In recent years a number of different factors have been identified that influence the behavior and success of soccer penalty taking. These include, among others, mental factors such as the coping strategy adopted by penalty takers, the perceptual behaviors of penalty takers (including gaze), and the strategies a penalty taker can employ. This thesis scrutinizes the theoretical and practical consequences of two factors in more detail. First, it addresses how the way a penalty taker approaches a penalty kick situation strategically (i.e., keeper independent and keeper dependent) influences kicking behaviors and success. Second, it examines how goalkeepers can influence the kicking behavior and success of a penalty taker, without the kicker being aware (i.e., the off-center effect). To this end, six studies were carried out, two of which addressed the effectiveness and risks of the two penalty kick strategies, while four studies aimed to shed light on the origin and pervasiveness of the off-center effect.

The first study examined whether the gaze behaviors differ between the keeper dependent and keeper independent strategies, and if so, to what extent these gaze characteristics relate to differences in the effectiveness and risks that are associated with either strategy (e.g., in terms of kicking accuracy), both in high and low anxiety situations. Penalty takers were equipped with a portable gaze-tracker and instructed to adopt their preferred penalty kick strategy – that is, in the case of a keeper dependent strategy, to wait for
the goalkeeper to jump to one side and then kick the ball to the opposite side, or in case of the
goalkeeper independent strategy, to choose a target area before the run-up and sustain that
choice regardless of the goalkeeper’s behaviors. The low and high anxiety situations did not
result in differential gaze behaviors, but the study did show that gaze behaviors in the keeper
dependent strategy were less optimal than in the goalkeeper independent strategy. Penalty
takers spent more time looking at the goalkeeper and less at the ball. An important theoretical
and practical conclusion is that the gaze behaviors directly related to kick accuracy.

The second study examined the degree to which high-skilled professional soccer
players indeed use the two penalty kick strategies, and whether the observed differences in
effectiveness and risks in experimental studies are also evident in international competitions.
To this end, a tool was developed that allowed the identification of the employed penalty kick
strategies in videotaped penalty kicks. A logistic regression model was able to identify the
correct penalty kick strategy in over 90% of penalty kicks (for which the adopted strategy was
known) using observer ratings for a series of penalty kick characteristics. The model was
subsequently used to analyze the frequency of occurrence and the effectiveness (i.e., the
success rate) of the two strategies at FIFA World Cups and UEFA European Championships.
Results showed that the keeper independent strategy was adopted in the vast majority of
penalty kicks, and also that the two strategies did not differ in effectiveness. Thus, in terms of
strategy it seems that the perfect penalty kick for maximizing success does not exist.

The four remaining studies scrutinized the off-center effect. The off-center effect
refers to the phenomenon that a penalty taker’s decision to kick to the left or right goal side is
influenced by the position of the goalkeeper on the goal line. When a goalkeeper stands only a
few centimeters from the exact midpoint of the goal (i.e., off-center), without the kicker
consciously noticing this, then this does influence goal side selection: the penalty taker will
chose to kick more frequently to the side of the goal with greater. The first study aimed to
establish if the off-center effect also occurs on the pitch with a proactive goalkeeper trying to
save penalty kicks – that is, previous studies were all conducted in a lab under somewhat artificial conditions. Penalty takers first indicated the location they consciously perceived as the exact center of the goal. Goalkeepers then positioned themselves at this position after which penalty takers carried out a penalty kick. Because human observers typically make systematic errors in perceiving the midpoint of line, the goalkeeper never stood in the true center of the goal. Yet and notwithstanding the fact that goalkeepers stood at the perceived middle of the goal, the penalty takers more often choose to kick to the goal side with more space, except when the penalty taker had employed a keeper dependent strategy and the goalkeeper moved relatively early. In short, the off-center effect also arises in more representative, complex and information-rich environments.

The pervasiveness of the off-center offers an opportunity to examine the impact of conscious and unconscious perceptions on decision-making in more complex, dynamic environments than the regularly used abstract stimuli on a monitor. Hence, two studies were carried out to test predictions of the increasingly influential taxonomy of (un)conscious perception processes by Dehaene and colleagues. The taxonomy holds that the involvement of conscious and unconscious perceptual processes depends on (a combination of) stimulus strength and top-down attention directed to the stimulus. In a first study this contention was examined using a modification of the line bisection task, which is an often-used paradigm in the cognitive sciences. The participating players had to direct the goalkeeper to exact center of the goal to then carry out a penalty kick. In the second study, participants only performed the penalty kick if they perceived the goalkeeper to stand in the exact center of the goal, which is a variant of landmark discrimination task. Both studies showed that the off-center effect results from differences in sensitivity of the conscious and unconscious perceptual processes. That is, in both studies systematic spatial errors were found for initial conscious perception of the position of the goalkeeper, while for the subsequent decision to kick to the left or right side the unconscious perceptual processes did get access to accurate information.
on the true position of the goalkeeper or the relative size of the goal areas to the left and right side of the goalkeeper. Importantly, both studies underlined that stimulus strength (i.e., the size of the displacement of the goalkeeper from the center of the goal) influenced the discrepancy in the accuracy of conscious and unconscious perceptual processes. This supports a pertinent prediction from the taxonomy of Dehaene and colleagues for relatively complex and dynamic environments.

The second important prediction of the taxonomy is that the degree of attention toward the stimulus (displacement of the goalkeeper or the relative size of the space to left and right of the goalkeeper) affects the interaction of conscious and unconscious perceptual processes (and hence the extent of the off-center effect). This conjecture was tested in a different sport environment, namely, the beach volleyball serve. In beach volleyball receiving players normally positioned themselves such that they divide the court in three areas of the same size. In this final study, one of the receiving players was displaced in such a way that one of the three areas was marginally larger than the other two areas. Different instructions were used to direct participants’ attention either toward or away from the position of receiving players. The off-center effect arose for both instructions, emphasizing that the effect also occurs in more complex environments than penalty kicking, but also that the extent of the off-center effects is reduced when participants deliberately pay attention to the players’ positions (i.e., the stimulus of interest) while deciding to what area to serve. This supports the second prediction from the taxonomy by Dehaene and colleagues.

11. Samenvatting

Recent onderzoek heeft verschillende factoren geïdentificeerd die van invloed zijn op het gedrag en het succes bij het nemen van een strafschop. Dit zijn bijvoorbeeld mentale factoren zoals de wijze waarop de schutter omgaat met stress, de waarneming (inclusief het