sunday School") establishes the folk-lore and levels of reasoning that are then accepted as the level of belief that is valid/reliable in later life.*

*The above features of course are emphasized by the charisma of the proselytizer and his/her self-promotions ("He who shouts loudest and most often is most heard").*

*The only guard against misinformation is to require dogmatists to "put their data where their mouths are". What are acceptable data becomes a sticking point, for the data have to be scientific (observable and measurable and obtained in a manner that is free from interpretive bias).*

*I believe we are getting some good examples of Momentum Pitching. A few are the case studies in the Appendix of my book (Rushall, 2007). It is not surprising they are young because their initial coaching has been along the tenets of Momentum Pitching. The difference between Momentum Pitchers and other pitchers is that Momentum Pitchers will not necessarily all look alike but they will adhere to the same movement principles (which are interpreted according to each individual's physical attributes), whereas many other pitchers try to look like some older professional model and neither accommodate their own individual attributes nor follow correct movement principles (principles that are now known in the scientific world).*

*Finally, I have often talked about the "25-Years Rule". That is an hypothesis/observation that it takes at least 25 years for a finding in human movement science to be accepted by and incorporated into coaching practices. After 50+ years in this science-coaching business, I still claim that rule is as valid today as it was in the 1950s (e.g., then interval training was being embraced as the new training paradigm although Gerschler wrote and published at length about it in the mid- to late-1930s).*

There are many avenues available for markedly increasing baseball pitching performances. The sooner those opportunities are exploited, the quicker players will be able to reap the benefits they deserve from playing baseball.

Good luck and wise thinking about your pitching and coaching.

Brent Rushall