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## Diffusion, Reinforcement, Geopolitics, and the Spread of War

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# Diffusion, Reinforcement, Geopolitics, and the Spread of War

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*The discussion reports the results of an examination of the possible diffusion of new war participations during the 1946–65 era. A theoretical argument is developed to yield more precise expectations about when, where, why, and how diffusion processes might operate. Four diffusion-related processes (positive spatial diffusion, positive reinforcement, negative spatial diffusion, and negative reinforcement) are discussed and analyzed. A series of simple turnover tables and a focus on nations' borders are used to go beyond the authors' previous stochastic modeling efforts. The results provide strong evidence that is consistent with both the authors' theoretical argument and the general war diffusion hypothesis. The analyses seem to indicate that certain types of wars may indeed have tended to diffuse across space from one nation to another between 1946 and 1965.*

The notion that an event may alter the probability of subsequent events through diffusion or contagion processes is not new. The work of scholars on a variety of topics suggests that wars may also diffuse.<sup>1</sup> As Rapoport (1960) observes,

international conflicts may spread from one nation to another in patterns that are similar to those followed by contagious diseases. Participation in war at one point in time may affect the likelihood of subsequent war participations. The French retreat from Indochina, the Middle East and Africa as one after another of its colonial possessions erupted in wars of independence may be one example of such a process. The involvement of South Africa in Angola and the intervention of both Israel and Syria in the Lebanese Civil War may be others.

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Most of the analyses of the causes of war have ignored the theoretical and empirical evidence that at least some wars have significant consequences for subsequent conflicts. Only a small number of analysts have focused on the war diffusion possibility, and such work has failed to do more than scratch the surface of the problem.<sup>2</sup>

<sup>1</sup>Scholars such as Naroll (1961, 1965, 1973), Lieber-son and Silverman (1965), Walker (1969), Spilerman (1970), Midlarsky (1970, 1974a, 1978), Gillespie (1970), Gray (1973), Job (1973), Most (1973), Collier and Messick (1975), Li and Thompson (1975), Siverson and Duncan (1976), Ross and Homer (1976), Eyestone (1977) and others have examined the diffusion of phenomenon such as race riots, coups and other types of domestic violence, alliance behaviors and policy innovations. The possibility that wars may similarly diffuse is suggested in research on the cyclical patterns in the onset of war and the amount of war that is underway in the system at any given point in time (Moyal, 1949; Wright, 1965; Denton, 1966; Denton and Phillips, 1968; and Singer and Small, 1972), the linkages between the international environment and foreign policy (Rosenau, 1969, 1971; Wilkenfeld, 1973), the impact of external conditions on violence within nations (Stohl, 1975), the relationship between domestic violence and foreign policy actions (Wilkenfeld, 1968, 1969, 1972) and research on arms races (Richardson, 1960a; North, Brody and Holsti, 1964; Zinnes, 1976; and Alcock, 1972). 1972).

<sup>2</sup>See, for example, Richardson (1960a, 1960b), Singer and Small (1974), Starr and Most (1976), Davis, Duncan and Siverson (1976, 1978), and Yamamoto and Bremer (1976). Richardson (1960b) investigated whether or not wars occurred randomly through time. Singer and Small (1974) probed whether the acceptance of war leads to more war, but their analysis focused on reinforcement patterns within nations rather than on diffusion from one nation to another. Siverson and Duncan (1977) used fairly sophisticated stochastic models to examine diffusion/reinforcement processes as they affected the temporal clusters of warring dyads drawn exclusively from the international wars included in the Correlates of War data set. These studies are similar to this article and our own earlier war diffusion research, but they are also sufficiently distinct from our work that comparative evaluations are precluded. Differences in the data sets used,

**The Argument**

The general war diffusion hypothesis concerns the possibility that the occurrence of one new war participation will alter the probability of subsequent occurrences. It is helpful, however, to disaggregate this general hypothesis in order to distinguish the four following diffusion-related processes:

*Positive Reinforcement:* The process in which the occurrence of a new war participation in a nation *increases* the likelihood that the *same* nation will experience subsequent war participations;

*Negative Reinforcement:* The process in which the occurrence of a new war participation in a nation *decreases* the likelihood that the *same* nation will experience subsequent war participations;

*Positive Spatial Diffusion:* The process in which the occurrence of a new war participation in a nation *increases* the likelihood that *other* nations will experience subsequent war participations; and,

*Negative Spatial Diffusion:* The process in which the occurrence of a new war participation in a nation *decreases* the likelihood that *other* nations will experience subsequent war participations.

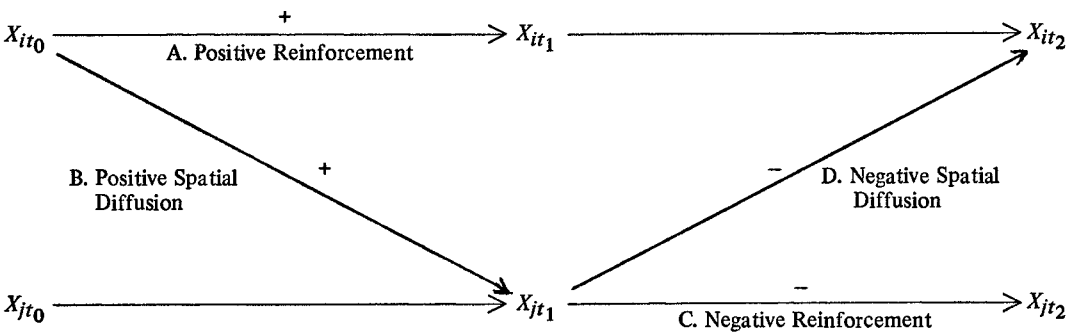
That all four of these processes are related to the general war diffusion hypothesis should be clear. In each, a war experience at one point in time affects the probability of subsequent conflicts. Positive reinforcement (see path A in Figure 1) is a within-nation, temporal diffusion process. It is an historical possibility: A nation's decision to go to war at some time increases the probability that it will make a similar decision at some subsequent time. Positive spatial diffusion (path B in Figure 1) more directly entails the transfer of one nation's war behavior to *other* nations. The two remaining possibilities—negative reinforcement (path C) and negative spatial diffusion (path D)—are somewhat more difficult to deal with because the researcher is placed in the awkward position of trying to analyze "events" that do not occur. It is, nevertheless, entirely plausible that such processes operate. Just as the toppling of the Allende government in Chile at least temporarily led Latin Americans in other nations to forestall coup efforts of their own, a nation's own war experiences or its interpretation of the war experiences of others may discourage a nation from going to war.

**Intra-Nation Reinforcement Processes**

Some initial assumptions can be made about the possible linkages between a nation's own war experiences at one time and some subsequent time:

1. The decision makers in any nation are confronted by an "operational milieu" (Sprout and Sprout, 1965, p. 30) that comprises the risks and opportunities that effectively impinge on the nation in question;

in the units of analysis examined, in the ways in which distinct phenomena are hypothesized to diffuse, and in basic questions and methodologies indicate that there is very little overlap with our discussion.



Source: Prepared by the authors.

Key: X = War behavior of nations i and j, respectively, at times t<sub>0</sub>, t<sub>1</sub>, and t<sub>2</sub>.

Figure 1. Diffusion-Related Processes

2. The operational milieu (and hence, the perceived risks and opportunities) may change through time, and such changes may induce decision makers to reassess their situations;
3. If decision makers are to protect themselves from the risks or avail themselves of the opportunities they perceive in their environment, they must possess both the capacity and the willingness to do so (Starr, 1978); and,
4. Just as changes in decision makers' operational milieus may alter their perceptions of the risks and opportunities, changes in the perceived environment may also result in changes in decision makers' willingness to undertake particular policies in response to the risks and opportunities confronting them.

The importance of these assumptions can be demonstrated by considering Boulding's "theory of viability" (1962, Ch. 4). Focusing on zones in which a nation is dominant ("unconditionally viable") and dominated ("conditionally viable"), Boulding argues that a nation will increase its defense expenditures in an effort to expand the first area and contract the second. Decisions to arm or disarm at one time thus have some effect on a nation's zones of unconditional and conditional viability at some later time.

The point to be noted, of course, is that an armaments decision is only one factor that may alter a nation's zones of unconditional and conditional viability, and hence, its decision makers' perceptions of risks and opportunities. Similar linkages can be posited to relate a nation's recent and future war behavior. Regardless of whether a nation wins or loses an initial conflict, the conflict may have some impact on that nation's viability zones. The fighting should induce the leaders of a warring (or a recently warring) nation to reassess risks, opportunities, and policy options. This reevaluation may alter the probability that the nation will soon take up arms again.

Losing a war, for example, may shift a nation from being unconditionally viable at its home to being only conditionally viable and may result in positive reinforcement. A defeat may frustrate a nation's leaders and encourage them to avenge the loss, recoup national pride, recover lost territory, and so on by waging a subsequent conflict (e.g., Germany's reaction to World War I and the Arab nations' reaction to successive Israeli victories in the Middle East). The shift from unconditional to conditional viability could also produce a negative reinforcement effect. An initial loss might decrease the likelihood of subsequent wars by reducing a nation's fighting capacity, increasing the nation's fear of war, or persuading leaders of the futility of the war option (e.g., Japan since World War II).

A victory which shifts a nation from being conditionally viable at its home to being unconditionally viable could produce similar results. In a process of positive reinforcement, success may embolden a nation's leaders—see Blainey's (1973) notions of "confidence" and "optimism"—and thereby stimulate their entry into subsequent conflicts (e.g., Hitler at the outset of World War II or the Vietnamese and their decision to attack Kampuchea). Alternatively, an initial victory may produce negative reinforcement and decrease the likelihood of subsequent wars if leaders are satiated or the nation's dominance over some territory is secured (e.g., wars of colonial conquest and national expansion or integration).

These scenarios could be extended, of course. The Vietnam defeat clearly did not shift the United States from a state of unconditional to conditional viability at its home, for example. Nevertheless, that conflict may have had a negative reinforcement effect insofar as it apparently induced the U.S. to forego subsequent overt war participations in Angola and Ethiopia. Despite the relative simplicity of these scenarios, however, their point should be clear: Just as a nation's decision to arm at one point in time may affect that nation's risks and opportunities and hence its armaments decisions at some subsequent time, fighting a war may have similar impacts. Because a war at one time will alter the risks, opportunities, and policy options facing decision makers, the likelihood that they will decide to become involved in another conflict may also be shifted.

### Inter-Nation Spatial Diffusion Processes

The possible operation of intra-nation reinforcement processes seems clear in comparison with inter-nation spatial diffusion effects. Even if a war participation by one nation alters the probability that other nations will become involved in wars, it seems unreasonable to expect that a new war participation by Cambodia, for example, would have more than a negligible impact on Bolivia's decision calculus. At a minimum, it seems more reasonable to hypothesize that *if* wars tend to diffuse, the process is most likely to operate among those nations that share high levels of *interaction*. In other words, it is plausible that spatial diffusion processes exist, but they may operate only within those groups of nations that interact most strongly rather than at the global level.

The difficulty, of course, is that nations interact with each other in different ways. Nevertheless, simple *geographic proximity* seems to constitute a very basic and at least initially useful basis for identifying those groups of interacting nations

within which diffusion processes are most likely. The importance of geographic proximity in determining the amount of interaction between nations and how it may create awareness, risks and opportunities have been discussed extensively by Zipf (1949), Richardson (1960a, p. 176), Gleditsch (1969), Gleditsch and Singer (1970), Weede (1970, 1973, 1975), Cobb and Elder (1970, p. 89), Pearson (1974), Starr (1975), and Garnham (1976). Nations that are "close" to one another in terms of distance are likely to interact and perceive each other's conditions and behaviors as important.

Simple distance—and especially the commonly used distance between nation's capitals—may not be the most useful indicator of the interaction/proximity concepts, however. As we have argued elsewhere (Most and Starr, 1975, 1976), it seems preferable to operationalize the concepts on the basis of shared borders. Nations possess both non-colonial frontiers (those that exist directly between nations) and colonial borders (those that exist indirectly between nations as a result of their colonies or territorial possessions). Simple distance measures and non-colonial borders seem roughly analogous. What the distance operationalization overlooks, however, is the possibility that even distant nations may interact with one another as a result of their colonial or territorial extensions. More important, a nation that borders on a large number of other nations is faced with a potentially high risk that it may be threatened or attacked by at least some of its neighbors. At the same time, of course, nations bordering on many other nations are provided with numerous opportunities for launching attacks of their own (Starr, 1978).

Two of the existing treatments of geographic proximity (as measured either by "short" distance or shared borders) are worthy of note. The first is Boulding's above-mentioned theory of viability (1962, Ch. 4). Boulding argues that the "power" of some entity is greatest at home and that the increases in the cost and time necessary to transport that power cause it to diminish along a "loss of strength gradient" (LSG) as the distance from home is increased. Each nation possesses some home strength in Boulding's formulation, and that strength is affected by the LSG. Hence, the LSGs of different nations overlap, thereby creating the zones of unconditional and conditional viability.

Arms races develop in Boulding's formulation because a nation that is unsatisfied either with the area in which it is dominant (its "sphere of influence") or with the area in which it is dominated begins to increase its home strength by arming. This will expand that nation's zone of unconditional viability, but at the same time it will expand the area in which neighboring nations are condi-

tionally viable. In response, those proximate nations may also begin to arm in order to reduce *their* areas of uncertainty and risk. In contrast, distant nations would be less likely to perceive a threat in increasing armaments because any increases would be offset or reduced by distance.<sup>3</sup>

According to Boulding's key tenet, "the further the weaker," one would expect that proximate nations would be perceived as more threatening than distant ones. Nations possessing many neighbors are given many targets or opportunities to use their power without being greatly affected by distance. At the same time, however, such nations are confronted with great risks and uncertainty because they must protect and defend themselves against many potential opponents. Nations with many close neighbors thus might seek to reduce their uncertainty by arming, by forming alliances, or by going to war.

Midlarsky's investigation (1974b, 1975) of the role of uncertainty in the occurrence of war brings one to a similar conclusion by an alternative route. In a variation of the frustration-aggression theory of violence (1975, pp. 37-38), Midlarsky argues that nations desire to reduce uncertainty, but they may be constrained from doing so even when they have the necessary capabilities. Political violence is more probable when such a nation is constrained and uncertainty not only cannot be reduced but actually grows. As Midlarsky and others hypothesize, more bordering nations may create more uncertainty by reducing control over the environment and nations may go to war to reduce uncertainty.

One should be extremely cautious in considering the relationship between borders and uncertainty. More borders may indeed contribute to increased interaction among nations, more opportunities for possible attack, greater risks of attack, and heightened levels of uncertainty, but it is unlikely that borders cause wars in a deterministic sense. It is more plausible to expect that they may—probably in combination with other factors—create structures of risks and opportunities that constrain the range of possible inter-nation interactions and make certain types of conflictual behavior more or less likely.

The important point, however, is that each nation's structure of risks and opportunities is likely to be changed once a war is under way and these changes may be most dramatic for those nations which are proximate to the warring nations. Two nations may wage a war to reduce their own uncertainty, but the fact that they are reallocating and expending some of their "power" in the

<sup>3</sup>For a more formal summary of Boulding's thesis by two geographers, see Cox and Agnew (1974).

fighting may alter their immediate neighbors' uncertainty, LSGs and zones of conditional and unconditional viability. For example, if a nation shifts from conditional to unconditional viability as a result of a war between other nations, it may join the conflict or initiate a war of its own in a process of positive spatial diffusion. Negative spatial diffusion might also develop in such a situation. Nations which would have gone to war in the prewar period may no longer need to do so if a war is initiated by other nations.

### Recapitulation

In summary, we have the beginnings of an argument that may explain when, where, why, and how new war participations at one point in time may alter the likelihood of subsequent occurrences in either the same (reinforcement) or different (spatial diffusion) nations. The thesis is not deterministic. Factors affecting decision makers' willingness to avail themselves of opportunities are omitted. Other factors that might also be related to war reinforcement and spatial diffusion patterns are not included.

While the linkages are neither complete nor fully specified, the basic outlines of the argument should be apparent. As Boulding and Midlarsky suggest, borders do not cause wars but the more borders a nation has,

1. the greater the number of risks and opportunities that confront that nation;
2. the greater the likelihood that that nation or its colonial or extra-territorial extensions will be only conditionally viable; and
3. the greater the level of that nation's uncertainty.

If nations are conditionally viable or have high levels of uncertainty, they should have a high likelihood of:

4. arming and becoming involved in arms races; and
5. going to war.

*Regardless* of why a "first war" is begun, however, that initial conflict may change the world for its participants and their immediate neighbors. The warring (or recently warring) nations and the countries bordering them may find themselves confronted with changed levels of uncertainty and altered viability zones. Depending on the nature of those changes and on the willingness of the decision makers in each nation to avail themselves of the risks and opportunities presented by the altered situation, the shifts in levels of uncertainty and viability zones may induce these nations to:

6. participate in wars that they had no intention of waging in the prewar context; or
7. forego their participation in wars that they had intended to fight before the first conflict began.

Recent events in Indochina may exemplify at least some of these effects. Having fought and eventually won wars against France and the U.S., the Vietnamese may have been encouraged or emboldened—in what we call a reinforcement process—to attack Kampuchea. The effects of that war may have altered Chinese perceptions and been instrumental in inducing them—in a spatial diffusion process—to launch their own attack against Vietnam.

While the empirical evidence and a new theoretical rationale seem sufficient for investigating the war diffusion possibility, a new attack on the problem is buttressed by a second set of considerations. Most analyses of the causes of war have ignored the diffusion/reinforcement possibility and assumed that each occurrence of war was independent of all other occurrences. Such an omission may be significant. If strong diffusion/reinforcement processes undermined the validity of the standard parametric statistical assumption of the independence of observations and such processes went unrecognized, then spurious correlations may have been obtained between systemic variables or national attributes, for example, and the amount of war (Naroll, 1965). The results of correlation and ordinary least squares (OLS) regression analyses may have been misinterpreted. The standard tests of significance may have been invalid. The sampling variances of the estimates may have been underestimated. The predictions obtained from OLS regressions may have been inefficient (Johnston, 1972, p. 246). Simply, the development of theories about the causes of war *may* have been impeded as a result of strong (but unrecognized) diffusion/reinforcement processes. Wrong decisions may have been made about which variables to retain and which to exclude from subsequent analysis.

For these theoretical and methodological reasons, a more thorough investigation of the diffusion/reinforcement argument seems warranted. The initial efforts to test certain aspects of that formulation are presented below.

### The Analyses

**Preliminary Findings.** In a series of earlier studies, two stochastic models—a simple Poisson model of random or independent occurrences and a Modified Poisson with diffusion model—were used to focus on the possibility that reinforcement or spatial diffusion processes influenced nations'

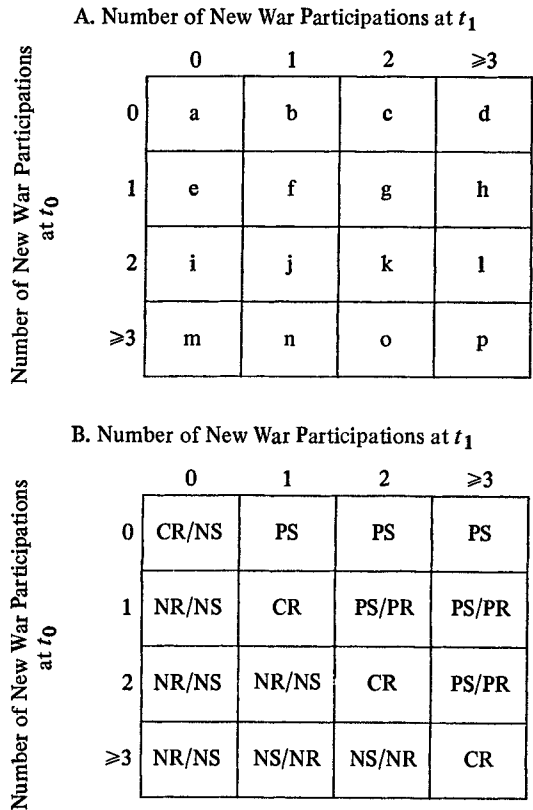
participations in wars between 1946 and 1965 (Most and Starr, 1976, 1977). Following a rationale for a comparative focus on three sets of war data and a discussion of the various advantages of each (Most and Starr, 1976), we drew data from: the Correlates of War (COW) project (Singer and Small, 1972, Ch. 2); a combined Wright and Richardson (WR) list as presented by Singer and Small (1972, Ch. 5); and the list of 53 wars reported in SIPRI (1970, Table 4A.1) for which there was at least some reported Richardson magnitude of deadliness.

The conclusions drawn from those analyses were fairly straightforward. Application of the Poisson/Modified Poisson procedures to the COW new war participations during the 1946-65 period yielded no evidence that such events had tended to diffuse. When identical procedures were applied to the SIPRI new war participations, however, the evidence was consistent with the proposition that such occurrences had tended to diffuse and that the nations that existed as of 1945 had had heterogeneous propensities to engage in such conflicts. Finally, tests on the WR data failed to provide clear conclusions either for or against the diffusion possibility.

These findings were intriguing, if not entirely conclusive. That such divergent results could be obtained from different, commonly used data sets had clear implications for scholars interested in the causes of war. The time may have come to develop a consensus about just what constitutes such a conflict. Even though the three war data sets overlap to a certain extent and thereby preclude any firm conclusions, the preliminary analyses provided some support for the contentions that different types of war may exist and that the dominant type of war may have changed through time (Kende, 1971; Starr, 1976). Even when allowances were made for the differences in the nations' rates of proneness to events, preliminary studies suggested that different types of conflicts may have had different propensities to diffuse.<sup>4</sup> The most important result from the pilot analyses, however, was that the diffusion problem could not be simply ignored. The theoretical argument was clearly not confirmed, but it was also quite clear that—under certain conditions—at least some war participations might not have been

mutually independent during the 1946-65 period. If the argument was not verified, it was not rejected either. Further examination of the diffusion possibility seemed warranted.

The new analyses reported here are not meant as an exhaustive test of the theoretical formulation; they simply focus on the more important facets of that argument. Once again taking a nation's new war participations during the 1946-65 period as the objects of the analysis (as reported by the COW, WR, and SIPRI lists) the new studies abandon the use of stochastic models and use two much simpler sets of procedures.



Source: Prepared by the authors.

Key: CR = Constant Rate  
 PS = Positive Spatial Diffusion  
 PR = Positive Reinforcement  
 NS = Negative Spatial Diffusion  
 NR = Negative Reinforcement

Figure 2. Turnover Tables: Expected Patterns under the Four Diffusion/Reinforcement Hypotheses

<sup>4</sup>The evidence is only preliminary, but it appears at this stage that large-scale interstate wars such as those tapped by the COW list did not tend to spread during the interval. In contrast, the evidence is consistent with the hypothesis that small-scale, guerrilla and colonial conflicts (such as those that dominate the SIPRI list) may have diffused quite readily. This is merely a working hypothesis, however.

**The Turnover Tables.** Potentially valuable insights on the diffusion problem can be obtained by considering simple turnover tables or transition matrices (see Figure 2A). If a nation had no war experience in some interval and none in a second period, it would fall into cell "a." If a nation had two occurrences in the first period and none in the second, it would fall into cell "i," and so on.

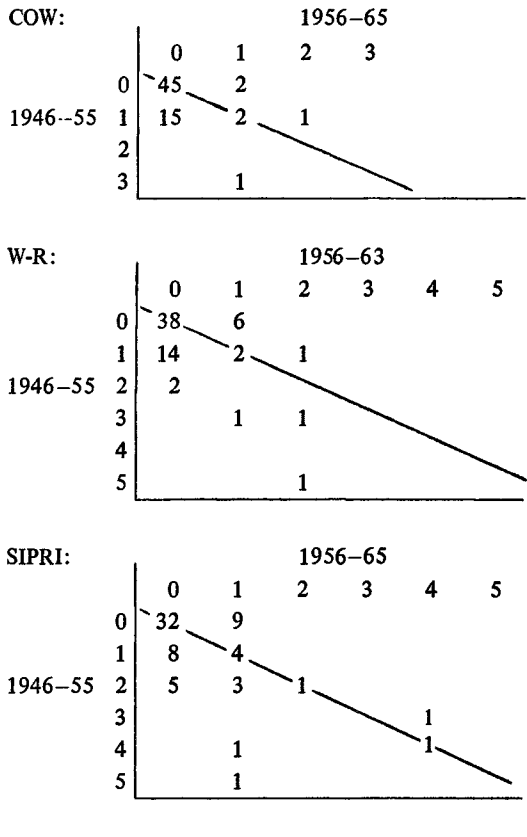
Using tables of this sort make it possible to develop expectations about where nations "should have fallen if" one or another of the four processes was operating. (A number of these expectations, developed originally in Most (1973) and Most and Starr (1975, 1976), are shown in Figure 2B and Table 1). There is some convergence in these expectations, of course, making it impossible to distinguish completely between positive reinforcement and positive spatial diffusion. Similar problems will be encountered in handling the two negative alternatives. Even with these overlaps, however, the expectations are sufficiently distinct to permit at least a modest step toward distinguishing among the four processes.

The application of these procedures begins with a comparison of new war participation experiences between ten- and five-year periods: 1946-55 versus 1956-65, and 1956-60 versus 1961-65 (see Figures 3 and 4). (Figure 3 concerns only those nations that Singer and Small (1972) classed as members of the international system during the entire 1946-65 interval. Figure 4 considers only those nations that were system members during the entire 1956-65 period.)

The results of these simple turnover procedures are summarized in Table 2. Regarding the comparison of the two ten-year periods (1946-55 versus 1956-65), it is immediately apparent that the expectations for positive reinforcement and positive spatial diffusion are generally not satisfied in any of the three data sets. Almost no signs of positive reinforcement appear, and there is only weak evidence of positive spatial diffusion. The results obtained for the second positive spatial diffusion expectation should not be completely overlooked, however. Three points should be noted. First, the nations that are included in this set of ratios fall precisely in the areas in which the positive spatial diffusion and positive reinforcement arguments *do not* overlap (see Figure 2B). Of the two positive possibilities, only positive spatial diffusion can account for the patterns observed. Second, these ratios are low—4.2 percent (2 of 47) for the COW data, 13.6 percent (6 of 44) for the WR data, and 22.0 percent (9 of 41) for SIPRI—and quite clearly do not strongly support the conclusion that at least the SIPRI new war participations tended to diffuse from one nation to another during the 1946-65 period. Nevertheless, the progression from COW to WR to SIPRI in the magnitude

of these ratios does once again suggest that SIPRI (rather than COW) new war participations were more likely to diffuse.

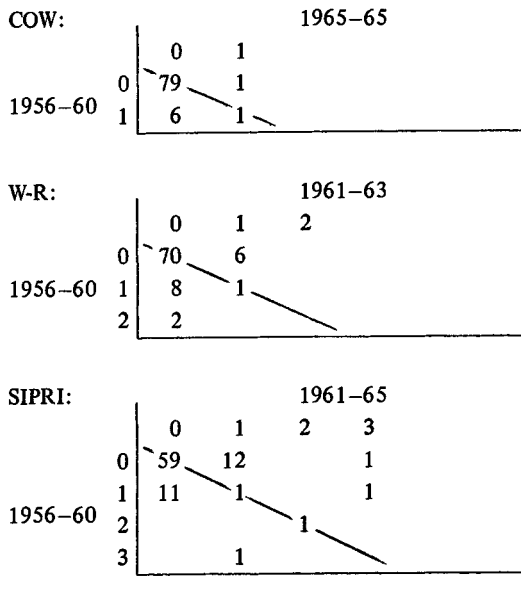
It should be emphasized, however, that neither the positive spatial diffusion nor the positive reinforcement arguments provide an accurate description of the overall patterns observed in the turnover tables. It is difficult to determine whether negative spatial diffusion or negative reinforcement provides a better accounting for those patterns, although the negative spatial diffusion possibility appears more likely. Leaving that consideration aside, however, the important point is that the Poisson/Modified Poisson procedures failed to tap such negative tendencies. This analysis indicates that nations that were at peace generally tended to remain at peace. Nations that were at war in one period may have had higher rates of proneness to subsequent new war participations, but they appear to have followed some natural "regression" toward (if not actually to)



Source: Prepared by the authors.

Figure 3. Turnovers in the Number of New War Participations, 1946-55 vs. 1956-65





Source: Prepared by the authors.

Figure 4. Turnovers in the Number of New War Participations, 1956-60 vs. 1961-65

peace, becoming involved in fewer war participations in subsequent intervals.

Those findings generally hold up, moreover, when the 1956-60 period is contrasted with the 1961-65 interval. The exception is the slight shift that may be observed in the SIPRI data set. Of the 15 nations experiencing at least one SIPRI new war participation between 1956 and 1960, 12 (80.0 percent) had fewer new war participations during the 1961-65 period. Hence, the negative trend is once again dominant, although to a lesser extent. At the same time, however, the positive spatial diffusion inequality is satisfied: The number of nations with no new war participations between 1956 and 1960 is greater than those having none between 1961 and 1965. In addition, 18.0 percent (13 of 72) of those nations with no new war participations in the first interval had at least one such event in the second period. (Although that percentage is smaller than the comparable one obtained when the two ten-year periods were contrasted, only 9 nations made the transition from peace to new war participations. The marked difference between the number of nations that were initially at peace in the two SIPRI turnover tables is at least partially accounted for by the fact that the five-year period comparison permits an increase in the number of nations from 66 to 87.)

In summary, while negative spatial diffusion or negative reinforcement tendencies may have influ-

enced those nations with at least one new war participation between 1956 and 1960, a positive spatial diffusion effect may have operated on those nations that had no new war participations between 1956 and 1960.

These simple turnover table analyses have not demonstrated, of course, that any of the four processes actually did operate. When an expected pattern was not observed, as in the case of positive reinforcement, it is legitimate to conclude that the process in question did not operate. When expectations were satisfied, however, similar categorical statements cannot be made. Nevertheless, the application of even these simple approaches has shown that *patterns that are consistent with* initial assumptions of negative spatial diffusion, negative reinforcement, and, to a lesser extent, positive spatial diffusion can be observed empirically.

Such demonstrations are not unimportant. They weaken the Poisson/Modified Poisson conclusion that at least the SIPRI new war participations tended to diffuse quite readily from one nation to another, even though some evidence was consistent with the positive spatial diffusion hypothesis. These simple analyses provide insight into an area almost completely untapped by our preliminary studies; namely, that rather strong negative spatial diffusion and negative reinforcement processes may have discouraged nations from beginning new war participations.<sup>5</sup>

One other point should be made. Both the Poisson/Modified Poisson and turnover table analyses focus on possible diffusion phenomena where such processes are the *least likely* to operate. The results are therefore somewhat surprising. Both sets of procedures yield some evidence that is consistent with the hypothesis that the diffusion/reinforcement processes were operating even at the global level where the theoretical argument predicted that the influence of those effects would not be particularly strong.

#### Diffusion Among Sets of Interacting Nations.

The theoretical formulation developed above suggests that diffusion/reinforcement processes should be most likely to operate—if indeed they operate at all—at a group level among those nations that share high levels of interaction. As we

<sup>5</sup>At the same time, the applications of these turnover tables have provided at least a partial escape from two limitations of the Poisson/Modified Poisson approach. It has been shown, for example, that these analyses can yield results that are generally consistent over at least ten- and five-year periods of aggregation, and that they can be applied to focus on different numbers of nations. Moreover, these tests have shown that it is at least partially possible to distinguish among the four alternatives under consideration.

have argued, nations close to one another or sharing some common border should interact and demonstrate high levels of mutual awareness. If this is the case and if new war participations do actually diffuse, then it seems reasonable to expect nations with a nation at war on their border at a given time will have a higher propensity to become involved in new war participations at some later time than those nations whose bordering nations

are initially at peace. In other words, one would expect nations to catch "the war disease," to borrow Alcock's (1972) phrase, if they border on a nation already stricken with the malaise.

As a first step toward testing this border operationalization of the general diffusion argument, we coded each nation in the international system for the number of borders it possessed in each year between 1945 and 1965. While details on

Table 1. Diffusion/Reinforcement Hypotheses and Empirical Expectations

#### Positive Reinforcement

*Expectation:* The ratio between (a) the number of nations which participated in at least one war at  $t_0$  and which participated in a greater number of wars at  $t_1$  than at  $t_0$  and (b) the number of nations which participated in at least one war at  $t_0$  approaches 1.00.

*Rationale:* If positive reinforcement is operative, then one would expect:

That if a nation was involved in one or more wars at  $t_0$ , it will have been involved in even more wars at  $t_1$ .

#### Positive Spatial Diffusion

*Expectations:*

- a. The number of nations not participating in any war at  $t_0 >$  the number of nations not participating at  $t_1$ ;
- b. The ratio between (a) the number of nations which participated in zero wars at  $t_0$  and which participated in at least one war at  $t_1$  and (b) the number of nations which participated in zero wars at  $t_0$  approaches 1.00; and
- c. The ratio between (a) the number of nations which participated in a greater number of wars at  $t_1$  than at  $t_0$  and (b) the total number of nations approaches 1.00.

*Rationale:* If positive spatial diffusion is operative, then one would expect:

1. That if a nation was involved in one or more wars at  $t_0$ , it will have been involved in even more wars at  $t_1$ ; and,
2. That even if a nation was not involved in any wars at  $t_0$ , it could still become involved in a war at  $t_1$ .

#### Negative Reinforcement

*Expectation:* The proportion between (a) the number of nations which participated in at least one war at  $t_0$  and which participated in a smaller number of wars at  $t_1$  than at  $t_0$  and (b) the number of nations which participated in at least one war at  $t_0$  approaches 1.00.

*Rationale:* If negative reinforcement is operative, then one would expect:

That if a nation was involved in one or more wars at  $t_0$ , it will have been involved in fewer wars at  $t_1$ .

#### Negative Spatial Diffusion

*Expectations:*

- a. The number of nations not participating in any war at  $t_0 <$  the number of nations not participating in a war at  $t_1$ ;
- b. The ratio between (a) the number of nations which were not participating in any war at either  $t_0$  and  $t_1$  and (b) the number of nations not participating in any war at  $t_0$  approaches 1.00; and
- c. The ratio between (a) the number of nations which participated in at least one war at  $t_0$  and which participated in a smaller number of wars at  $t_1$  than at  $t_0$  plus those which participated in zero wars in both periods and (b) the number of nations approaches 1.00.

*Rationale:* If negative spatial diffusion is operative, then one would expect:

That whether a nation is at peace or at war at  $t_0$ , it will refrain from becoming involved in any (or as many) wars at  $t_1$ .

these codings are available in Most and Starr (1975, 1976) and Starr and Most (1976, 1978), suffice it to say that they are based on a mutually exclusive and cumulative six-way classification scheme that taps the following types of international frontiers:

1. Non-colonial borders (those that exist directly between two members of the international system):
  - a. contiguous land borders
  - b. 200-mile limit water borders
  - c. proximity zone borders.
2. Colonial borders (those that indirectly exist between two members of the international system as a result of colonies or territorial possessions):
  - a. contiguous land borders
  - b. 200-mile limit water borders
  - c. proximity zone borders.

Additional yearly codings recorded each occasion in which any given nation shared some border with a second nation that was involved in a war. In this way, it was possible to calculate the total number of *warring border nations* that each nation had in each year between 1946 and 1965 and to construct simple contingency tables (see Figure 5).

Regarding the existence of a warring border nation as a "treatment" that nations either did or did not experience in any given year, this strategy

permits a focus on the following implicit transitions:<sup>6</sup>

1. From peace to peace with no border nations at war at  $t_0$  ( $a_{11}$ );
2. From peace to at least one new war participation with no border nations at war at  $t_0$  ( $a_{12}$ );
3. From peace to peace with at least one warring border nation at  $t_0$  ( $a_{21}$ ); and
4. From peace to at least one new war participation with at least one warring border nation at  $t_0$  ( $a_{22}$ ).

If the border operationalization of the positive spatial diffusion hypothesis holds, then two expectations should be satisfied:

<sup>6</sup>These exploratory analyses focus exclusively on nations that were at peace at  $t_0$ . Two considerations suggest the need for such a strategy. First, if a nation is already at war, that fact is likely to influence that nation's decision calculus more strongly than the simple existence of warring border nations. Second, a focus on those nations that were at peace at  $t_0$  permits an investigation of positive spatial diffusion in the only area in which the expectations from that hypothesis do not overlap with expectations from the positive reinforcement argument. Thus, a focus on those nations that were at peace at any given point in time serves to maximize the likelihood that evidence of the warring border nation operationalization of the positive spatial diffusion hypothesis will be isolated.

Table 2. Summary of Results Relating to the Four Diffusion/Reinforcement Hypotheses

	1946-55 vs. 1956-65						1956-60 vs. 1961-65					
	COW		W-R		SIPRI		COW		W-R		SIPRI	
	%	Ratio	%	Ratio	%	Ratio	%	Ratio	%	Ratio	%	Ratio
Positive Reinforcement Expectation	5.3	1/19	4.5	1/22	4.0	1/25	0.0	0/7	0.0	0/11	6.7	1/15
Positive Spatial Diffusion Expectation (a)	No*	-	No	-	No	-	No	-	No	-	Yes	-
Expectation (b)	4.2	2/47	13.6	6/44	22.0	9/41	1.2	1/80	7.9	6/76	18.0	13/72
Expectation (c)	4.5	3/66	10.6	7/66	15.2	10/66	1.1	1/87	6.9	6/87	16.1	14/87
Negative Reinforcement Expectation	84.2	16/19	86.4	19/22	72.0	18/25	85.7	6/7	90.9	10/11	80.0	12/15
Negative Spatial Diffusion Expectation (a)	Yes*	-	Yes	-	Yes	-	Yes	-	Yes	-	No	-
Expectation (b)	95.7	45/47	86.4	38/44	78.0	32/41	98.8	79/80	92.1	70/76	81.9	59/72
Expectation (c)	92.4	61/66	86.4	57/66	75.6	50/66	97.7	85/87	92.0	80/87	81.6	71/87

Source: Prepared by the authors.

Note: Calculations are based on the expectations shown in Table 1.

\*"Yes" and "No" entries denote whether or not the given expectation was or was not satisfied.

A. Number of New War Participations  $t_1$  to  $t_5$

		0	$\geq 1$
Number of Warring Border Nations $t_0$	0	$a_{11}$	$a_{12}$
	$\geq 1$	$a_{21}$	$a_{22}$

B. Number of SIPRI New War Participations, 1959–63

		0	$\geq 1$
Number of SIPRI Warring Border Nations, 1958	0	21	0
	$\geq 1$	45	14

Source: Prepared by the authors.

Figure 5. Contingency Table Format, with an Example Using SIPRI Data (for All Nations at Peace at  $t_0$ )

$$a_{22} > a_{12}$$

and

$$(a_{22}) / (a_{12} + a_{22}) \rightarrow 1.00.$$

In Table 3, the tests for these expectations are presented for the COW, WR, and SIPRI data sets. The first column denotes the appropriate  $t_0$  for each test. The second column identifies the five-year period, subsequent to  $t_0$ , during which new war participations were aggregated.

The results of these analyses show impressive evidence in support of the border operationalization of the positive spatial diffusion hypothesis. In the 43 five-year lags examined (15 each in COW and SIPRI; 13 in WR), the inequality is not satisfied only twice. Overwhelmingly, for all three data sets,  $a_{22} > a_{12}$ . In the same number of tests, the ratio dropped below .50 on only four occasions. (Of the two expectations delineated above, the ratio test is more likely not to be satisfied. The majority of the nations were always at peace. Hence, the implicit transition from peace to at least one new war participation under the condition of 0 warring border nations could carry a low probability and still cause a number of nations to make that shift.)

Perhaps the most useful summary of the test results, however, are the following comparisons of the mean transition rates:

$$\text{COW: } \bar{a}_{22} = .1499 \quad \bar{a}_{12} = .0303$$

$$(\bar{a}_{22}) / (\bar{a}_{12}) = 4.9472;$$

$$\text{WR: } \bar{a}_{22} = .1558 \quad \bar{a}_{12} = .0345$$

$$(\bar{a}_{22}) / (\bar{a}_{12}) = 4.5159;$$

$$\text{SIPRI: } \bar{a}_{22} = .1855 \quad \bar{a}_{12} = .0589$$

$$(\bar{a}_{22}) / (\bar{a}_{12}) = 3.149,$$

where the COW  $\bar{a}_{22}$  denotes the mean  $a_{22}$  obtained in the 15 five-year lag tests shown in Table 3, and so on.

Even though a nation has at least one warring border nation at some point in time, it should be evident that that nation will *not* necessarily participate in at least one conflict during the subsequent five-year period. Like lung cancer, wars are rare events. Nevertheless, just as in the relationship between smoking and cancer, having a warring border nation *does increase the odds* that a subsequent new war participation will occur within five years. On the SIPRI data set, those chances are increased over three times; on the WR data set, four and a half times; and on the COW data set, nearly five times.

We have again asked the question: What would the world “look like” if there were positive spatial diffusion? This question could best be answered by focusing on a group of nations that could not also be involved in positive reinforcement, those nations that had not been at war at some given time. These nations were submitted to a “treatment”—the presence or absence of warring border nations. The possible effects of this treatment are apparent. The presence of warring border nations may have increased a peaceful nation’s probability of going to war from three to five times.

### Conclusion

The empirical findings may be readily summarized under the procedures used in this and our earlier analyses:

**The Poisson/Modified Poisson Approach:** The application and subsequent testing of the Poisson and Modified Poisson models yielded no evidence that COW new war participations diffused from one nation to another between 1946 and 1965. When identical procedures were applied to the SIPRI new war participations, however, exactly the opposite findings were obtained: SIPRI new war participations apparently did diffuse from one nation to another during the 20-year period. Tests on the WR data failed to yield clear conclusions that diffusion processes were or were not operating.

Table 3. Tests of the Positive Spatial Diffusion/Warring Border Nation Hypothesis:  
Subsequent New War Participations for All Nations at Peace at Each Successive  $t_0$

Row Variable ( $t_0$ )	Column Variable ( $t_1$ to $t_5$ )	$a_{12}$	$a_{22}$	Ratio: $a_{22}/a_{12} + a_{22}$
A. Results Based on COW Data				
1946	1947-51	.000	.364	100.0
1947	1948-52	.128	.500	72.2
1948	1949-53	.083	.393	78.6
1949	1950-54	.103	.343	73.3
1950	1951-55	.000	.098	100.0
1951	1952-56	.000	.082	100.0
1952	1953-57	.000	.078	100.0
1953	1954-58	.000	.077	100.0
1954	1955-59	.052	.130	50.0
1955	1956-60	.063	.105	33.3
1956	1957-61	.000	.000	0.0*
1957	1958-62	.000	.027	100.0
1958	1959-63	.000	.026	100.0
1959	1960-64	.000	.026	100.0
1960	1961-65	.025	.000	0.0*
B. Results Based on WR Data				
1946	1947-51	.083	.313	93.8
1947	1948-52	.000	.292	100.0
1948	1949-53	.091	.196	90.0
1949	1950-54	.000	.231	100.0
1950	1951-55	.000	.020	100.0
1951	1952-56	.000	.098	100.0
1952	1953-57	.000	.094	100.0
1953	1954-58	.000	.096	100.0
1954	1955-59	.077	.128	62.5
1955	1956-60	.071	.158	66.7
1956	1957-61	.000	.118	100.0
1957	1958-62	.065	.170	81.8
1958	1959-63	.131	.185	38.5
C. Results Based on SIPRI Data				
1946	1947-51	.176	.300	80.0
1947	1948-52	.000	.209	100.0
1948	1949-53	.100	.163	87.5
1949	1950-54	.100	.217	90.9
1950	1951-55	.100	.061	75.0
1951	1952-56	.091	.167	88.9
1952	1953-57	.000	.170	100.0
1953	1954-58	.083	.200	90.9
1954	1955-59	.063	.172	90.9
1955	1956-60	.059	.180	91.7
1956	1957-61	.000	.123	100.0
1957	1958-62	.045	.172	90.9
1958	1959-63	.000	.237	100.0
1959	1960-64	.000	.186	100.0
1960	1961-65	.067	.226	93.3

Source: Prepared by the authors.

\*Zero New War Participations occurred in the lagged period. Such occurrences omitted from the error totals.

**The Turnover Table Analyses:** The turnover tables indicated that strong negative reinforcement and/or negative spatial diffusion processes may have influenced the subsequent war behavior of those nations that experienced at least one new war participation during the initial period. Although those tendencies dominated the results in all three data sets, they were strongest in the COW set and weakest in the SIPRI data. Some evidence to support the hypothesis of positive spatial diffusion was also isolated. Although it was weak in comparison with the above-mentioned negative effects, the strength of the positive spatial diffusion appeared to increase as one moved from the COW to the WR to the SIPRI data sets. No evidence of positive reinforcement was found in any of the analyses.

**The Contingency Table Analyses of the Warring Border Nation Operationalization of the Positive Spatial Diffusion Hypothesis:** These procedures yielded very strong evidence in support of the warring border nation/positive spatial diffusion hypothesis. While having a warring border nation clearly did not mean that a nation would necessarily have at least one new war participation in the subsequent five-year period, it certainly increased the probabilities that subsequent new war participations would occur. If the numbers of occasions in which the expectations were not satisfied were used as an index, those results were strongest on the SIPRI data and weakest in the COW set. However, calculation and comparison of mean transition rates indicated that having a warring border nation increases the likelihood that a subsequent new war participation would occur over three times on the SIPRI set and nearly five times on the COW data.

Clearly, further effort is required to synthesize these findings. Different types of wars appear to have different propensities to diffuse, but further exploration of this problem will require the development of new data sets that make more precise distinctions between large- and small-scale conflicts. It will be necessary to probe whether or not different types of borders tend to drive diffusion processes and whether or not major and minor power nations tend to react in similar ways to wars on their frontiers. It will be important to investigate whether warring border nations have varying impacts on nations that are themselves at peace and war. Finally, it may be of interest to consider other, non-border-related operationalizations of the general theoretical argument with a view toward exploring whether factors such as alliance partnerships, trading unions, and linguistic affinities might also define sets of interacting na-

tions within which diffusion processes might operate.

In lieu of such additional work, however, our argument is generally supported by the existing results. War participations during the 1946-65 period do indeed seem to have altered nations' levels of uncertainty and their zones of unconditional and conditional viability. Much like arms races, wars appear to have caused leaders to reassess the situations confronting them. The evidence is consistent with the proposition that conflicts at one point in time affect leaders' decisions to participate in or refrain from subsequent wars. The evidence is weakest in the global-level stochastic modeling analyses; as predicted, it is most apparent in the examination of diffusion processes among groups of bordering nations. With only one exception, however, the analyses yield results that are consistent with the argument. The occurrence of a new war participation by one nation during the 1946-65 period did alter the probability that: (a) that same nation would experience subsequent new war participations, and (b) other nations would experience subsequent new war participations.

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