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Ringelmann Rediscovered: The Original Article

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A current focus of research on individual versus group performance is *social loafing,* the decrease in individual effort that occurs when the individual works within a cooperative group rather than alone. Theory and research on this issue have been strongly influenced by results reported in Moede (1927) and attributed to Ringelmann. Despite the importance and frequent citation of Ringelmann's study, the location of his original report has been a mystery. In this article Ringelmann's original article is discussed and described in detail. Ringelmann was a French agricultural engineer who gathered his data in the 1880s. He (Ringelmann, 1913b) reported the performance of human workers as a function of the method that the workers used to push or pull a load horizontally. Comparison of individual and group performance was a secondary interest in this experiment. Ringelmann interpreted the obtained decrement in group performance in terms of coordination loss, although he was also aware of motivational factors. Ringelmann's results are briefly related to contemporary theory and research.

For decades social psychologists have been studying the effects of group membership on individual performance (e.g., Allport, 1924; Dashiell, 1930; Triplett, 1898; Zajonc, 1965) and the difference between individual and group performance (e.g., Hill, 1982; Laughlin, 1980; Lorge, Fox, Davitz, & Brenner, 1958; Shaw, 1932; Thomas & Fink, 1963). One phenomenon within this area that has recently received considerable attention is *social loafing,* where social loafing refers to the "decrease in individual effort when performing in groups as compared to when they perform alone" (Latané, Williams, & Harkins, 1979, p. 822). In line with Steiner's (1972) discussion, this effect has generally been explained as due to either coordination or motivation losses, or to both.

Contemporary work on social loafing was initiated by Ingham, Levinger, Graves, and Peckham (1974). They in turn were stimulated by data attributed to Ringelmann in Moede (1927). The importance of Ringelmann's work for the group performance area in general and for social loafing in particular is well illustrated by the title of the Ingham et al. (1974) article, "The Ringelmann Effect: Studies of Group Size and Group Performance." Ingham et al. (1974) bemoaned the fact that "Apart from Moede's summary description, we have been unable to find any additional information about the Ringelmann study despite its widespread citation in American literature on group performance" (p. 372). Indeed this study has been widely cited during the past few decades. The chapter that apparently introduced Ringelmann's work to English-speaking researchers was written by Dashiell (1935). Subsequently, Steiner (1972) devoted several pages to it in his excellent and influential monograph. Largely due to the important works of Dashiell and Steiner, and to Moede (1927) from which they drew their information, Ringelmann's work has been regularly covered in monographs and texts on small group behavior (e.g., Davis, 1969; Forsyth, 1983; Hare, 1976; Zajonc, 1966).

In the secondary source, Moede (1927), Ringelmann's results were given in a small figure with the name *Ringelmann* in parentheses at the end of the figure caption. There is no citation and no mention of Ringelmann in the text. Furthermore, Moede consistently used the word *we* when discussing the results. There seems to have been a general assumption that Ringelmann was a German psychologist (e.g., Zajonc, 1966, p. 102), possibly Moede's student (e.g., Ingham et al., 1974, p. 371), who gathered his data in the 1920s (e.g., Steiner, 1972, p. 32). It has also been stated that Ringelmann never published his study (Latané et al., 1979, p. 822). These inferences were quite reasonable given the manner in which Moede (1927) presented Ringelmann's results.

However, Kunze and Schulhof (1925, p. 171) wrote, "In [reference] Ringelmann has already reported on experiments that fall in this area. The research results that are reported there, and that have already been widely taken over in the German literature . . . ."[1] This suggests that Moede failed to cite Ringelmann because no citation was needed: Moede's readers were already well acquainted with the study.

Max Ringelmann was a French agricultural engineer, not a German psychologist. His data were not collected in the 1920s, but rather between 1882 and 1887. As Moede was not born until 1888 (Marbe, 1938), it is clear that Ringelmann was not his student. Furthermore, Ringelmann's 1913 research report contains much information that Moede (1927) did not mention.

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All quotations from French and German sources are given in English in the text—translated by the present authors—and in the original language in Footnotes 1 and 3-10.

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[1] "In [reference] berichtet Ringelmann bereits über Versuche, die in dieses Gebiet fallen. Die dort beschriebenen und vielfach auch schon in die deutsche Literatur übernommenen Ergebnisse dieser Untersuchungen. . . ."

The remainder of this article will be devoted to a discussion of Ringelmann's work, particularly Ringelmann (1913b). We describe this study in detail because we think it is important and we suspect that it would be difficult for most interested readers to obtain and/or read the original report.[2]

Ringelmann and His Research

At the time of his 1913 article, Ringelmann was a professor of agricultural engineering at the French National Institute of Agronomy and director of the Machine Testing Station. He was also a member of the exclusive French National Society of Agriculture.

Ringelmann's interest lay in determining the relative efficiency of work furnished by horses, oxen, men, and machines in various agricultural applications. His work on horses and oxen began in 1881 when he was still a student. Ringelmann (1907) reported some studies on oxen in an article that also contains a long discussion of general factors relevant to the efficient performance of animals. Ringelmann (1913a) is an example of his tests of agricultural machinery. In each case, his concern seems to have been the following: Which machine, method, or animal type is most efficient in actual use? He did not draw sharp distinctions between animate and inanimate sources of power, and within animate sources hardly distinguished men from animals. This focus on efficient performance predated the scientific management movement developed by Gilbreth (1914), Taylor (1911), Moede (1920), and others; and Ringelmann's work obviously influenced Moede.

Ringelmann (1913b) is a report of research on human workers carried out primarily between 1882 and 1887 at the agricultural school of Grand-Jouan. Thus this may be considered the first social psychological experiment, although it was published well after Triplett (1898). Ironically, his subjects were enthusiastic male student volunteers. Ringelmann (1913b) focused on maximum performance as a function of the method that the worker used to push or pull a load horizontally; that is, it was human factors research. Comparison of individual and group performance was only a secondary interest in the report.

The report consists of a discussion of 8 preliminary and 26 primary series of investigation, where each series is equivalent to what we would now call an experimental condition.

Before discussing the preliminary series, Ringelmann presented normative data on human dimensions and on certain aspects of human performance that had previously been gathered by Quetelet and Galton. He then gave comparable information about a subset of his subjects so that the reader could compare them to the normative data.

The preliminary tests consisted of eight series in which the subjects pulled horizontally on a rope. The rope was 5 m long. (This is explicitly stated only in the discussion of Series A, but we assume that it was true in all eight series.) The track was a garden walk of well-beaten earth covered lightly with small fragments of schist. Here and later it is unclear whether Ringelmann encouraged, discouraged, or simply ignored the possibility of competition among the subjects. For a few tasks Ringelmann asked the subjects to maintain a maximum pull for 4 to 5 s, but his primary variable, which is the measure that concerns us, was the momentary maximum force exerted. This force was measured with a recording dynamometer. The manner in which the dynamometer was anchored and in which it was attached to the rope being pulled by the subject was not specified. Before the actual experimental tests, Ringelmann carried out unspecified preparatory tests to make sure that his subjects were in the proper frame of mind.

Series A related maximum momentary effort to subject weight and to maximum sustained effort. As we are concentrating on the social psychological rather than on the human factors aspects of this research, this series does not concern us. The position used by the subjects in Series B through H was probably that shown in Figure 1a. (This figure was actually presented in the discussion of the primary series, but the description of the task it represents is exactly the same in primary and preliminary series.) In Series B, each of the 14 male subjects pulled alone. In Series C, 7 of these 14 subjects pulled together as a group, and in Series D the remaining 7 subjects pulled as a second group. Series C and D were run after completion of Series B, permitting a fatigue effect. But Ringelmann allowed ½ hr after B before beginning C, probably precisely to reduce fatigue. (Here and later Ringelmann was careful to control errors in his conclusions that could arise through differences among subjects or differences among days, and as a result was forced to accept the confound of fatigue.) Series E, F, and G were replications of Series B, C, and D, with a different set of 14 male subjects. Finally, after another rest this second set of subjects pulled together as a 14-man group (Series H). In all of the group series, the subjects attempted to pull simultaneously on command, another example of Ringelmann's careful attention to control.

Ringelmann presented all of the individual and group data, some of which are repeated in Table 1. If we consider mean individual performance—rather than summed performance—over all 28 subjects, the mean force per individual was 85.3 kg when they pulled alone, 65.0 kg when they pulled in 7-man groups, and 61.4 kg when they pulled in the 14-man group. A t test indicates that the difference between the individual and 7-man-group conditions was not significant, $t(3) = 3.015$, $p = .0570$, although we assume that this was due to the lack of power. Ringelmann (1913b) presented no statistical tests, but he did verbally compare the mean performances in the different conditions. (The first article on Student's t appeared in 1908 [Kirk, 1982, p. 55]; there is no reason for the test to have been in common usage in 1913.)

Ringelmann (1913b) explained the decrease in performance with increasing group size as being due to coordination loss: "the lack of simultaneity of their efforts" (p. 9).[3] Related to this issue, he presented a table "summarizing a great number of findings" (p. 9).[4] This table is repeated in Table 2 and includes the data that have been discussed by Moede (1927) and various other authors during the past 7 decades. Note that total performance asymptotes at size 7. Ringelmann pointed out that the efficiencies of his 7-man groups ranged from .63 to .83, whereas the figure given in Table 2 is .56. He explained this difference by stating

[2] We will be happy to send a photocopy of Ringelmann (1913b) at cost to interested readers.

[3] "manque de simultanéité de leurs efforts."

[4] "résumant un grand nombre de constatations."

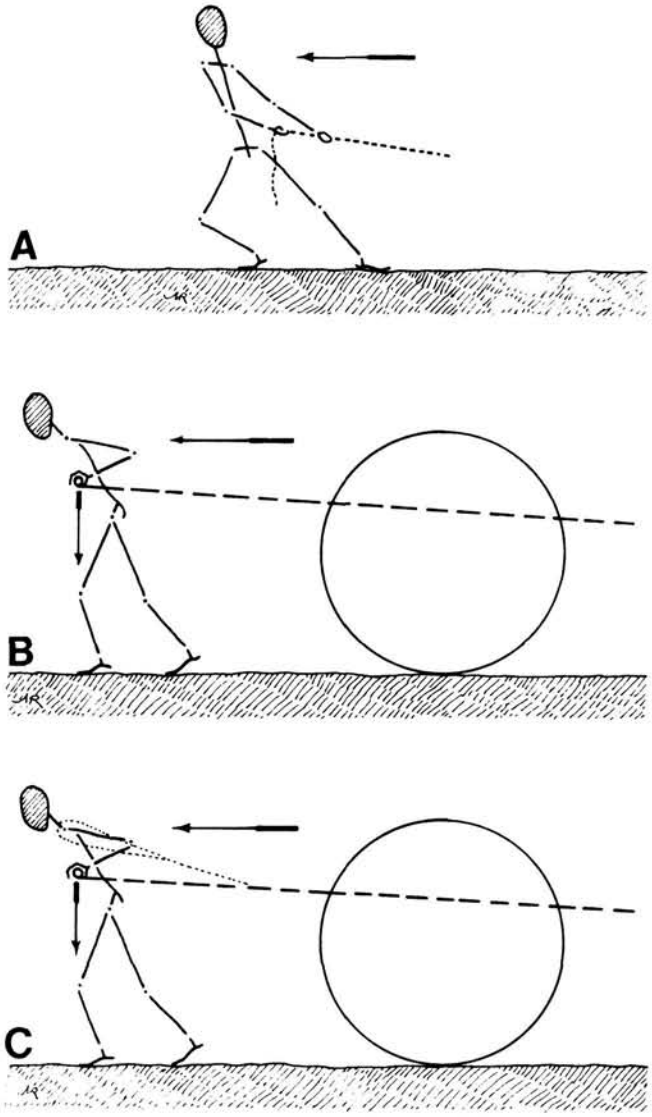

Figure 1. Positions used by subjects in Ringelmann (1913b).

that "it is necessary to take account of the fact that, in our tests, the students put all their attention into acting simultaneously on command, a condition which is not encountered in practice in

Table 1
Results of Individual and Group Conditions in Preliminary Series

Individuals	Individual efforts (sum)	Group effort	Ratio of group/individual
01–07	764.0	480	.628
08–14	516.0	432	.837
15–21	533.7	435.4	.815
22–28	575.5	471.2	.818
15–28	1109.2	858.9	.774

Note. These are the data as presented by Ringelmann (1913b). Effort exerted is given in kilograms. Note that the number of significant digits given varies, and in two cases the group/individual ratio is off by .001.

Table 2
Relative Performance as a Function of Group Size

No. of workers	Work usable in practice (relative figures): Furnished per worker	Work usable in practice (relative figures): Total
1	1.00	1.00
2	0.93	1.86
3	0.85	2.55
4	0.77	3.08
5	0.70	3.50
6	0.63	3.78
7	0.56	3.92
8	0.49	3.92

Note. This table is a translation and copy of the table given on page 9 of Ringelmann (1913b).

work" (p. 9).[5] This implies that the data given in Table 2 are drawn from a number of uncontrolled field studies or observations. Note that Ringelmann did not specify the tasks on which the data in Table 2 are based. This is inconsistent with the statement by Moede (1927)—and thus all subsequent writers—that these data were based on rope pulling. Also note that Moede and subsequent authors have given only the data from group sizes 1, 2, 3, and 8. Unfortunately Ringelmann (1913b) provided less information about these data than about any other data discussed in his article. It is ironic that it has been precisely these data that have had such a profound impact on social psychology.

Ringelmann explicitly stated that similar performance decrements had been observed in draft animals, although he gave no references. He then gave other examples in which the effect had been observed, as with men turning cranks to operate a machine or in animals harnessed to a roundabout (mill). He also mentioned that men have attempted to reduce the effect in some tasks by singing to coordinate their efforts.

Ringelmann did discuss one example of reduced productivity explained by motivation loss—one in which prisoners provided the motive power for a flour mill. He reported that "the result was mediocre because after only a little while, each man, trusting in his neighbor to furnish the desired effort, contented himself by merely following the movement of the crank, and sometimes even let himself be carried along by it" (p. 10).[6] But Ringelmann's common interest in men, animals, and machines led him to focus on coordination loss rather than motivation loss as an explanation for the performance decrement, especially as he knew that similar drops in performance occurred with inanimate sources of power. (He cited supporting data drawn from observations of multicylinder combustion engines, in which larger engines produced less power per cylinder.)

[5] "il faut tenir compte que, dans nos essais, les Élèves ont mis toute leur attention à agir simultanément au commandement, condition qui ne se rencontre jamais pratiquement dans les travaux."

[6] "le résultat a été médiocre parce qu'au bout de peu de temps, chaque homme, se fiant sur son voisin pour fournir l'effort voulu, se contentait de suivre seulement le mouvement de la manivelle, et quelquefois même de se laisser entrainer par elle."

Ringelmann (1913b) then turned to the primary focus of his article. These 26 series were run sequentially on a single day in 1883, and the subjects were 20 male students who "very much wanted to take part in these tests" (p. 11).[7] Ringelmann explicitly stated that he used the same subjects on the same day as a form of experimental control.[8] The object of these series was "finding out what efforts a man can supply under different conditions of work" (p. 11).[9] The 26 series involved pulling a rope with and without a crosspiece, pulling with a harness, pushing or pulling on the crossbar or shafts of a small hand cart (sometimes also with a harness), pulling and pushing a wheelbarrow, and pushing a low platform cart that resembled a mining cart. In no case did Ringelmann explicitly state how the dynamometer was anchored or how it was attached to the rope or vehicle that the subjects were attempting to move. Most of these series can best be considered human factors research and do not concern us here. In each case, Ringelmann rank ordered the methods of accomplishing a task based on their efficiency in his study. The four series that dealt with individual–group differences are discussed shortly. Before presenting his results, Ringelmann gave the heights and weights of his subjects for comparison with the normative data previously given.

In Series 8 and 13 the subjects pushed at a crossbar that connected the shafts of a two-wheeled cart (see Figure 1b). A weight of 8.5 kg was attached to the crossbar to represent a slightly off-balance load on the cart. In Series 8 the subjects pushed alone, and in Series 13 they pushed in dyads. Ringelmann did not explicitly state how the 2 subjects were placed, but as the cart (one of the fire engines of the school) was normally moved by two men, they were probably side by side. Ringelmann presented all of the data of the individuals and dyads, and these data are repeated in Table 3. A t test indicates that the difference between the two series is significant, $t(9) = 2.637$, $p = .0271$. The mean force of the dyads (143.2 kg) was less than the mean sum of the dyad members pushing alone (160.8 kg).

In Series 11 and 14, the position shown in Figure 1c was used. Note that the only difference between Positions 1b and 1c is the addition of a simple harness in the latter case. The same two-man cart from Series 8 and 13 was used. The loading of the crossbar was 18.5 kg when the subjects pushed alone, but only 8.5 kg when they pushed in pairs. Thus it is not strictly appropriate to compare these two conditions. Note, however, that the expected effect of this confounding is directly opposed to the obtained superiority of the individual condition. In addition, crossbar loading seems to have made little difference. Ringelmann used three different loadings with the position shown in Figure 1b (Series 8, 9, and 10), and loading had no significant effect: Loading = 8.5 kg, force = 80.4 kg; loading = 12.5 kg, force = 79.7 kg; loading = 18.5 kg, force = 83.5 kg; all differences *ns*. Although Ringelmann discussed the difference between Series 11 and 14 in the text, he did not present the data together in the appendix as he did for Series 8 and 13. Thus he may well have been cognizant of the confounding caused by the different loading. In any case, the results of Series 11 and 14 are given in Table 4. Once again a t test indicates a statistically significant difference, $t(9) = 2.686$, $p = .0297$. The mean force of the dyads (154.1 kg) was less than the mean sum of the dyad members pushing as individuals (170.8 kg).

Table 3
Individual Versus Dyadic Performance Using the Position of Figure 1b

Individual performance			
Subject 1	Subject 2	Sum	Dyadic performance
60.0	114.0	174.0	180.0
85.2	79.2	164.4	120.0
97.2	78.0	175.2	174.0
72.0	81.6	153.6	156.0
84.0	78.0	162.0	132.0
54.0	72.0	126.0	140.4
78.0	88.8	166.8	144.0
78.0	102.0	180.0	152.4
78.0	86.4	164.0[a]	122.4
72.0	69.6	141.6	110.4

Note. These data are adapted from Ringelmann (1913b, pp. 34 & 36). Effort exerted is given in kilograms.
[a] Note that the sum of the individual performances is incorrect here.

Ringelmann (1913b) clearly explained these results in terms of coordination losses:

> In comparing the series XIII and VIII, as also the series XIV and XI, one verifies what we have shown above: when several sources of motive force work simultaneously on the same thing, the utilizable force of each is less, with the same fatigue, than if the sources of motive power function separately. We have seen that this is due to the lack of simultaneity of the muscular contractions of the individuals. (p. 19)[10]

Note the point about "with the same fatigue." Again it is clear that Ringelmann was aware of the importance of experimental control, and he tried to have his subjects attain the same level of fatigue in each series.

In summary, in 1913 Ringelmann reported on research dealing with individual versus group performance that he had completed 3 decades previously, and explained the results in terms of coordination loss. He was aware of the possibility of motivation loss but did not consider it likely in his research. We found Ringelmann's understanding of the importance of experimental control to be remarkably sophisticated in today's terms.

It is unfair to judge Ringelmann's research by standards that developed slowly during the century after it was completed. We have pointed out places where his procedures do not meet current standards, simply because the modern reader will find this information relevant. We also pointed out that Ringelmann left unspecified important information about his procedures. We

[7] "Ont bien voulu prendre part à ces expériences. . . ."

[8] "Pour obtenir des chiffres comparatifs, il nous fallait expérimenter dans *la même journée* sur un grand nombre de *mêmes moteurs*."

[9] "de chercher les efforts que l'homme peut fournir dans différentes conditions de travail."

[10] "En comparant les séries XIII et VIII, ainsi que les séries XIV et XI, on vérifie ce que nous avons exposé plus haut: lorsque plusieurs moteurs travaillent simultanément sur la même pièce, l'effort utilisable de chacun est plus faible, avec la même fatigue, que si les moteurs fonctionnaient séparément. Nous avons vu que cela est dû au manque de simultanéité des contractions musculaires des individus."

Table 4
Individual Versus Dyadic Performance Using the Position of Figure 1c

Individual performance			
Subject 1	Subject 2	Sum	Dyadic performance
73.2	121.2	194.4	174.0
98.4	81.6	180.0	138.0
98.4	79.2	177.6	180.0
84.0	75.6	159.6	162.0
73.2	96.0	169.2	158.4
78.0	90.0	168.0	168.0
97.2	73.2	170.4	175.2
96.0	94.8	190.8	145.2
76.8	81.6	158.4	120.0
60.0	79.2	139.2	120.0

Note. These data are adapted from Ringelmann (1913b, pp. 35–36). Effort exerted is given in kilograms.

have the impression that he did so either because he assumed that his readers would know the information without its being given, or because he assumed his readers would trust him to have used the proper procedures. Ringelmann's methodological sophistication is consistent with the importance of agricultural research in the original development of research techniques (Kirk, 1982, p. 9). Note that when Ringelmann collected his data, Karl Pearson was in his mid 20s and R. A. Fisher had not yet been born.

Ringelmann's work is still relevant to contemporary theory and research. The connection to Steiner's (1972) conceptualization is obvious, and not accidental. As Steiner pointed out, Ringelmann's (1913b) research dealt with additive tasks and illustrates the principle that actual group productivity equals potential productivity minus motivation and coordination losses.

Ringelmann's research is most closely linked to the contemporary research on social loafing, which it inspired. An interesting difference between some of Ringelmann's data and current social loafing results is the shape of the function relating mean individual performance to group size. Current research has obtained a curvilinear relation (e.g., Ingham et al., 1974; Latané et al., 1979), as did Ringelmann in his preliminary series (see Table 1). But the data from Ringelmann that have been cited over the years exhibit a linear relation (see Table 2), consistent with other early research on group performance (Köhler, 1927), but inconsistent with current data and theories about group effects (Latané, 1981; Mullen, 1983). Unfortunately we know so little about the conditions under which the data in Table 2 were gathered that it is impossible to use them to evaluate contemporary theories. For example, we don't know how many other people (nonworkers) may have been present. In addition, competition or any other factor that could eliminate social loafing might well lead to a linear rather than a curvilinear function. Rather than use Ringelmann's data to evaluate contemporary research and theories in detail, we prefer to let them stand on their own. They have had a long-term impact on social psychology, and that suffices.

Ringelmann (1913b) provided all of the data of all 26 primary series in an appendix. If we recall the length of time this article has been lost to sight and that the only data from it that have been cited are also those about which he provided the least information, there is a terrible irony in his expressed reason for giving the raw data:

> We thought briefly of suppressing all these tables giving the individual figures ascertained for each [subject]; we abandoned the idea in case others should take up this research in order to continue it; it might then be interesting to know what each [subject] supplied under each of the conditions of work in which he was placed. (p. 12)[11]

[11] "Nous avions un instant pensé à supprimer tous ces tableaux donnant les chiffres individuels constatés sur chaque moteur; nous avons abandonné l'idée pour le cas où d'autres reprendraient ces recherches pour les continuer; il pourrait être alors intéressant de savoir ce que chaque moteur a fourni dans chacune des conditions de travail où il a été placé."

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